Life through a mathematical lens: Building parental awareness of home numeracy practices through photography

by

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Abstract

The home is a rich site for mathematics exploration, communication and discovery and parents play an invaluable role as their children’s first math teachers. However, literature suggests that parents do not often realize the mathematics in which their children engage at home (Beningno & Ellis, 2008; Tudge & Doucet, 2004; Warren & Young, 2002; Winter, Salway, Lee, & Huges, 2004). Pound (1999) highlights that unless children’s everyday activities are viewed with a mathematical lens the mathematics may go unnoticed. This study, grounded in the theoretical framework of numeracy as a social practice, examines the ways in which parental awareness of home numeracy experiences may be enhanced through photography and the photo interview. These methods have been frequently used in examining literacy practices and it seems reasonable that photographs may provide a language of inquiry for numeracy practices.

Four parent dyads of prekindergarten to kindergarten aged children participated in two photo assignments where they were invited to capture events where their children were engaged in mathematics. Each assignment was followed up by a photo interview where parents were invited to discuss the mathematics being portrayed in photographs. An exit interview was conducted to allow parents to share what they learned from the experience. All parents pointed to an increased awareness of mathematics in the home. These results suggest that strategies such as used here foreground math for the parents and heighten their sensitivity to it.
Preface

This research was approved by the Behavioural Research Ethics Board at the University of British Columbia (ethics certificate number H09-01566).
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1 Introduction

It all started with a scrapbook

While browsing through a friend’s scrapbook, I noticed a full four-page spread dedicated to photographs of her two-year-old daughter stacking cans in the kitchen. When I asked why she included these photos in her scrapbook she replied that she just found it interesting how every day for about a week, her daughter would toddle into the kitchen, open up a cupboard, pull out some cans and start stacking. Each photograph documented how her daughter persevered with the task to make the sturdiest tower possible. Although she faced failure (her mother shared that the tower tumbled several times) with persistence she finally stacked the cans to construct a very stable tower. I was amazed at the amount of mathematics portrayed in the photographs. It was evident that the two-year old was grappling with some pretty sophisticated mathematical concepts – comparing sizes of circles and exploring symmetry. More importantly, she was employing problem solving strategies such as trial and error. When I noted that her daughter was quite the little mathematician, my friend replied “I didn’t realize she was doing math, I just thought it was interesting!”

After the brief conversation, we continued to look through the scrapbook. However, this time, the mother would stop and note if something mathematical was being portrayed in a photograph. It seemed as if our conversation had compelled her to look afresh at her family photographs with an eye toward mathematics. In reflecting on this event, I wonder how many “interesting” family photos actually show numeracy events. More specifically, in what ways can
conversations surrounding these photographs help raise parents’ awareness of the mathematics their children encounter everyday at home?

In the same way, I recall a similar experience when working with a family mathematics focus group. The purpose of this group was to review a list of math activities for a proposed family mathematics brochure. Our task was to review a list of activities in the home which contained mathematics such as sorting knives and forks, measuring laundry detergent or estimating the amount of time needed to run errands. The parents shared that they hadn’t realized the rich math activities their children engaged in at home. Afterward, they shared that they began to see the math in daily home activity. In this case, it seemed that simply discussing the types of math that could happen in the home encouraged parents to consider other experiences through a mathematical lens.

Likewise, after completing a family mathematics walk around the community, parents of elementary-aged children realized that math was situated within the everyday occurrences around their community such as the post office, gas station and playground. Some shared that they had even started to ask their children questions as they performed the commonplace activities around the community such as “If gasoline is $1.04 per litre, how much would it cost to fill our 40 litre tank?”

Considering these experiences, it was not that parents were unable to engage in meaningful mathematics with their child; it was that they were simply unaware of the rich mathematics they encounter on a daily basis. Rather, these everyday events were motivated by other needs and not teaching mathematics per se. In other words, they were not looking at these occurrences through a mathematical lens.
It has been argued that mathematics education begins at home. In this context, children engage in legitimate mathematical activities (Anderson & Gold, 2006), and become competent in home mathematics practices (Benigno & Ellis, 2008). Parents also play a key role in this informal yet vital process by facilitating mathematical learning and communication (Anderson, 1997). The value of home mathematical experiences is articulated emphatically in the words of Merttens (1999), “what happens before the child gets to school has an [effect] which reverberates throughout the rest of that child’s educational career” (p. 79).

Beningno and Ellis (2008) emphasize that much of young children’s exposure to mathematics “does not occur during explicitly didactic interactions, but rather while participating in routine cultural activities such as mealtime, shopping, household chores and play” (p. 294). Unfortunately, these informal home activities may not mirror the formal mathematics children encounter in school. Moreover, they do not resemble the mathematics most parents encountered in their formal schooling; hence, parents may not interpret these informal math activities as anything other than playing (Tudge & Doucet, 2004). In contrast, parents are more adept at recognizing an activity as literacy related (i.e. reading, writing, and speaking) and thus are “more likely to intervene and expand upon literacy activities than those dealing with mathematics” (p. 24).

Winter, Salway, Lee, and Huges (2004) claim that parents are often unsure whether they possess any knowledge to assist their child’s numeracy development. Likewise, Benigno and Ellis (2008) acknowledge that parents often do not interpret activities as “opportunities to teach their children about number” (p. 294).

Although there has been a significant amount of research surrounding home literacy practices, “there is still a long way to go when it comes to maths” (Merttens, 1999, p. 88). Tudge
and Doucet (2004) emphasize that “little research to date has focused on the everyday, naturally occurring mathematics activities in which children engage” (p. 34). Benigno and Ellis (2008) also highlight that the mathematics in which children engage outside of the school with their parents is under-researched and possibly undervalued.

The current study aims to address the gap in literature pertaining to home numeracy practices; more specifically it concentrates on parental awareness of numeracy experiences in the home. As suggested by the literature (Benigno & Ellis, 2008; Tudge & Doucet, 2004; Warren & Young, 2002; Winter et al., 2004) parents often do not realize the mathematics embedded in their children’s everyday activities. Pound (1999) explains that unless children’s everyday activities are viewed with a mathematical lens, the mathematics may go unnoticed and seem frivolous - like the mother who perceived her child’s work with stacking cans as “interesting” without noticing the mathematical concepts her daughter was exploring.

Informed by Pound’s (1999) notion of the mathematical lens and my personal experiences, I examine the ways in which photographing children engaged in everyday ‘mathematical’ events, in conjunction with parent-educator conversations about these photos, can assist parents in “seeing” the math in their children’s everyday activities.

This study is grounded in the theoretical framework of numeracy as a social practice (Baker, 1996; Baker & Street, 2001; Baker, Street, & Tomlin, 2003, 2005; Boaler, 2000). Within this theory, numeracy is conceptualized as a social practice that is neither acultural nor value-free (Baker, Street, & Tomlin, 2005). Numeracy as a social practice closely parallels the work carried out under the framework of literacy practices. One of these parallels lies in the “adoption of the concepts of numeracy events and numeracy practices as analogous to literacy events and literacy practices” (Baker, Street, & Tomlin, 2005). Shirley Brice Heath (1982)
characterized the term *literacy event* as “any occasion in which a piece of writing is integral to the nature of the participants’ interactions and their interpretive processes” (p. 93). Street (2000) expanded on this concept by identifying the term *literacy practice* as a means of describing the values, beliefs and conceptions surrounding an event. Street contrasts literacy events and practices by emphasizing that one could take a photograph of a literacy event but not a practice. A literacy event is thus an occurrence or act where literacy is integral. Similarly, a numeracy event is an act where numeracy or mathematical thinking is central. Literacy practices include not only literacy events, but also their underlying culture, values and beliefs (Hamilton, 2000; Street, 1993). Likewise, numeracy events are undergirded by numeracy practices. For purposes of this study then, photographs may capture numeracy events – snapshots of a moment in time where numeracy was at the centre of the activity being portrayed. The photo interviews, conversations with parents where the photographs (i.e., numeracy events) are described, should bring to light the numeracy practices surrounding the event. Cappello (2005), who has made use of the photo interview in literacy research, notes that photo interviews are a viable means of exploring parent perspectives and understandings surrounding home literacy practices. It seems reasonable, then, that the photo interview could also be a powerful tool for mathematics educators and researchers.

In this study I investigate the ways in which the photo interview can enhance parental awareness of home numeracy events. Another goal of this study is to draw attention to how mathematics is embedded in the family context and how parents are invaluable facilitators of numeracy development. I therefore use the following research questions to frame my study:

1. In what ways can the act of photography and the corresponding photo interview assist parents in gaining insight into home numeracy practices?
2. What types of mathematics are parents aware of?
The following chapters chronicle my journey as a researcher in uncovering the answers to these questions. Chapter Two presents the current body of literature pertaining to family numeracy and situates this study within the theoretical framework of numeracy as a social practice. I also discuss current research methods for studying mathematics within the family context and introduce photography and the photo interview as an alternative means of data collection. Chapter Three introduces the participants of the study and provide detailed descriptions of the photography assignments and photo interviews. In addition, I describe my methods for data analysis. In Chapter Four, I present key findings from the study as well as secondary findings. Chapter Five provides space to situate and discuss the findings (Chapter Four) within the context of the theoretical framework (Chapter Two), and the analytic framework (Chapter Three). It also connects secondary findings to current literature.
2 Review of Literature

A child’s mathematical education begins at home long before he or she enters school and parents are a child’s first “teachers.” Anderson (1997) asserts that parents “who are neither mathematics teachers nor teachers can engage their children in activities” (p. 508) that lead to mathematical learning and communication. Naturalistic research by Baker, Street, and Tomlin (2003, 2005) reveals that the home is a rich site for informal mathematics learning. In addition, Anderson and Gold (2006) suggest that “children engage in legitimate mathematical activities” (p. 264) at home and within the community.

At the same time, these informal home activities may not mirror the formal mathematics children encounter in school. As a result, children often fail to connect their home numeracy practices to school or simply leave them at home (Anderson & Gold, 2006). In the same way, home mathematics practices may not be recognized as “mathematical” by the school. Too often, schools assume that there is a deficit of mathematics at home and some have even perceived the family as a threat to their children’s mathematics education (Sheldon & Epstein, 2005).

Researchers in the field of family literacy (Auerbach, 1995; Reys & Torres, 2007), argue that parents engage their children in literacy practices situated within the home culture. In their view, although these practices are different from school literacy they are not deficient. Such a critique of family deficit in mathematics education seems warranted. Baker and Street (2001) propose an “alternate view which sees the home as [a] possible site of rich educational resources” (p. 44). They believe that numeracy, like literacy, is a situated social practice that is deeply rooted within the home. Drawing upon Moll’s (1992) concept of funds of knowledge they
suggest that “instead of viewing underachievement in terms of deficit” (p. 43), schools should seek to understand and build upon informal and home numeracy practices.

Motivated to understand the kinds of mathematical interactions shared between parents and children, Anderson (1997) conducted a study with a group of 21 middle-class parents and their 4-year-old children. Each parent-child dyad was provided a “mathematics kit” including 50-60 multilink blocks, a book, paper, two pages from a trade preschool mathematics workbook and a pencil. Parents were asked to share the materials with their children on 4 separate occasions over a 48-hour period. In addition, they were asked to audiotape 15 minutes of each session and complete a 5-minute exit interview. The audio taped sessions were transcribed and mathematical interactions were coded according to a specific coding scheme. Anderson employed the term numeracy event to describe an interaction where a child or parent engages in a mathematical process or communication. The investigation confirmed that parents and children playfully “co-construct activities in which a variety of mathematics is verbalized with little intervention beyond the supply of selected materials” (p. 508). Moreover, the results supported previous research that “many children enter school having had a variety of experiences with mathematics and possessing considerable mathematical knowledge” (p. 508). Anderson cautions, however, that the study is limited in scope because it does not address the natural, everyday mathematical events that take place between parent and child. She suggests that further research under more “naturalistic conditions” (p. 492) is necessary to understand the extent of parent child mathematical interactions and home practices.

A more “naturalistic” investigation of home and school numeracy practices conducted by Baker, Street, and Tomlin (2005) considered the “meanings and uses for numeracy in school and community settings” (p. xx). The purpose of the study was to examine the relationships between
home and schooled numeracy practices and how these relationships may affect achievement in school mathematics. Researchers carried out field work in three communities in the United Kingdom: Mountford, a white working class neighborhood on the edge of a large town; Tarnside, a multi-ethnic and mixed socio-economic inner city neighborhood; and Rowan, an upper middle-class suburban neighborhood. The researchers followed three classes of children for the first three years of primary school. Individual case studies were also carried out with one child from each community. The study raises several issues, mainly that there needs to be a greater emphasis on acknowledging and valuing home numeracy practices. The authors assert that “[h]ome and school numeracy contexts are very different, and … we need to understand the extent to which the numeracy practices sited within them are different” (p. 17). The study also revealed the “importance of teachers building on students’ interests, experience, knowledge of mathematics and drawing on home based funds of knowledge of mathematics” (p. 167) so that students may develop stronger identities as learners of mathematics.

Anderson and Gold (2006) maintain that home mathematics practices are often overlooked by educators “especially when a child comes from a family background that differs from that of the teachers in social class, race or ethnicity” (p. 262). In addition they propose that the disjuncture between home and school numeracy practices may partially explain underachievement in mathematics. With these constructs in mind, they investigated “the ways in which numeracy activities and thinking are embedded in the social activities of children’s homes and community as well as the classroom” (p. 262) and how they contribute to mathematical identity. Four children from a Head Start classroom were chosen to participate in the case study. The study took place in an elementary school of a working class, African American neighborhood marked by signs of economic deterioration and violence in Philadelphia, PA. The
researchers observed four representative students in the classroom 14 times over a 13-month period. In addition, they conducted one after-school home visit where the children were observed and caregivers interviewed. These visits were supplemented by telephone and in-person conversations with parents and caregivers. The researchers also formally interviewed the head teacher and assistant to gather information on the program and teacher beliefs on mathematics learning. The results supported their initial claim that home mathematics practices are often overlooked or misinterpreted by educators. This is highlighted in the observation of 3-year-old Danny playing chutes and ladders at home and school. At home, Danny had devised a double-counting strategy so that he would always land on a “ladder” or avoid a “chute”. When he introduced this strategy at school his teacher perceived it as “cheating” whereas at home his grandmother described it as being “smart.” Anderson and Gold claim that these conflicting views could have a negative effect on Danny’s mathematical identity. At home, he was told that his strategy was intelligent and creative, thus contributing to a positive mathematical identity. At school his behavior was deviant, “thus Danny through introduction of his home practices, gained an identity of being a ‘cheater’” (p. 279). Lave and Wenger (1991) maintain that “learning and a sense of identity are inseparable; they are aspects of the same phenomenon” (p. 115). Through understanding and valuing home numeracy practices, schools can foster positive mathematical identities and perhaps greater success.

Several studies highlight the need for further empirical research in the area of home/family mathematics (Anderson, 1997; Anderson & Gold, 2006; Goos, 2004; Sheldon & Epstein, 2005; Warren & Young, 2002). However, several researchers point out potential obstacles in researching home mathematics; for example, González, Andrade, Civil, and Moll (2001) stress that mathematics is so embedded in the home culture that it is often problematic to
see the math. Likewise, Winter et al. (2004) revealed a lack of understanding of home mathematics in their work with four schools in the United Kingdom. The participants (both parents and teachers) expressed that they were unsure about whether they (the family) possessed any information or knowledge that may help their children in learning and understanding mathematics.

While reviewing this research, I am reminded of the conversation I had with a mother regarding the photographs she had taken of her daughter stacking cans. Was the can stacking not a mathematics event? Was her daughter not problem solving, sorting, classifying and comparing? The child was engaged in some form of mathematical exploration; however, the mother simply did not “see” the math in the situation. The issue of parental awareness of the mathematics their children engage in at home is rarely addressed in the literature. However, I believe that it plays a vital role in understanding home and family mathematics. Are there ways, then, in which we can assist parents in gaining awareness of the valuable mathematics they and their children already do?

2.1 Theoretical Framework: Numeracy as a Social Practice

Mathematics has often been regarded as a discipline that is abstract, de-contextualized, culture free and value free (Baker, 1996). In the past decades, however, several researchers have adopted an expanded view of mathematics, one which is more complex than just basic skills (counting, number operations) and procedures (algorithms). In this expanded view, mathematics is seen as a socially constructed practice and is “embedded in different relations and purposes” (Baker, Street, & Tomlin, 2005, p. 16) where the learner functions as part of a broader world (Boaler, 2000). Numeracy as a social practice closely parallels the work carried out under the
framework of literacy practices (see Hamilton, 2000; Heath, 1983; Street, 2000). One of these parallels lies in the “adoption of the concepts of numeracy events and numeracy practices as analogous to literacy events and literacy practices” (Baker, Street, & Tomlin, 2005). Shirley Brice Heath (1982) characterized the term literacy event as “any occasion in which a piece of writing is integral to the nature of the participants’ interactions and their interpretive processes” (p. 93). Street (2000) expanded on this notion by identifying the term literacy practice as a means of describing the values, beliefs and conceptions surrounding an event. Street contrasts literacy events and practices by emphasizing that one could take a photograph of a literacy event but not a practice. A literacy event is thus an occurrence or act where literacy is integral. Likewise, a numeracy event is an occasion in which a numeracy activity is integral to the nature of the participants’ interactions and their interpretive processes (Baker 1996). Literacy practices include not only literacy events, but also their underlying culture, values and beliefs (Hamilton, 2000; Street, 1993). Similarly, numeracy events are undergirded by numeracy practices.

2.2 Numeracy and Mathematics

In many cases numeracy is synonymous with mathematical literacy and is generally understood as a “competence in interpreting and using numbers in daily life, within the home, employment and society” (Brown, 2008, p. ix). The term numeracy is used mostly within the mathematics education community context, whereas it is still referred to as mathematics in the home. Winter et al. (2004) notes that mathematics is still the most prevalent term amongst educators, parents and children and “to all intents and purposes they [the terms numeracy and mathematics] have become synonymous within these contexts” (p. 61). Moreover, “[s]ome families do not recognize the word numeracy” (p. 61, emphasis mine). Baker, Street, and
Tomlin (2005) have outlined numeracy and mathematics as synonymous. However, they employ the term “numeracy” to “reflect the links with literacy” (p. 20).” For purposes of this thesis I will employ the term mathematics when I am communicating with parents and numeracy when analyzing the data and reporting findings.

2.3 The Mathematical Lens

Pound (1999) notes that unless activity is viewed through a mathematical lens the mathematics can go unnoticed and seem frivolous. Similarly González et al. (2001) note that mathematics is so embedded within the home culture that it is often problematic to see it unless “armed with a lens to focus on mathematics within households” (p. 120). From this stance, mathematics and numeracy is analogous to an operating system which underlies our day-to-day activity. For example, when asking a child to set the table, a parent’s primary intention may be to teach about sharing household responsibilities. However, the child is also grappling with the idea of sorting and classifying, counting and one-to-one correspondence. Hence, unless we intentionally put mathematics in the foreground, it is difficult to see that math is actually happening.

2.4 Observing Home Mathematics

What we know about home mathematics practices by and large depends on the methods used to collect data. While there has been an increased emphasis on understanding home mathematics practices, there remains a “relative dearth of research focusing on how much, and under what conditions, young children play with mathematical shapes, talk about time, estimate distance, and so on in the course of their typically occurring everyday activities” (Tudge, Li, & Stanley, 2008, p. 188). As Tudge and Doucet (2004) suggest, observing mathematical activity in
everyday activities like play is challenging because it occurs unobtrusively as a part of another activity. They contrast it to observing literacy which is usually more “visually apparent” and “may lend itself more readily to direct observation than . . . mathematics, an activity that may occur in more subtle ways” (p.24). Tudge et al. (2008) highlight and critique four commonly used means of collecting data on home mathematics practices: parental reports, researcher observations, audiotape and videotape.

Although parents are usually keen to participate in research, their reports of mathematical activities often miss a lot of the mathematics in which their children are involved. Mathematical experiences often go unreported because parents have other things to do than simply observe their children; moreover, parents may define mathematics differently than the researcher. Therefore, “experiences of which parents are either unaware or view as unimportant are left unreported” (Tudge et al., 2008, p. 24). Therefore, it seems that parental awareness of home mathematics greatly impacts what they are able to report.

It has been suggested that researcher observations have some advantages over parental reports mainly because they focus more on the mathematical activities in which the children are engaged. However, they often miss important details. Tudge et al. stress that these “methods are simply not sensitive enough to see the extent of young children’s math experiences, particularly those that are not the focus of the child’s attention” (p. 199). In other words, if mathematics is an operating system underlying the rest of our actions how can we tell if a child is engaged in mathematics if he/she is providing no visual evidence? For example, a child may be comparing quantities while playing with modeling clay; however, the mathematics may not be apparent.

Tudge et al. (2008) suggest that audio-recorded observations provide details missed in observation alone. Furthermore, data can be collected without observer obtrusion. However, it
misses non-verbal mathematics and action occurring around mathematical conversation. I also question the unobtrusive nature of audio taped observations. Although a researcher is not present, the presence of an audio recorder may be perceived as intrusive.

Tudge et al. (2008) suggest that videotape is “most clearly able to capture the extent to which math… occurs frequently and regularly in young children’s lives” (p. 192). Video data, however, may be as or more obtrusive than researcher observations. Likewise, it may still be difficult to decipher what mathematics is actually happening.

Based on my experience with my friend’s can stacking photos, I began to consider how photography may be used to investigate home mathematics events and practices. It seems that when parents take photographs, they choose which events to capture. Hence I argue that parent photographs and conversations surrounding these photographs may be a minimally obtrusive means of researching home numeracy experiences. That is, since parents are choosing which events to capture and discuss, they are controlling how much the researcher “sees.” However, it seems plausible that the act of taking photographs and the conversations surrounding these photographs may assist parents in seeing the mathematics they engage in with their child every day.

Bearing in mind the distinctions between numeracy events and numeracy practices (Baker, Street, & Tomlin, 2005), it seems that photographs may capture numeracy events – snapshots of a moment in time where numeracy is at the centre of the activity being portrayed. In contrast, conversations about the photographs (i.e., numeracy events) are needed to assess the numeracy practices surrounding an event. Hence, in this study, parents’ photographs captured numeracy events whereas the photo interviews provided opportunity to share numeracy practices.
2.5 Photography in Research

Photography may serve as a research method for getting an insider’s view of home numeracy practices in two ways: through parent-made images and photo interviews (Cappello & Hollingsworth, 2004). One of photography’s greatest strengths is its capability to function as a source of data in that the photos themselves document events and contexts. In addition, the photos can serve as a means of eliciting data such as in a photo interview where images are used “to guide conversations” (p. 444) when employed as a stimulus. The photo-interview is one of the most common uses of photography for qualitative inquiry and is especially useful when interviewing individuals who may have preset ideas about interacting with researchers. Photo elicitation (i.e., the photo interview) has been used in anthropology research for over half a century (see Collier, 1957) to “enrich and extend existing interview methodologies” (Collier & Collier, 1986, p. 99), yet it has not been widely used in the field of educational research.

Walker (1993) offers another advantage of visual information (i.e., photographs). He describes the medium as a “silent voice” for the researcher: another language we can use in constructing understandings and communicating them to others. Photography is offered as a researcher’s dialect for discussing complexities that cannot be sufficiently captured in oral or written language. If this can be the case for researchers then it seems reasonable it may serve in similar ways for participants in research. Recalling Tudge et. al.’s (2008) critique of parental reports, photography may offer parents a less time-intensive means of collecting data. Similarly, it may also shed light on some of the embedded mathematical activity.

For instance, Moss (2001) notes that photographs allow the researcher to “gain access to information we could not otherwise collect” (p. 281). Her study employed photography as a method of tracking how reading resources were made available in the home. She asked children
from 27 households to photograph everything they could find to read in the house and also who was reading. Participants were then interviewed and asked to describe what was happening in each photo. Moss highlights that photos in her study could be read in two ways: First, they record what literacy resources were available in the home. Second, and perhaps most importantly “the composition of the pictures, and their place in a longer sequence, does give some idea of what reading means to the participants in the photographs, both those who took them and those who were featured in them” (p. 283). In addition to representing home-reading practices, the photographs provided a glimpse of how “reading was embedded in the ebb and flow of everyday activity” (p. 281). Could photographs also provide glimpses of how numeracy is embedded in the ebb and flow of everyday activity? In other words, could photographs provide a window onto home numeracy practices?

Moran and Tegano (2005) highlight that photographs have a capacity “to make visible much of what has been taken for granted about teaching and learning” (p. 2). In addition, they advocate that photography is a powerful language of teacher inquiry, through generating communication and developing new ways of knowing. Drawing examples from their collective research with teacher inquirers, Moran and Tegano propose that photography functions in three ways: (1) representational, (2) mediational, and (3) epistemological. “The representational function of photography is about creating meaning” (p. 8); photographs are imbued with meaning and may convey different meanings to different viewers. The value in multiple perspectives is that it is “through sharing diverse meanings that new understandings are co-constructed” (p. 3). Moran and Tegano provide an example of a conversation between a novice and master teacher where they are sharing perspectives on a class project. Photographs from the novice teacher’s class engaging in a mural project served as a springboard into the discussion.
Although both teachers had different perspectives on what was (or should be) happening, they were able to co-construct a plan of action for subsequent lessons. In addition, photography provides a “lens to focus the teacher's attention”—the lens mediates between the mind’s eye of the teacher and the essence of the teacher's intention” (p. 12). The teachers participating in Moran and Tegano’s study gained a greater understanding of their classroom literacy practices through conversations surrounding photographs they had taken in their classrooms. In reflecting on what was and was not taken, the teachers were able to question their own perceptions of classroom practices. The epistemological function of photography is the use of the photographs and photo elicited conversations as a source of new knowledge. “As such, teachers who use photography as a language of inquiry have a chance to continually construct [and co-construct] new understandings about children's learning” (Moran & Tegano, 2005, p. 15).

As in Moran and Tegano’s study of literacy, it seems reasonable that photographs may provide a language of inquiry for researchers/educators and parents to co-construct understandings of numeracy in the home. In addition, involving parents in the data collection helps lessen researcher influence, while providing a “lens” into the home practices. In turn, conversations around the photos offer opportunities for the researcher to hear parental perspectives. As such, the photo interview allows me to investigate the ways in which photography and photo interviews may assist parents in gaining insight into home numeracy practices.

In brief, mathematics is a social practice which is deeply rooted within the context of the home and family life. Often, without being aware of it, parents engage their children in rich, authentic and meaningful mathematics experiences as they participate in everyday activities. These experiences, or numeracy events, provide evidence for even more deeply embedded
numeracy practices. What we know and understand about these events and practices depends on the methods we use to collect data on home numeracy. In the preceding chapter, I sought to build an argument for photography and the photo interview as a means of increasing parental awareness of mathematics in the home, in other words, to help them look at life through a mathematical lens. The subsequent chapters will document my journey in discovering the ways in which photography and the photo interview invites parents to peer through that mathematical lens.
3 Methods

In this study, I sought to explore the ways in which photography can assist parents in “seeing” the math their children are engaged in on a daily basis. Through photography and photo interviews, I worked with parents to document their awareness of home numeracy events and underlying numeracy practices. More specifically, my main research questions are as follows:

1. In what ways can the act of photography and the corresponding photo interview assist parents in gaining insight into home numeracy practices?

2. What types of mathematics are parents aware of?

The study was a qualitative case study with parents of pre-kindergarten to kindergarten children in urban and sub-urban neighborhoods in Western Canada. Parents were invited to take photographs of their children engaged in everyday activities that they perceived as mathematical. In this respect, the parent collected the photo data for this study.

The previous chapter discussed the affordances and limitations of using photography and photo interviews in research. Perhaps the most appealing affordance of using photography is that it allows parents to actively engage in the research process. Cook and Hess (2007) highlight that photography allows “opportunities to engage with those who may not speak the language of researchers, of policymakers and officialdom” (p. 30). This is what initially drew me to the idea of using photography. Parents already play a vital role in their children’s numeracy education; hence, they can play an equally vital role in the research of it. Therefore, in this study, parents not only collected a portion of the data (i.e., the photographs), they also provided a narrative account of the photographs during the photo interviews.
3.1 Participants

For this study, I chose to recruit parents of kindergarten and pre-kindergarten children, since this is when most children are introduced to formalized mathematics instruction. Furthermore, in my experience as an educator, parents of kindergarten children are keen to keep an account of their child’s first year of school. After distributing letters of consent through two independent kindergarten schools and to families in the community at large over a period of four months, a small group (n= 4) of kindergarten parents or parent dyads volunteered. I decided to work with a smaller group of parents so that I could focus more intently on exploring the changes in their awareness of math in the home. Issues that were raised in this smaller group of participants could then be used to formulate new research questions for a greater range of participants. Two mother-father dyads participated and two mothers participated. Together, these four families had five children – one family had twins. Parents had professional backgrounds and lived in 4 neighbouring sub-urban centers in Western Canada. The families did not seem to have any connections to each other. In addition, all parents and children were Caucasian.

3.1.1 The Children\(^1\)

“Jack”

Jack’s mother, an early childhood educator, was the first to volunteer for the study. Jack was six at the time of the study and in his second semester of kindergarten at a public school in a sub-urban centre. He is an only child who lives with both parents but also spends a great deal of

\(^1\) Children were assigned pseudonyms for the duration of the study. These pseudonyms will be used to refer to children throughout this study.
time with his grandparents. Jack’s mother shared that he particularly enjoys learning the language associated with mathematical concepts.

“Amber”

Amber was five years old at the time of the study and was also in her second semester of kindergarten. She lives with her parents (both members of clergy) and older sister in a sub-urban centre and attends a public neighborhood school. Amber enjoys helping with household chores and disclosed to me her love of counting.

“Olivia”

Olivia is four-and-a-half years old and was starting kindergarten the following fall. She lives with her mother (a nurse), father and two-year-old brother in a sub-urban neighborhood. Her mother, a nurse, revealed that Olivia enjoys helping with household chores such as food preparation and has a love for counting.

“Max” and “Lily”

Max and Lily were the youngest participants. Almost four, they attended a Montessori pre-kindergarten program in a sub-urban neighborhood. They live with both parents and are just getting used to numbers and counting.

3.1.2 The Parents

Two mothers and two mother-father dyads participated fully in the study. The two remaining fathers could not participate in the photo interviews due to work commitments; however, there was evidence of their participation in photography and numeracy events.
3.1.3 The Researcher

In my seven years as a primary-elementary teacher I have encountered many parents who would label themselves as “innumerate” and unskilled (or unconfident) in helping their children with mathematics. Also, in an attempt to make mathematics relevant to the children I was teaching, I would often ask children to brainstorm for ways in which they “did” math outside of school. When faced with these challenges, students seemed to struggle to see where math fit into their day-to-day lives. These two trends led me to an interest in how mathematics happens in the home.

For the most part, primary-elementary education is often considered to be child-centred; however, I began to shift my thinking to consider the role family plays in math education. This led me to pursue several family-centred activities to help link “school math” to “home math.” Family math nights were well received by parents but they still seemed to introduce a brand of “school math” to the home. This led me to consider new ways to engage parents and children in mathematics, one of which being a family math walk around the community. In this activity, parents and children were provided a preset list of locations with corresponding math problems (e.g., identifying shapes at a playground, comparing prices at a grocery store, or estimating the cost of gas at a gas station). What struck me about this experience is that parents were quick to expand upon these problems and even create more on their own. After, parents commented that they felt compelled to look for more math in their day-to-day lives. When reflecting on these two experiences (the family math night, located at the school; and the family math walk, located in the community), I began to reconsider how I thought about family math. Although the family math night was well received, the family math walk happened in a context that was more
familiar to the parents. Likewise, it seemed to give parents the opportunity to start where they felt comfortable.

These experiences also helped me view the home and surrounding community as a rich site for mathematics communication, exploration and instruction and consequently led me to pursue studies in family mathematics.

3.2 Focus on Parent Voices

The primary goal of this study was to assist parents in seeing or identifying the mathematics in familiar everyday practices with their children. One of my main concerns, however, was how I could help raise parental awareness of their home numeracy practices without interjecting my “math educator” view. In essence, I did not want this to become an interventionist study. This concern led me to consider the research of Marta Civil and her colleagues (Civil, Andrade, & Anhalt, 2000; Civil, Quintos, & Bernier, 2003). Civil et al. (2000) worked with a small group of Spanish speaking women in a talleres matemáticos (mathematics workshops). Although she came to the group as a mathematics educator, she was not there to teach but rather converse with the women about mathematics. Drawing upon the work of Flecha (2000), Civil et al. grounded her study in the notion of dialogic learning – engaging egalitarian dialogue where different contributions are taken into consideration. In other words, through the talleres matemáticos, Civil and the women co-constructed a notion of home numeracy and worked together to identify the math in familiar household practices. Although I do not plan to engage parents in mathematical activities as in Civil et al. (2000, 2003) studies, I invited parents to share the mathematics they see in photographs of their children. Civil’s work made me consider how I should frame my questions during the photo interview so as not to impose my
view of mathematics, but to help parents create a clearer view of their conceptions of mathematics.

Like Civil and colleagues, my goal was to focus on parent voices and not my own – hence, I needed to ask questions that were specific enough to focus parents’ attention on the mathematics but general enough to prevent my view of mathematics from interfering. If, however, parents invited me to share my conceptions of the mathematics in the photograph, I delayed interjecting by asking them a specific question about a photograph (i.e., “you took a photograph of your child playing with modeling clay, how might that be mathematical?”). It was hoped that, this would further focus the parents’ attention on the math and help them extract their own view of the mathematics occurring in the photograph. In a sense, this was a co-construction and my contribution was to help parents see the math happening at home through asking see.

3.3 Method

Four interviews were conducted with each parent or parent dyad over a two-month period. Interviews took place in locations that were convenient for the parents and settings ranged from coffee shops to kitchen tables and staff rooms to family rooms. Interviews were audio-recorded and field notes were also written. To maintain a focus on parent voices during this process, scripted interview questions were specific enough to focus parents’ attention on the mathematics but general enough to prevent my view of mathematics from interfering.

There were instances where non-scripted questions arose. For example, there were occasions when I may have sought clarification or asked parents to expand on a certain issue. During the photo interviews I also asked further questions regarding aspects of the photograph that parents did not previously discuss or I inquired about what may have been happening before
or after the photograph was taken. As in my scripted questions, I was mindful to not interject my own interpretations.

3.3.1 Initial Interview

The purpose of the initial interview was to gain a sense of how the parents conceptualized mathematics and consisted of two core questions:

1. In what ways do you see your child engaging in mathematics at home?
2. In what ways do you and your child engage in mathematics at home?

Although quite similar, the former question invited parents to share how they think their child independently engages in mathematics at home; the latter aimed to address how parents and children engage in mathematics at home. If parents shared that they engage in “school-like” activities, I also asked if there are any other ways in which they engage in mathematics through everyday activities. At this point, as well as throughout the series of interviews, I took extra care not to share my “educator” views of mathematics but rather encourage parents to begin to identify mathematics in familiar practices. The overarching purpose of this interview was to assist parents in engaging with their mathematical lens.

3.3.2 Photo Assignment 1: Photographing Life through a Mathematical Lens

Toward the end of the initial interview, parents were invited to photograph twelve different incidents where they observed their children engaging in mathematics. If parents indicated that they do not see their children engaging in mathematics at home, I asked them to take photographs of whatever interests them. All parents indicated that they wished to use their
own digital cameras\(^2\) but were provided with USB memory sticks for storing the photos. This measure was taken to ensure safer transport of the finished photos to the researcher (rather than sending them electronically over the internet). Parents were given approximately two weeks to complete this assignment, after which we met for Photo Interview 1, during which we discussed four of these photos.

3.3.3 Photo Interview 1: Refining the Mathematical Lens

Before the photo interview, parents were invited to choose four photographs they wished to discuss. There were no specific criteria given for choosing the photos; parents were simply asked to pick photos they wished to share in detail. The chosen photographs were used as a springboard for discussion about home numeracy practices. Discussion around each photograph followed four interview questions:

1. What is happening in this photograph?

The intention of this question was to provide a general idea of events depicted in the photograph. It also allowed parents to share the context of where the photo was taken.

2. Why did you decide to take this photograph?

This question is intended to directly address why the photo was taken and the value of the photographed event.

3. What mathematics do you see happening in this photograph?

This prompt is intended to directly address the mathematics that is taking place in the photograph. It is meant for parents to share what they see – not what I see. While we discussed these aspects, I asked clarifying questions, paraphrased what the parents already shared or

\(^2\) If parents indicated that they did not own a digital camera, I would have provided one for the duration of the study.
pointed out specific aspects of the photo I wanted them to discuss further. However, I used this approach sparingly to ensure the utmost care was taken to keep my voice/views out of the discussion.

4. What other things could be mathematical in this photograph?

The purpose of this question was to encourage parents to look deeper into the photograph for any aspects of mathematics they may have missed on the first viewing.

The main purpose of the first photo interview, which lasted 30 and 45 minutes, was to help parents refine their mathematical lens.

3.3.4 Photo Assignment 2: Photographing Life with a Refined Mathematical Lens

As photo interview 1 concluded, I again invited parents to capture twelve more images of their children engaged in what they perceive as mathematical activities. This second photo assignment followed the same time frame as the first. Also, the USB, with the previous photos removed, was returned to the parents so that they could again store their images. No additional instructions were provided. In addition, a time and place for the second photo interview was arranged.

3.3.5 Photo Interview 2: Fine-Tuning the Mathematical Lens

This meeting lasted approximately 30 to 45 minutes. Once again, I took extra care not to share my perspectives on the mathematics in the photographs; I aimed to simply invite parents to share what they see. The interview followed the same format as the first photo interview, with no additional scripted questions. The focus of this interview was the same as photo interview 1 - to capture their awareness, with the intent that a comparison between the two interviews might capture a change in awareness
3.3.6 Exit Interview

A final 30 minute meeting was scheduled approximately two to three weeks after the second photo interview. At that time I asked parents to share if the photo assignments had helped them become more aware of the mathematics in which their children engage at home. The following two questions were used to frame this interview:

1. What did you learn from this experience?
2. Do you feel that you are more aware of the mathematics your child engages in at home? If so, please explain.

3.4 Data Sources

The audio tapings of all interviews (two photo interviews and initial and exit interviews) were transcribed verbatim in their entirety by the researcher. In addition, the photographs discussed by parents in the photo interviews were coordinated with the respective transcripts. Also, all remaining photographs saved on the USB served as data.

3.5 Data Analysis

3.5.1 Revisiting the Primary Research Question - In What Ways Can the Act of Photography and the Corresponding Photo Interview Assist Parents in Gaining Insight of Home Numeracy Practices?

To address my primary research question, transcripts from all 4 interviews were analyzed to see if parents explicitly disclosed any change in awareness through their discourse. The exit interview questions invited parents to share if they experienced a shift in how they “see” the math in everyday situations.
Bearing in mind the notion of mathematics events and practices, I analyzed each photo interview with an eye towards the types of math activities parents identified, and the domains of practice they described. I also focused on when parents disclosed information pertaining to their awareness. When reading the transcripts I kept a running tally of each math activity identified by parents. For the most part, I used the key words parents were using to describe the event (i.e., counting, measuring, sorting, classifying, etc.). There were times, however, when parents alluded to problem solving situations by using language such as “figuring out,” “strategy” and asking questions to “take it further.” I decided to code these events as problem solving, since the term problem solving is most commonly used in the field of math education and not by parents. With this analysis, I kept note of the parents’ reasoning behind the mathematics event, and where the event took place in the context of the home (which may speak to the underlying practice). After compiling an exhaustive list, I began to see a range of themes emerge from the contexts the parents were describing. I recorded these themes and categorized each instance that matched each theme. For example, if parents shared that their child uses a chore chart to learn responsibility, I categorized this as “teaching values”; if parents described a particular game, I categorized this as “game play.” Finally, I highlighted key instances where parents directly spoke to their level of awareness or how the study influenced them to intentionally seek out math experiences in the home.

Analysis of the two photo interviews provided insight into the home numeracy practices. Hamilton (2000) highlights that the literacy events captured in a photograph are “just the tip of the iceberg” (p. 18) and the underlying literacy practices can only be inferred. This assertion was assumed to hold true for numeracy events and practices. Through analyzing the parent
communication surrounding the visible traces of numeracy practices (i.e., the photographs) I documented the underlying home numeracy practices.

3.5.2 Revisiting the Secondary Research Question – What Types of Mathematics Are Parents Aware Of?

I also conducted a content analysis of the mathematics events portrayed and numeracy practices inferred in each photograph from both sets of photographs (including those shared by parents in photo interviews and not shared). For the most part, I used the key words that emerged from the interview transcripts. The aim of this analysis was to reveal which types of mathematics were more often captured by parents. For this analysis, I adapted the framework employed by Hamilton (2000) to analyze photographs of literacy practices. Hamilton analyzed newspaper images “[l]ooking for visual traces of literacy practices” (p. 32) focusing on what was seen (images captured in the photographs) and what was unseen (literacy practices inferred from the photographs). The visible and invisible elements of literacy events and practices were organized according to four criteria: participants, settings, artifacts and activities. These four criteria served as a starting point for my analysis of the parent photographs (Table 3.1).
3.1 Analytic framework for photographs

<table>
<thead>
<tr>
<th>Elements visible within <strong>numeracy events</strong> (These may be captured in the photographs)</th>
<th>Non-visible constituents of <strong>numeracy practices</strong> (These may only be inferred from the photographs)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Participants:</strong> The people who can be seen to be engaging in mathematical activity.</td>
<td><strong>The hidden participants:</strong> Other people involved in the social relationship of producing, interpreting and otherwise regulating the mathematical activity.</td>
</tr>
<tr>
<td><strong>Settings:</strong> The immediate physical environment where the mathematical activity is taking place.</td>
<td><strong>The domain of practice</strong> in which the event takes place and takes its sense and social purpose.</td>
</tr>
<tr>
<td><strong>Artifacts:</strong> The material tools that are involved in the mathematical activity</td>
<td>All of the other resources brought to the numeracy practice including non-material values, understandings, and ways of thinking, feeling, skills and knowledge.</td>
</tr>
<tr>
<td><strong>Activities:</strong> The actions performed by participants in the numeracy event</td>
<td><strong>Structured routines and pathways</strong> that facilitate actions; rules of appropriateness and eligibility – who does/does not, can/can’t engage in particular activities</td>
</tr>
</tbody>
</table>

Hamilton explains that visible literacy events can only be inferred from observable evidence (such as photographs) because they contain “invisible elements” (p.18) such as knowledge, feelings, values and social purposes. Literacy practices are even more evasive and are defined by knowledge the viewer brings. Hence, it is recognized that such an analysis provides secondary evidence to the first-hand information supplied by parents, the people with the most knowledge of the context in which the photographs were captured.

Since Hamilton’s (2000) analytic framework focused on literacy, I simply substituted the word “numeracy” for “literacy” and made no other modifications. Furthermore, photographs from the first assignment were compared to those of the second set. The aim of this analysis was to see if events captured in the second set of photographs differed from those in the first. However, it is acknowledged that reasons for differences between events captured in the first set
to those in the second set are speculative at best, since parents may have simply decided to photograph different activities or had different experiences. In the case of depicting a baking situation in the first set of photographs but not in the second set may be because the parent chose to depict another activity (since a baking situation was already shared) or the parents simply did not bake at the time of the second photo assignment.

Hamilton’s (2000) analytic framework also proved to be useful for answering my primary research question. For example, when analyzing the interview transcripts I took a special note of the activities parents described in each interview. Likewise, I was particularly interested in how parents interpreted the activities and disclosed information surrounding the domain of practice in which the event takes place. I interpreted the domain of practice as the social purpose of the activity. Since the domain of practice can only be inferred from a photograph, the parental account of the social context in which the activity was occurring was especially helpful in better understanding the underlying numeracy practices. Employing this aspect of analysis proved to be more helpful in discovering a change in awareness than simply analyzing the types of math identified.

While undergoing the critical analysis of the photographs, I struggled with the question of how the math I was “seeing” in the photographs was impacted by what the parents shared. I had taken so much care in keeping my interpretations silent that I found myself, in many cases, looking through the parents’ lens. Therefore, I shared the photos and my interpretations on occasion with my thesis advisor to ensure that I wasn’t missing any types of mathematics that could be happening or that I may have been “seeing” math based on the parents’ interpretation and not my own. My advisor acted as a critical friend who troubled my findings and encouraged me to reconsider my interpretations. Hence, I found myself revisiting, revising, and reflecting on
my analysis against the backdrop of the parents’ interpretations, Hamilton’s (2000) analytic framework, my advisor’s recommendations, and my own interpretations.

As I delved deeper into the transcripts and photographs, I realized that it was difficult to answer my primary research question without responding to the second. Hence, I began to explore how my secondary research question could help answer my first. I decided to achieve this by examining each set of interviews for the types of mathematics and their corresponding photographs. During this analysis, I depended on the parental accounts of what was happening and did not add any of my own interpretations of the photographs.

The strength of this study is that rather than analyzing photographs for the numeracy events an educator/researcher might see, parents were invited to contribute to share what they see. Furthermore, inviting parents to share what they see, on two separate occasions may help us determine if their lens towards the mathematics occurring at home is altered or sharpened so that they come to realize that the home is a rich site for mathematics learning.
4 Findings

When analyzing the data, I chose to explore each set of interviews in chronological order. The purpose of the initial interview was to acquire a sense of parents’ awareness of math in the home before they participated in the study. When I juxtaposed what the parents shared in the initial interviews to each subsequent photo interview, I sought to capture any change or lack thereof in parent awareness. More specifically, I analyzed parental discourse to document when and if parents suggested the ways in which photography and the corresponding photo interviews helped them become more aware of the math happening in the home. Hence, I have presented my findings so that the reader may get a sense of my journey toward answering my core research questions:

1. Can photography and photo interviews assist parents in gaining insight into home numeracy practices?

2. What types of mathematics are parents aware of?

The first part of this chapter focuses on each step of the study, from initial interview, through both photo interviews and finally to the exit interview. It also includes some discussion around my analysis of those photographs not mentioned in the photo interviews. The second part of the chapter centers around the key discoveries I made about how photo interviews and photography may assist parents in becoming more aware of mathematics in the home. Lastly, the chapter closes with findings emerging from my secondary analysis.
4.1 The Interviews

4.1.1 The Initial Interview

The initial interviews provided insight into parents’ initial perceptions and conceptions of math in the home. All parents shared that math is an integral part of home life and that their children do engage in mathematics in one form or another. Jack’s mother shared that it “is so embedded in so many things” and suspected that “people do it more than they realize they do”. She noted that “rather than sitting down and doing a [worksheet], let’s just mix it into common practice”. Likewise, Olivia’s mom indicated that most of the math at home was spontaneous and emerged from daily activities such as baking, cooking, shopping and playing. She also noted that it usually arises from her daughter’s interests. Max and Lily’s parents explained that they try to incorporate math into their daily interactions with their children in an attempt to get them to see the value of math. Similarly, Amber’s parents shared that math is a part of everyday family life and most incidents arise from performing household duties.

Parents shared that the opportunities to engage in math at home depends on realizing it and “taking it to the next level”. Olivia’s mother, for instance, recalled an incident where Olivia spontaneously said, “Mommy, I think we should all have two pets.” Because she was invited to participate in a study on math at home, she decided to press on and rephrased her daughter’s request in the form of a question, “If all four of us have two pets, how many pets would we have?” She added “we ended up adding 2 + 2 + 2+ 2 and then 4 + 4 to equal 8 with her fingers.” Similarly, Max and Lily’s parents indicated that they find themselves expanding on literacy experiences to incorporate mathematics. They will often ask their children to count the number of objects on a page while reading story books. Amber’s parents spoke about linking home and school through a “Math at Home” program established by Amber’s kindergarten teacher. They
explained that they find the activities helpful and have been intentional about incorporating them into their daily routine. Jack’s mother explained that she engages in math with her son primarily through “the encouraging of” exploring math. She added that she tries to use a lot of math language in her interactions with Jack.

These incidents suggest that parents see the value of integrating math into their everyday routines and attempt to connect it to real life situations. In a similar vein, all parents shared that they engage in intentional math instruction through educational videos and games. However, they all revealed that they probably put the least emphasis on intentional math instruction. Amber’s father noted that he was very intentional about literacy instruction but most of the math was unintentional. Max and Lily’s parents shared that they purchased a video that was recommended by another parent to help their children learn about numbers. However, their mother confided that she wasn’t “in love with it”. The father noted that it was “the only thing that we give them that’s intentionally educational” and that their (the parents) main focus was instilling the value that math is fun and “something we do”. Olivia’s father noted that he is more intentional than his wife when it comes to direct math instruction but often pulls the math from everyday practices (i.e., asking her to count her favorite books). Thus, even though his main intention may be to teach a mathematical concept, he integrates it into the “real” experience of counting her books.

4.1.2 Types of Math Identified by Parents in Initial Interview

While examining the initial interview transcripts, I discovered that parents shared that they engaged in a great deal of math with their child. Table 4.1 illustrates the types of math identified in the initial interviews. In the case of the initial interviews, I was interested in only
the types of math activities parents identified and not the frequency. Hence, although parents may have described several incidents of counting activities, I identified counting in the table only once. In addition, since I was investigating parental awareness, I decided to count Max and Lily as a single unit (since they had the same parents).

Table 4.1 Types of math activities identified by parents in initial interview

Parents identified fourteen math activities in which their children engaged which included concepts such as number sense, patterns, shape and space and data management. Interestingly, they made no mention of probability.
All parents and parent dyads identified counting and three identified number operations (mainly the process of adding and subtracting). Max and Lily’s parents explained that their twins love to count everything and that both parents encouraged this passion by asking them to count things around the house. Olivia’s mother noted that they do subtraction when they are counting down the days to a special event (a birthday or grandparent visit).

Measurement was also mentioned by three families within the context of baking and cooking. For example, Amber’s mother shared that she asks her daughter to measure ingredients when baking. Measurement was also described within in the context of distance. Jack and his mother discuss the concept of “how far” when they go on bike rides.

Likewise, sorting and classifying activities were mentioned by three of the four parents or parent dyads. Amber, for instance, enjoys sorting her books into categories and is especially keen on organizing groceries into bags (canned goods, produce, etc…), while Jack’s mother often finds him using different classification schemes to organize his toy cars. Max and Lily on the other hand are currently fascinated with learning their colours, and hence, often sort items (i.e. Easter eggs) according to colour. Thus, with the exception of Olivia’s parents, these families pointed to classification as an everyday mathematical activity in which children attend to various attributes of both household and play based items.

Geometry concepts such as identifying shapes and spatial awareness were mentioned only by Jack’s mother. And although two families shared that they use a chore/reward chart, only one identified the data management aspect of it. Likewise, three parents provided the example of working with the idea of “wholes”, “halves”, and “quarters” within the context of baking, but only one parent identified it as exploring fraction concepts.
There was evidence that the age of the children may have influenced the types of math in which they engaged. Number recognition, the act of recognizing and identifying numbers in the environment was noted as the most frequent mathematical activity engaged in by Max and Lily, the youngest participants. Jack, the oldest participant seemed to engage in the greatest variety of math.

Another influence may be parents’ professional backgrounds. For instance, Jack’s mother noted that her education and experience in Early Childhood Education may have made her more aware of the math that could be happening. She drew on the specific example of setting the table and noted that it’s very easy to see the counting aspect: “we have four [people] at the table so we need four spoons”. However, “a lot of people may look at [an activity] as adding and subtracting and not see the geometry and spatial awareness” (referring to the way the table is set).

Problem solving was implied by two parents but only Olivia’s mom identified it in the interview when recalling the incident where Olivia told her that everyone in the family should have a pet. She reframed her daughter’s request using school-like problem solving language: “If all four of us have two pets, how many pets would we have?” She then helped her daughter add $2 + 2 + 2 + 2$ to find the solution. Jack’s mother described problem solving as “encouraging” the exploration of math. For example, “If I have four quarters and you have four quarters, how many do we actually have?” She also noted that she uses a lot of questioning with her son (e.g., when baking, she may ask: “We need a cup of this, how many half cups do I need?”)

So findings from the initial interview reveal that parents self-reported that their children engage in a variety of math activities. Thus, for the most part the majority of parents began the study already aware of mathematics in the home.
4.1.3 Domains of Practice Identified by Parents in the Initial Interview

In addition to the types of mathematics identified in home life, I was also interested in the social/family contexts in which they occurred. When analyzing transcripts, several contexts emerged (Table 4.2). These contexts include technology (computer and video games), teaching values, play (unstructured/imaginative), literacy practices (bedtime stories, reading), household chores (setting the table, washing dishes), shopping (usually grocery shopping), game play (with rules or implied rules), food preparation, and educational.

Table 4.2 Domain of practice identified by parents in initial interview

<table>
<thead>
<tr>
<th>Domain of practice identified by parents in initial interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>technology</td>
</tr>
<tr>
<td>teaching values</td>
</tr>
<tr>
<td>play</td>
</tr>
<tr>
<td>literacy practices</td>
</tr>
<tr>
<td>household chores</td>
</tr>
<tr>
<td>shopping</td>
</tr>
<tr>
<td>game play</td>
</tr>
<tr>
<td>food preparation</td>
</tr>
<tr>
<td>educational</td>
</tr>
</tbody>
</table>

All parents noted that math naturally emerges from situations involving the preparation of food (cooking, baking, making coffee). Olivia’s mother noted that “Olivia likes to bake and cook with us so she would do the measuring of things, the ingredients for whatever we’re cooking. And when she’s helping me make coffee she’ll count the spoonfuls of coffee she puts

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Amber’s mother shared that she will often ask to bake with her mother, “so she’s just learning [about] half cup, whole-cup but she still needs a lot of help with that.” Although the ultimate goal of helping is food preparation and family bonding, parents recognized math as a component.

Play or game play was mentioned by all parents. For example, Amber’s father recalled a time when Amber “spontaneously engaged” in mathematics through play. She set up a pretend restaurant and made little menus. She handed them out during a family gathering and took orders in a notebook. She then “prepared” the pretend food and served it to her customers. Afterwards she gave them a bill with a dollar amount on it. With regards to more structured game play, two families highlighted that board games play a central role in family numeracy activities. Although parents shared that they play games regularly for bonding time, they were also aware of the mathematical component of games. Olivia’s father understands that a simple card matching game has a strong mathematical component because they have to count the cards afterwards to see who won the game. Here, counting has a very specific and important purpose. On the other hand, Max and Lily’s parents explained that they often invent games to provide their children with a “fun” way to learn and explore math concepts. For example, they ask their children to identify numbers in books and in the environment.

All parents singled out educational-based activities such as homework, instructional videos, and educational computer games; however, they indicated that these programs are not their preferred means of mathematics instruction. Jack’s mother mentioned that instead of asking her son to “do a worksheet” she prefers to mix math instruction into common practice. When describing a popular educational video series for children, Max and Lily’s mother revealed that the program was supposed to help teach numbers and operations but she wasn’t “in love
with it”. Instead, Max and Lily’s father shared that they aim to make math a part of everyday experiences. Olivia’s mother shared that her husband tried to get Olivia interested in an educational computer game but she didn’t seem interested. Amber’s father was the only parent to describe an educational activity in a positive light. He noted that Amber receives a “Math at Home” booklet from her teacher every semester and they often refer to it for ideas on how to incorporate math into home activities.

4.1.4 Looking Forward to Photography

In the initial interview parents demonstrated a firm understanding of the math in which they engage their children. However, all parents were curious to see how much math they were “missing”. Amber’s parents shared that literacy is often their main focus but understood the importance of expanding on the math that naturally occurs at home. Likewise, Max and Lily’s mother shared that she was excited to discover more ways that her twins engage with math. Therefore, it seemed as if the parents were already preparing their mathematical lenses at the end of the first interview.

4.2 The Photo Interviews

4.2.1 Types of Math Identified by Parents during Each Photo Interview

When analyzing transcripts from both photo interviews, a wide variety of mathematical activities emerged from the parental description of the numeracy events portrayed in the photographs. Table 4.3 illustrates the math activities identified by parents in each interview. Unlike the initial interview where I was interested only in the math activities parents identified in general, in this analysis I was interested in what math activities parents identified in each of the 4 photos. Hence, every time a parent mentioned a specific math activity while describing a photo,
I counted is as one occurrence of that activity. For example, if a parent identified counting in all four photographs, I counted four counting activities for that particular interview. Similarly, if a parent shared that a child was measuring and counting in a photograph, I counted it as one occurrence of measuring and one of counting. Therefore, the table displays the math activities identified in each mathematics event. To display this data, I assigned a colour to every child. Math activities identified in the first interview are denoted by a darker shade than those of the second interview. To compare the two interviews, I placed the math activities identified in photo interview 1 first and photo interview 2 second.

Table 4.3 Math activities identified by parents in photo interviews 1 & 2
When compared to the types of math parents described in the initial interviews, it seemed that parents were identifying a slightly greater range of mathematical concepts in the photos interviews (16 as opposed to 14). As in the initial interviews, all parents most easily identified counting, perhaps because it is usually a very evident activity. Number concepts such as counting, number operations, number recognition and number representation were the most prevalent activities identified by parents in the photographs. All parents identified measurement concepts with most of the photographs depicting food preparations. Sorting and classifying activities were also readily identified by all parents.

As a whole, parents were describing the same types of math activities in the first and second interviews with the exception of time, money and data management, which were only identified in the first interview and problem solving, which, with the exception of one parent, was only identified in the second interview.

When I analyzed how many math activities parents were identifying per photograph, of the sixteen photos shared in the first photo interview, parents identified forty-seven occurrences of math activities. Hence they identified an average of 2 to 3 activities per photograph. When compared to the sixteen photographs shared in the second photo interview, parents identified 52 math activities, an average of 3 math activities per photo. Based on this breakdown, it seems that parents were not “seeing” quantitatively more math in the photographs from the first interview to the second.

Jack’s mother was the only parent to make note of estimation, an activity not identified in the initial interview. Likewise she was the only parent who identified geometry and spatial awareness activities in both interviews (note that she is the same parent who identified these activities in the initial interview.) In describing a photo of Jack constructing an Inukshuk during
the first photo interview (Figure 4.1), his mother described that he was grappling with concepts such as planes, angles and shapes.

Figure 4.1 Photograph by Jack's mother, shared in photo interview 1, February 15, 2010

It’s noteworthy that all parents identified problem solving when describing some events in the second photo interview [however, it was often implied]. Amber’s father, for instance, shared a photo of his daughter reading a bedtime story about a group of animals at a picnic (Figure 4.2). In recalling the story, he shared that there were nine animals at the picnic and some apples. Amber immediately counted the apples and found that there were only 8 of them; hence, one animal had to go without an apple at the picnic. Amber’s father highlighted that the book gave no mention as to how the problem was solved but he and Amber discussed what the animals could do. Amber suggested that she use her “imagination to solve the problem”. In describing the event, her father added that she also had to collect information from the picture to solve the problem (count the apples, count the animals, notice that some animals were bigger than other animals and may need more food than their smaller counterparts). He noted that
although the story wasn’t about math, he and his daughter were able to identify a mathematical component in the story.

Figure 4.2 Photograph by Amber’s Father, shared in photo interview 2, May 19, 2010

Jack’s mother shared that her son was using specific strategies in a game of Connect Four (Figure 4.3). She also noted that he was beginning to “think ahead” and imagine possible moves based on his opponent’s possible moves. Thus, although Jack’s mother never stated he was solving problems, the acts described seem to suggest that he was. In addition, when parents described situations as “taking it further”, “figuring out”, “using a strategy”, “thinking ahead” and using “critical thinking, these were categorized as instances of problem solving. Likewise she noted that he was using “a lot of trial and error” to construct a stable Inukshuk (as illustrated in Figure 4.1). Hence she also identified problem solving.

Furthermore, parents noted that they often ask questions to expand upon a situation involving math. For example, when baking, Max and Lily’s parents often ask them to help add ingredients to a recipe and use questions such as “how many more of this [ingredient] do we
need?” In these instances, it seemed as if parents were describing what math educators and researchers would label as “problem solving” without directly using the words “problem solving”.

![Figure 4.3 Photograph by Jack’s mother, shared in photo interview 2, March 29, 2010.](image)

Olivia’s mother explicitly mentioned two problem solving situations. She noted that she found herself facilitating more problem solving situations and she attributed this to the study. By using questioning language (If… then… questions) and providing concrete materials, she helped guide both her children through problems that arose from their daily activities. She noted that the study helped make her more aware of the math that “could be happening” and she facilitated it to “the next level.” In reference to a photograph where Olivia and her brother were playing number games with tomatoes she specifically noted that “it’s like they’re doing problem solving” and it was in a context that “meant something to them.”
Max and Lily’s parents described how problem solving experiences emerge spontaneously from everyday activities. They shared an incident where their son started counting the sandwiches that were laid out for lunch (Figure 4.4). Their mother added that Max and Lily “want to count everything” so she decided to continue the conversation and “take it to the next level”. She took the opportunity to pose addition and subtraction problems to her children: “We have four sandwiches, now you’ve taken one away. How many do you have left?

There were instances where there is evidence that the act of talking about the photographs (i.e., the photo interview) led to the parents identifying more math. For example, in photo interview 1, Jack’s mother shared a photograph of her son with his chore chart. She initially identified the counting aspect of the photograph. However, it was not until I asked if there was any other math she saw in the photograph, did she identify using the chore chart as a means of graphing his love of chores. She added that it was a good visual for him “because he’s seeing [his chores] specifically on a graph as to what he tends to do more than others”. This suggests
that through discussing the photograph, she became aware of the data management component of using the chore chart.

This also occurred when Olivia’s mother was describing a photo of her daughter helping prepare coffee (Figure 4.5). When I first asked her to identify the math in the photo, she noted that Olivia was engaging in measuring and counting each scoop of coffee. I then asked her to review the photograph to see if she could identify any other math activities Olivia was engaged in. She then recalled that she asked Olivia “after we add this scoop how many more scoops do we need?” Olivia’s mother identified this aspect of the event as addition and subtraction.

Likewise, Max and Lily’s parents discussed a photograph where Max was counting mangoes in a bowl. At first their mother noted that he was simply counting. After I asked parents if they saw any other mathematics happening, in the photographs the father mentioned that the idea of fairness is very important to the twins. Their father then recalled the events
surrounding the time the photo was taken: Max was indeed counting his mangoes but he then compared the number and sizes of mango pieces he had to that of his sister.

Also in the first interview, Amber’s parents shared a photograph of their daughter counting jelly beans (Figure 4.6). Her mother was making a game for Sunday School and Amber wanted to help. In the initial description, Amber’s mother identified the counting aspect of the photograph. However, when I asked the parents to consider any other mathematics happening, Amber’s mother pointed to the sorting and grouping aspect of the activity. Amber’s father noted, “We don’t see it here because it’s just a picture but after she put [the jelly beans] into two stacks.” Her mother added, “She made sure that each stack [of jelly beans] had each colour of jelly bean, so she was sorting according to colour”.

![Figure 4.6 Photograph by Amber’s mother, shared in photo interview 1, March 24, 2010.](image)

After comparing both sets of photo interviews it is clear that the parents seem to have an astute awareness of the math in which their children engage at home. In addition, it seems that although the parents may not have demonstrated a greater awareness of home mathematics in the
photo interviews as compared to the initial interviews, they were taking the initiative to facilitate it “to the next level” by seeking out and expanding upon problem solving situations.

Nevertheless, evidence suggests that the photo interview may have assisted parents in identifying more mathematics than at the time the photograph was taken. Hence, the photo interview may help parents recall an experience and extract more mathematics out of it.

4.2.2 Domain of Practice Identified in Photo Interviews

Parents also identified a range of social domains in their photographs which supported their prior assertion that math is embedded in the ebb and flow of their everyday activities. As parents shared the circumstances in which they either engage with their children or see their children engage in mathematics, similar contexts arose across photos and families. Table 4.4 illustrates these domains and how often they were mentioned in describing photos.

**Table 4.4 Domain of practice identified by parents in photo interviews 1 & 2**
It is important to note that parents identified more domains in the photo interviews than the initial interviews. Again, this may be a result of the parents having more time to think about and explore the contexts where math happens; however, it may also point to the fact that parents are reconsidering the domains in which they and their child engage in mathematics.

Similar to the initial interviews, teaching math was not the primary focus of most events. For example, a parent dyad and another parent shared photographs of their children using chore charts. They expressed that the purpose of the activity was a means of teaching their children a specific value (i.e., household responsibilities) but also identified the graphing aspect of such activities. Amber’s father identified that the chore chart (Figure 4.7) was a good visual because it highlighted “areas where she’s excelling and areas that she needs to work on.” He also suggested that it is good way to compare numbers, especially when she compares her chore chart to that of her sister. They also noted that the chore chart gave her a real purpose for counting to see if she has “beat” her sister.

Figure 4.7 Photograph by Amber’s mother, shared in photo interview 1, April 7, 2010
Similarly, Jack’s mother indicated that Jack uses a chore chart to help him earn allowance money (figure 4.8). He keeps track of his chores by attaching stars or moons to his chart. At the end of the week, he counts his stars and moons and receives a quarter for each one. His mother immediately identified the mathematical concept of money and commerce in the photo and explained that “part of the reason we started this is so he gets the concept of… things cost money.” In this instance the concept of “money” is a mathematical concept, however, understanding the notion that we have to earn money is the value.

Figure 4.8 Photograph by Jack's mother, shared in photo interview 1, February 15, 2010

However, mathematics was not always a by-product of teaching other values. Parents also shared that they implicitly try to teach their children values about math, primarily that math is fun and that it is useful. In reference to a photo of their children playing a “game” on a number mat (Figure 4.9, shared in photo interview 1), Max and Lily’s parents explained that although an activity may have centered around a specific math concept (e.g., number recognition), their main purpose was to instill the value that math is fun. Likewise, they share that they get their children to bake with them, not only to teach them about measurement in the
kitchen but that math is something “we use”. Their mom explained that “we’re always measuring stuff [with them] but they’re [also] seeing us measure in real life!” Hence, it appears that Max and Lily’s parents engage their children in math at home simply to teach the value that math is both enjoyable and practical.

Figure 4.9 Photograph by Max and Lily’s father, shared in photo interview 1, April 29, 2010

Playing games was a domain of practice described by all four parents or parent dyads (mostly in the 2nd photo interview). In keeping with most of the other photographs, the main focus for the game playing was not math – it was a means for the family to bond and have fun together. However, parents were also quick to identify the math components of the games (without prompting).

In some cases, parents shared photos where children were engaged in a commercial game (i.e., following the prescribed rules) whereas others showed children incorporating their own rules. In one photograph, Max and Lily were shown playing a Dora the Explorer game, similar to Sorry! (Figure 4.10). Their mother decided to capture the moment because it was the first
time the twins initiated playing a game on their own. She pointed out that “they kind of made up their own rules but they knew that the number on the die was the amount of spaces they had to move.” She added that “sometimes they miscounted [the number of spaces] but they understood that the game was about numbers” and taking turns. Hence, the photo prompted the parent to reveal that Max and Lily were coming to understand the social conventions of game playing, while they were also grappling with the mathematics embedded in it.

![Photo of Max and Lily playing a game](image)

**Figure 4.10 Photograph by Max and Lily's mother, shared in photo interview 2, May 20, 2010.**

Likewise, Olivia’s mother also shared a photograph in the second interview taken after she and her daughter played a memory game (Figure 4.11). The original rules were to find the correct matches for each card; however, her mother expressed that Olivia “got bored with the game” and started to sort and count the cards. Her mother then took the opportunity to teach a lesson on subtraction. She noted that the cards provided a “visual that she needs to count in order to do the subtraction.”
In sum, parents shared that mathematics happened over several domains of practice. There is some evidence to suggest that the study may have enticed parents to look for or at least notice math in domains of practice they had not previously considered. It should be noted, though, as in the analysis of the types of mathematical activities portrayed in photographs, that the differences in the domains of practice across the photo interviews cannot be definitively linked to increased awareness. Other factors related to contextual circumstances and time frames may have influenced the photos gathered.

4.2.3 The Exit Interviews: Focus on Parent Voices

The exit interviews perhaps shed the most light on whether the act of taking the photographs and the corresponding photo interview had any effect on parents’ overall awareness of the mathematics happening in their homes. Most parents shared that just taking part in the study and being asked to take photographs of their children engaged in mathematics was enough to raise their awareness. Olivia’s mother shared that “collecting the photos gave me a level of
accountability to actually look for math around the house. I felt like I was actually more aware of what she was doing.” She also shared that the experience gave her “an overall greater awareness of the math that happens at home.” Finally she summed up her experience as follows:

Now that I’m more aware, I’m actually taking advantage of opportunities to initiate learning math around the house, whereas before I couldn’t. I would just let her do a lot of things on her own but now that I’m more aware I feel I can take it further (exit interview, May 20, 2010).

Amber’s parents shared that the experience definitely made them more aware of the math they do at home. Her mother added that “before, reading was more or less a part of our regular routine but now I’m starting to become aware of the math.” Furthermore, she stressed that mathematics comes into the home in simple ways as a part of their everyday practice. Amber’s father explained that a highlight of the study for him was the heightened realization that math extended way beyond numbers – he added, often when we think of math, numbers and counting come to mind at first. He recalled how problem solving is a bigger part of their lives than he initially realized. In addition, he remarked how there is usually such an emphasis put on reading and writing that all other things are secondary, including math – “I could see through this project that it’s not just reading and writing, as important as that is, there are other components that are just as important”. He recalled how much fun he had with his daughter realizing and engaging in math at home and added how he felt positive about putting emphasis on math. Finally, both parents shared how talking about the photos (i.e., the photo interview) helped them to understand more of the math that was happening in the home.

Jack’s mother shared that the experience made her more aware of the mathematics embedded in her son’s day-to-day play and compelled her to think about how she could encourage it more.
I’ve always talked the talk: “Oh learning is through how they play,” which it is. But I actually had to sit there and think: I know it’s there, but how do I break it down? Where is the math embedded within this particular aspect of play? (exit interview, April 8, 2010)

She added that with an enhanced awareness she is more confident with “taking it to the next level and perhaps making it more complex.” On the other hand, she may even feel like bringing a mathematical experience down to her son’s current level of understanding. For example, she noted that she could start introducing the specific language of the math in which her child engages. For example, telling Jack that his weekly chore chart is a type of graph and pointing out other uses for graphs in their day-to-day lives. She even discussed that bringing the types of math to her son’s attention could even help raise his confidence: “It’s like I can do this!”

Jack’s mother also shared that the study encouraged her to look beyond the “obvious math” to see other aspects of math in his play. With respect to the photo interviews she noted,

I’d be pressed if somebody said: “Name five things off the top of your head your child does in the space of a week that’s mathematical.” I’d have no problem but those would be the very obvious ones. So then looking for and taking photos of different aspects of math in his play, I know it’s there, but just physically having to look for it. Then drudging up the memories and having to say “okay, what’s mathematical about this?” There are things that you don’t necessarily attribute to math, like problem solving, that really do fall under the umbrella of math. It’s just so embedded in everything that we do what we don’t always see it or don’t realize its math when we do see it (exit interview, April 8, 2010).

Hence, according to Jack’s mother, the study had helped her engage her mathematical lens when looking at the day-to-day activities in which her son participates.

Max and Lily’s mother shared that they had definitely become more aware of mathematics at home. She remarked “I learned that when you listen to them, they are talking about numbers more often than we think they are. I didn’t really take notice of that before.”
Likewise, she highlighted that the act of taking the photographs in and of itself helped to raise her awareness but when coupled with the photo interview it helped her achieve an even deeper awareness. “The photographs helped but then when you asked us to talk about the math we were more aware because we had to remember what happened.” She also added that the study may have affected Max and Lily’s interest in math. During the study, Max and Lily’s Montessori teacher had approached her and highlighted that the twins were choosing to engage in more math activities at school. Likewise, they were advancing in these activities more so than their peers.

Olivia’s mother had a similar experience. While she was taking notice of the types of math Olivia was engaged in, she began to notice how much her two-year-old son seemed to enjoy math. She noted “I’m actually noticing that there’s quite a bit of [math] that he’s doing, like counting”. She was unable to conclude whether her son’s interest in math and counting was a result of the study or if she had simply become more aware of it.

In sum, all parents disclosed that the study helped raise their awareness of the math their child engages in at home. Furthermore, all four parent groups explained that with this newfound awareness, they feel confident in expanding on their children’s experience and taking it to the next level. Lastly, their heightened sense of awareness may also have had an effect on their children’s interest and confidence in mathematics.

4.3 The Photographs

In addition to analyzing the interviews, I thought it would be beneficial to do a separate analysis of the complete set of photographs (instead of just those that were the focus of the photo interview). The aim of this analysis was to attempt to position what parents saw and shared and the math that was there to see. In other words, the purpose is to examine whether the photos
covered the same mathematics activities and contexts as those discussed in the interviews or if there were key differences. When examining the photographs I employed a slightly revised model of Hamilton’s (2000) analytic framework (Figure 3.1 in methods chapter). In doing so, I hoped that I would be able to shed light on both my research questions. First, is there evidence in the photographs to suggest that parental awareness of mathematics in the home changed as a result of the study and secondly, what types of math were they noticing?

4.3.1 Types of Math in Photographs

I analyzed the complete set of photographs (including those shared in the photo interview) to see what math activities were being portrayed. As in the photo interviews, I looked at each photo to identify what math “could be happening”. Likewise, I used the same coding scheme as in interview transcripts analysis. In this analysis, parents seemed to be depicting similar events as they discussed in the photo interviews. However, without the parents’ account of the events surrounding the photograph it was difficult to pinpoint what math was actually happening. I could identify the more obvious math but could only speculate about the types of math that could be embedded in the situation. Similarly, I was challenged to look beyond the visible numeracy event to understand the structured routines and pathways (Table 3.1) that facilitate these actions.

Like the parental accounts, counting seemed to be the most prominent activity along with other number concepts such as number recognition and number operations. Likewise, measurement seemed to be portrayed in many photographs. The types of math from each set of photos are illustrated in Tables 4.5 - 4.8.
### Table 4.5 Types of math identified in photographs (Jack)

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<tr>
<th>Category</th>
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<th>Set 2 n=8</th>
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</thead>
<tbody>
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<td>time</td>
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<tr>
<td>sorting/classifying</td>
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<td>3</td>
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<td>size</td>
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<td>1</td>
</tr>
<tr>
<td>problem solving</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>patterns &amp; relationships</td>
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<td>5</td>
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<tr>
<td>number representation</td>
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</tr>
<tr>
<td>measurement</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>making sets/sharing</td>
<td>1</td>
<td>2</td>
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<tr>
<td>geometry/spatial awareness</td>
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<td>5</td>
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<td>4</td>
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### Table 4.6 Types of math identified in photo analysis (Amber)

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Table 4.7 Types of math identified in photo analysis (Olivia)

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<td>problem solving</td>
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<td>measurement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>making sets/sharing</td>
<td></td>
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<tr>
<td>geometry/spatial awareness</td>
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<tr>
<td>fractions</td>
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<tr>
<td>estimation</td>
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<tr>
<td>data management/ graphing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>counting</td>
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<td></td>
</tr>
</tbody>
</table>

Table 4.8 Types of math identified in photo analysis (Max and Lily)

<table>
<thead>
<tr>
<th>Types of Math</th>
<th>Set 1 n=10</th>
<th>Set 2 n=5</th>
</tr>
</thead>
<tbody>
<tr>
<td>time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sorting/classifying</td>
<td></td>
<td></td>
</tr>
<tr>
<td>size</td>
<td></td>
<td></td>
</tr>
<tr>
<td>problem solving</td>
<td></td>
<td></td>
</tr>
<tr>
<td>patterns &amp; relationships</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number representation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number recognition</td>
<td></td>
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<tr>
<td>number operations</td>
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<tr>
<td>money</td>
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<tr>
<td>measurement</td>
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<tr>
<td>making sets/sharing</td>
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<tr>
<td>geometry/spatial awareness</td>
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<td>estimation</td>
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<td>data management/ graphing</td>
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<tr>
<td>counting</td>
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</tbody>
</table>
It seems for the most part, parents were photographing similar types of mathematical activities in both sets, except for Amber’s parents who seemed to be depicting different types of math events. Also, it is interesting to note that counting seemed to be portrayed in all photographs shared by Olivia’s mother.

When analyzing the photos in isolation from parental comments, it is difficult to pinpoint if there was an actual shift in what parents saw as mathematical or if they simply took photographs of different events and thereby captured different math. Likewise, these differences may simply reflect that the activities in which the families were engaging from week to week had changed. For example, I noted that Amber engaged in a measurement activity in the second set of photographs but not in the first. This could have happened because the activity in which she was engaging simply did not happen during the time of the initial interviews or the photo interview 1.

The separate analysis did not seem to bring any significant evidence of a shift in parental awareness of the mathematical activities in the home. The activities I identified in the complete set, however, do seem to mirror those identified by parents in the photo interviews. Hence, parents did not demonstrate a significant shift in awareness based on the types of math activities they depicted.

4.3.2 Settings and Domains of Practice

I also took notice of the setting of each photograph: the immediate physical environment where the numeracy event was taking place. It was evident that most of the math was happening when the family was in the private home environment. However, there does not seem to be sufficient evidence to conclude whether or not parents see math as a private, family activity. This
may have been a result of the request as most of the discussion surrounded the notion of “home mathematics”. In addition, parents may not have photographed math happening in outside settings, like the grocery store because it is uncommon to take photos there. Or, they may have perceived photography as restricted to the home. Also, it seemed that there was little difference in the settings between the first and second set of photographs. This finding also lends credence that the photography was not “forced” but blended into daily activity.

However, when I examined the domains of practice in which the math was happening I noticed that there seemed to be more variation between the first and second sets of photographs (Tables 4.9 – 4.12). Again, the idea of domains of practice, or social purposes behind the numeracy events, can only be inferred from the photographs alone. However, my analysis suggests that although parents may not have seen different math altogether, they were seeing it in different contexts of their day-to-day lives. At the very least, parents seemed to have decided to take photographs in different places and social settings in the second photo assignment.

Table 4.9 Domain of practice identified in photographs (Jack)
Table 4.10 Domain of practice identified in photographs (Amber)

Domain of Practice (Amber)

<table>
<thead>
<tr>
<th>Category</th>
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<th>Set 2 n=6</th>
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</thead>
<tbody>
<tr>
<td>technology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>teaching values (responsibilities, chore charts)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>play (unstructured, imaginative)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>literacy practices (bedtime stories, reading)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>household chores (setting table, wasing dishes)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>grocery shopping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>game play (rules or implied rules)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>food preparation (cooking, baking)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>family outings (park, museum)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>family gatherings (mealtime, parties)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>entertainment (music, sporting event)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>educational (extra-curricular, homework, direct teaching)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>daily routines (bedtime, etc...)</td>
<td></td>
<td></td>
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<tr>
<td>adult tasks (taxes, work related)</td>
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Table 4.11 Domain of practice identified in photographs (Olivia)

Domain of Practice (Olivia)

<table>
<thead>
<tr>
<th>Category</th>
<th>Set 1 n=9</th>
<th>Set 2 n=5</th>
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</thead>
<tbody>
<tr>
<td>technology</td>
<td></td>
<td></td>
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<tr>
<td>teaching values (responsibilities, chore charts)</td>
<td></td>
<td></td>
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<tr>
<td>play (unstructured, imaginative)</td>
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<tr>
<td>literacy practices (bedtime stories, reading)</td>
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<tr>
<td>household chores (setting table, wasing dishes)</td>
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<td>grocery shopping</td>
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<td>game play (rules or implied rules)</td>
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<tr>
<td>food preparation (cooking, baking)</td>
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<td>family outings (park, museum)</td>
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<td>family gatherings (mealtime, parties)</td>
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<tr>
<td>entertainment (music, sporting event)</td>
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<tr>
<td>educational (extra-curricular, homework, direct teaching)</td>
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<td>daily routines (bedtime, etc...)</td>
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<td>adult tasks (taxes, work related)</td>
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Although my analysis was somewhat limited by a lack of knowledge of the invisible elements of the numeracy practices, it did shed some light on the types of mathematics parents were “seeing” and the social settings and domains in which they take place. My analysis also suggests that parents were “seeing” similar types of math as a math educator in both sets of photographs. However, it also indicates that parents may be becoming aware of math happening in different settings and domains than before. This finding also emerged from the photo interview analysis.

In sum, analyzing the photo interviews and the photographs separately provided similar findings. First, parents seemed to be depicting similar math activities in each set of photos. Secondly, parents seemed to be portraying these activities happening in different domains. However, the photo interview did provide more evidence of a shift in parental awareness. First, when parents were prompted to review the photographs for additional math activities, they were able to identify more. Second, the exit interview allowed parents to explicitly disclose if and
how the photo assignments and photo interviews helped them gain a greater awareness of the math happening at home.

### 4.4 Drawing It All Together – Discoveries Made from Analysis

After reflecting on my analysis of the interviews and photographs, I began to see four distinct themes emerge from the data. These themes suggested the ways in which photography and the corresponding photo interviews may assist parents in becoming more aware of mathematics in the home.

1. Photography establishes a level of accountability
2. Photography and the photo interview challenges parents to search for deeper math
3. Photo interviews help parents gain a greater appreciation of children’s mathematical understanding
4. Photo interviews help parents identify how math is woven into their daily routines

#### 4.4.1 Photography Establishes a Level of Accountability

Parents shared that the study established a level of accountability to consciously look for math in daily activities. Simply asking them to take photographs of mathematics in the home required them to re-examine routine activities through a mathematical lens. Olivia’s mother noted “collecting the photos gave me a level of accountability to actually look for math around the house. I felt that I was actually more aware of the math she was doing.” She also noted that she also became more aware of the math in which her two-year-old son engages: “I’m actually noticing that there’s quite a bit of [math] that he’s doing… he’s starting to count… and he’s very interested in numbers.” She recalled a time when she was eating lunch with her children and her son wanted the last four tomatoes in the container (Figure 4.12). She asked Olivia how many tomatoes were left in the container, and her son ended up counting them. She then asked what would happen if he ate one. He physically ate the tomato and recounted the remaining tomatoes
to solve the problem. Olivia’s mother added, “I’m more aware of the math around the house… and [I notice that] they sometimes do it together.” She then noted that this new awareness compelled her to actually take advantage of opportunities, citing that she may not have expanded on the situation if she was not prompted by the study to seek out mathematical activities in the home.

Figure 4.12 Photograph by Olivia’s mother, shared in photo interview 2, May 10, 2010.

Throughout the photo interviews, Amber’s parents shared that they found themselves intentionally looking for the math in their daily routines, something they admitted they “never really took notice of before”. Amber’s mother recalled how math was often found in the “simple stuff;” hence, it didn’t require them to change their routines to incorporate math but to review their daily activities through a mathematical lens. Max and Lily’s parents also shared that the task of taking the photos challenged them to look for different aspects of math in everyday routines.
These examples illustrate how parents gained a greater awareness of their responsibility to facilitate mathematical learning in the home. Although they shared that they had already done this, they suggested that the study raised this level of accountability.

4.4.2 Photography and the Photo Interview Challenges Parents to Search for Deeper Math

Jack’s mother shared that mathematics is “so embedded in everything we do that we don’t always see it, or don’t realize all the math when we see it.” This assertion perfectly echoed the words of González et al. (2001) who stressed that mathematics is so embedded in the home culture that it is often problematic to see it. With regards to the act of photographing mathematics around the home, Jack’s mother shared that it required her to ask herself, “Okay, where is the math embedded in this particular aspect of his play?” It also challenged her to look beyond the “obvious math” to understand deeper, perhaps more invisible, mathematics processes. Hence, it pressed her to concentrate on where the math was happening in her home and family context. For example, when describing a photograph of Jack “playing” with a school of computer-generated fish at a museum, (Figure 4.13), she shared that the “obvious” math was counting (the fish) and spatial sense (following the fish as they moved). However, Jack eventually figured out that the fish were following a predetermined pattern but his interaction with the school of fish somehow changed the pattern. His mother shared that he was employing trial and error to figure out how his movement would affect where the fish swam. After time, he was able to pinpoint what movements he should make to ensure the fish swam in a particular direction. On the surface, he was simply following the fish. As his mother indicated, looking
deeper, however, suggested that he was grappling with much more advanced math (i.e., predicting, trial and error).

![Image of a child with toys]

**Figure 4.13 Photograph by Jack’s mother, shared in photo interview 2, March 29, 2010.**

Similarly, the photo interviews challenged parents to reexamine the photographs to see if there was any math they were missing. For example, Olivia’s mother talked about a photograph of her daughter identifying numbers on a license plate (Figure 4.14). At first, she noted that her daughter was recognizing and saying the number words. I then asked her about what Olivia had in her hand. Her mother added that Olivia likes to collect things and on this particular day she was interested in cones. She then recognized that Olivia had actually collected different types of cones. In further discussing the photograph, Olivia’s mother was able to identify that her daughter was also grappling with identifying different attributes and classification.
A similar experience happened when Amber’s parents were sharing a photograph of their daughter counting stars on her chore chart (Figure 4.7). Amber’s mother initially identified the counting aspect of the photograph. However, after further discussion, her father noted that “it could be a type of graph”, thus identifying the data management nature of the photo. Following further discussion, her father shared that Amber’s older sister has the same chore chart and Amber will routinely compare her stars to that of her sister. Hence, through engaging in discussion around the photo, Amber’s parents went from identifying counting to becoming aware of data management and comparing quantities.

Jack’s mother gave a thorough explanation of the measurement, estimating and geometry concepts in describing a photograph of her son taken during a weekend Science class (Figure 4.15). Then I made an inquiry about the paper bug cutout on the periphery of the photograph. She shared that it was another project from that day where they were asked to fold a sheet of
paper in half and cut out a very specific shape. With her attention drawn to the bug cutout, she noted that each side of the bug was a mirror image and made a symmetrical design.

![Image of children cutting paper](image)

**Figure 4.15 Photograph by Jack’s mother, shared in photo interview, March 29, 2010.**

4.4.3 Photo Interviews Help Parents Gain Greater Appreciation of Children’s Mathematical Understanding

Max and Lily’s parents were excited to see that their children are engaging in activities and conversations about mathematics “more often than we think they are”. In the initial interview she noted that she was unsure whether Max and Lily really understood math and number concepts and shared that “they say numbers but they’re just repeating things”. However, during the first photo interview, when Max’s father shared the story behind the photograph of him and Max adding numbers with a calculator (Figure 4.16), the following exchange took place.

Mother: Was he doing the [adding]?
Father: Yes, he wanted to push the buttons, he was like, “I want to do what you’re doing.”
Mother: (Still somewhat astonished) He wasn’t always accurate, was he? You had to do it again? (Photo interview 1, April 28, 2010)
Max’s father confirmed that his son was accurate in putting the numbers into the calculator and his mother was very impressed. Hence, through a simple recount of a mathematical experience, Max and Lily’s mother seemed to greater appreciate her children’s mathematical understanding.

Jack’s mother also indicated a deeper realization of her son’s mathematical understanding. When recalling an experience at a hockey game (Figure 4.17), she shared that it was the first time she ever took notice of Jack’s ability to perform calculations mentally. She recalled this exchange:

Max: What’s the score?
Mother: Well, [our team] has 3 and the other team has 1.
Max: So, if the other team gets two more then we’re tied, right? (Photo interview 1, February 15, 2010)

She added:

What I found really interesting is that he was doing it in his head. Which again, I think is a new step for him. Sometimes I would ask, “If you had four quarters and I gave you another four quarters, how many would you have?” Up until now he would have [use his fingers] to count, count, count… but this was all in his head (photo interview 1, February 15, 2010).
Jack’s mother noted that her son’s quick mental calculations may have had something to do with the context in which he was doing them. Max was desperate to see “his team” win and hence had a personal stake in the differences between scores. However, she was still amazed that her son was beginning to perform calculations mentally.

Figure 4.17 Photograph by Jack’s mother, shared in photo interview 1, February 15, 2010.

Hence, it seems that parents were not only becoming more aware of the math in which their children engage but also the depth of their mathematical understanding.

4.4.4 Photo Interviews Help Parents Identify How Math Is Woven into Their Daily Routines

The photo interviews also helped parents gain insight into their home numeracy practices. When talking about a photograph of their son Max counting mango pieces in a bowl (figure 4.18), his parents shared that their twins have a fascination with “fairness” and that they will routinely compare quantities to ensure that they both get the same amount. The parents then realized that they use the concept of comparing quantities to encourage their children to eat.
Their father noted that “we sometimes use [comparing quantities] as a tool to get them to eat more. I’ll say, ‘How many does Max have left? How many do you have left? Max has two and you have four, he has eaten more than you so you have to eat yours.’” He realized that “sometimes [we] use numbers as a way of getting them to eat instead of a tool to get them to learn numbers.”

Figure 4.18 Photograph by Max and Lily's father, shared in photo interview 1, April 29, 2010.

As previously illustrated, parents shared that math is also embedded in the direct teaching of other values (recall Jack and Amber’s chore charts), family time (playing board games), literacy practices (Amber problem solving while reading a bedtime story) and meal times (Olivia and her brother problem solving while sharing veggies at lunchtime).

In the exit interviews, all parents alluded to the realization that mathematics is entrenched in the ebb and flow of daily activity. Hence it seems that photography and photo interviews may have scaffolded this realization.
Parents also shared that the study helped expand their view of mathematics. This suggests that simply engaging in the study and thinking about the types of math at home helped parents to expand their conceptions of math. When I compared the first set of photographs to the second, in each case there wasn’t a lot of variation in the types of math parents identified. However, there was a noticeable difference in the domains in which they were happening. This leads me to reconsider my idea of an expanded view of mathematics. It may not necessarily mean that parents see more math but they see it happening in places they never considered before. For example, Amber’s parents realized that she was sorting and comparing sizes and measures when helping her mother do the dishes (Figure 4.19). They had mentioned sorting before, so realizing this didn’t expand their view of what mathematics is (i.e., the math activity); however, it seemed as if they were realizing it was happening in a context that they may not have considered before.

Figure 4.19 Photograph by Amber's mother, shared in photo interview 2, May 19, 2010
Parents also shared that various math activities could happen simultaneously, for example, counting was frequently depicted in photographs, but often it was in conjunction with another activity such as measuring, sorting, data management, and problem solving.

In sum, although parents didn’t seem to identify more math activities in which their children engage, they were sharing photographs of these types of activities happening in different contexts. This suggests that they are seeing the “same old math” in “new places.”

### 4.5 Secondary Findings

The main focus of this study was to investigate the ways in which photography may assist parents in becoming more aware of the mathematics their children engage in. However, in addition to providing evidence to support my key research questions, the study raised some residual findings that are worthy of note.

#### 4.5.1 The Study May Have an Effect on How the Children View Mathematics

There was evidence to suggest that the impact of the study reached beyond the parents. Max and Lily’s mother shared that as the study progressed, her twins “seem[ed] to be more interested in numbers and maths.” At first she questioned whether Max and Lily’s newfound interest in math was because “they’re more interested” or she was “just more aware.” She went on to explain how she was approached by Max and Lily’s Montessori teacher about their sudden interest in numeracy activities: “She [the teacher] said that it was like all of a sudden they’re advancing in projects that mainly kids their age don’t quite do, like they were spending more time with the number rods. [The teacher] was surprised that the kids had such an interest in numbers because most children there focus on getting their letters and reading down first”. Max and Lily’s mother speculated that her children’s sudden interest in math and numbers was a
result of the study, which seems to suggest that parental awareness has an effect on a child’s interest and perhaps even confidence in math. Furthermore, by taking photographs it was adding value to the activities. It was as if the children realized “if my parents are taking pictures of me doing this, it must be important.”

4.5.2 The Study May Have Had an Effect on Others

Olivia’s mother mentioned how the study may have had an effect on her close friends. She shared how she was talking about the study with friends of the family while they were visiting for lunch. It seemed to spark the other parent’s interest in identifying math at home. Hence, one parent’s mathematical lens may impact those of others.

For these four families, photography in tandem with photo interviews afforded increased awareness of mathematics in the home. The types of math activities of which parents were aware were varied but remained constant over the three interviews but the contexts in which the math occurred varied. This suggests that awareness of mathematics in the home depends not only on the activities parents see as “mathematical” but the domains in which they occur.
5 Discussion

This study sought to address a gap in literature pertaining to home numeracy practices (see Anderson, 1997; Anderson & Gold, 2006; Goos, 2004; Sheldon & Epstein, 2005; Warren & Young, 2002) and more specifically concentrated on parental awareness of numeracy experiences in the home. In this study I investigated the ways in which photography and the corresponding photo interview may assist parents in gaining awareness of home numeracy practices.

5.1 Links to Literature: Numeracy as a Social Practice

It is noteworthy that the findings of the current study support claims from previous research on numeracy as a social practice. For instance, it was evident from the photographs and the corresponding interviews, that the home is indeed a rich site for informal mathematics learning (Baker & Street, 2001; Baker, Street, & Tomlin, 2003, 2005) and that children engage in legitimate mathematical activities at home (Anderson & Gold, 2006). Likewise it can be gleaned from the current study that parents engage their children in activities that lead to mathematical learning and communication (Anderson, 1997).

The theory of numeracy as a social practice closely parallels the notion of literacy as a social practice. One criticism of literacy as a social practice (or the New Literacy Studies) is it’s over emphasis on local literacies. In other words, the framework (of literacy as a social practice) has been criticized of “romancing the local” (Street, 2003, p.80). Likewise, I believe that numeracy as a social practice may face a similar criticism.

For example, the parents in this study claimed that they had become more aware of the mathematics in which their children engage at home. Hence, they were, in a sense, gaining a
greater appreciation of “local numeracies.” The question remains, so what? Why is this valuable? If a parent has a greater awareness and greater confidence to expand on home numeracy events, what does that mean in the grand scheme of things? How does it translate into, what some may refer to as the “real world”?

In addition to presenting a criticism of the NLS, Street (2003) proposes that the aim of the theoretical framework is not to overemphasize the local but to investigate how local literacies interact with global literacies. Hence, at the heart of the NLS approach is the “recognition of [the] hybridity… regarding the relationship between local literacy practices and those of the school” (Street, 2003, p. 80). From a numeracy perspective, the need is to investigate how home numeracies (or local numeracies) relate to schooled numeracies (perhaps even mathematics curriculum standards) and vice versa. For example, how does Jack’s chore chart help him understand the concept of data management? Conversely, how does Jack’s formal learning of data management help him make a deeper connection to his chore chart?

The interaction between local and global numeracies was brought forward by Max and Lily’s mother. She commented on how their preschool teacher noticed that the twins started to choose more mathematics based activities at school. Not only were the children choosing to do more math, they were choosing to do math activities that were intended for slightly older children. Their mother speculated that because they were putting more emphasis on and communicating more about math, Max and Lily had become more interested in and thus took more risks in math at school.

This raises questions about how parental (and even child) awareness of mathematics in the home may affect how the child approaches schooled-math. In addition, how does parental
awareness affect the child’s mathematical identity? (An issue raised by Anderson and Gold (2006)).

The current study also supports claims brought forth by Benigno and Ellis (2008), who emphasized that much of young children’s exposure to mathematics “does not occur during explicitly didactic interactions, but rather while participating in routine cultural activities such as mealtime, shopping, household chores and play” (p. 294). Indeed, it was clear that most of the mathematics these parents captured was embedded in the day-to-day activities in their home. Although parents claimed that they performed some explicit instruction (through encouraging homework and providing educational videos), they admitted that they did not put too much emphasis on intentional math instruction (unlike literacy, which they felt they emphasized more).

Parents also shared that some of the math emerges from their child’s daily play, but highlighted that it was often problematic to “see” the math in their child’s day-to-day play – which corresponds to another issue raised by Tudge and Doucet (2004). They propose that math occurs in subtle ways and parents (and teachers) may not be aware of children doing anything else but playing. Hence, parents must be aware of the nuances and subtleties of the mathematics in play in order to understand what is happening. One parent shared that the photographs and photo interviews helped her to do just that, unravel the layers of play to understand what types of math were happening.

I’ve always talked the talk: “Oh, learning is through how they play” which it is. But I actually had to sit there and think: I know it’s there, but how do I break it down? Where is the math embedded within this particular aspect of play?

She added:
So then looking for and taking photos of different aspects of math in his play, I know it’s there, but just physically having to look for it. Then drudging up the memories and having to say, “Okay, what’s mathematical about this?”

If anything, the photography task compelled her to look at play through the lens of mathematics and the photo interview brought her back to the situation so that she could try to analyze it to identify the mathematics embedded in it.

Generally speaking, it would seem that once parents began to “unravel the layers of play”, they seemed to have a greater confidence in expanding on the math in which their children are already engaged. Again, Tudge and Doucet (2004) advocated that rather than engaging their children in formal math lessons, “that they pay more attention to ways in which they can expand on what the children are already doing” (p. 35). Olivia’s mother, for example, noted that in addition to an overall greater awareness of math in the home, she now takes advantage of opportunities to initiate learning math around the house. Similarly, Jack’s mother revealed that her heightened awareness of math in the home has encouraged her to bring it to her son’s attention and to introduce the language of math. Furthermore, Max and Lily’s mother shared that whenever they see their children engaging in mathematics they take the opportunity to talk about it, whereas before [the study], the math “probably would have stopped there”.

Although I did not intentionally seek to examine the differences between how parents identify literacy events as opposed to numeracy events (and hence did not ask questions regarding literacy events in the home), some parents shared that it was often easier to see the literacy component in a situation. For example, Amber’s father shared that “reading is more or less a part of our regular routine” and “reading is usually our main focus”. Likewise, Max and Lily’s parents highlighted that they focus a lot on literacy activities such as identifying letters
and reading books. Tudge and Doucet (2004) claim that parents are more adept at recognizing an activity as literacy-related (i.e., reading, writing, and speaking) and thus are more likely to intervene and expand upon literacy activities than those dealing with mathematics. Literacy activities are often more “visually apparent” and literacy “may lend itself more readily to direct observation than mathematics, an activity that may occur in more subtle ways” (p. 24).

Amber’s father also shared that he feels there is a greater emphasis on literacy from a school perspective. He noted that “it’s always been, from the beginning… such an emphasis on reading… like you want your child to excel in reading comprehension and writing and a lot of other things come secondary, including math”. Tudge and Doucet (2004) suggested that this is reflective of cultural norms. Math may often take a back seat “where there is a great deal of emphasis placed on the importance of reading, particularly related to children’s development and education” (p. 35). Hence, it was no surprise that parents revealed that they often spent more time on literacy activities in the home.

On the whole, parents shared that most mathematics activities occur spontaneously out of daily home practices. Therefore, it is woven into the different relations and purposes (Baker, Street, & Tomlin, 2005) and the child is a learner in these contexts (Boaler, 2000). As suggested by Hamilton (2000), numeracy events are merely the tip of the iceberg and are undergirded by numeracy practices which include hidden notions about culture, values and beliefs. The photo interviews invited parents to share snapshots of their children engaged in numeracy events so that they may provide insight on the underlying numeracy practices. By foregrounding the mathematics being portrayed in the photographs, the photo interviews also provided a means of discovering different types of mathematics embedded in each practice.
5.2 Revisiting My Research Questions

My primary research question focused on exploring the ways in which photography and photo interviews can assist parents in gaining awareness of home numeracy practices. My second research question addressed the specific types of math parents become aware of. Although expressed differently, all parents pointed to an increased awareness of mathematics in the home. These results suggest that strategies such as those used here foreground math for the parents and heighten their sensitivity to it.

Given that parents revealed they had gained a greater sense of awareness of the mathematics in the home, I was able to identify five ways in which photography and photo interviews may assist parents in becoming more aware of the mathematics in which their child engages at home. In the following sections I discuss these emergent themes in relation to the broader research literature.

5.2.1 Photography Establishes a Level of Accountability

Parents shared that the study established a level of accountability to consciously look for math in daily activities. Hence, simply asking them to take photographs of mathematics in the home required them to re-examine routine activities through a mathematical lens. Once parents felt comfortable in identifying the math in home activities, they felt compelled to further facilitate mathematical learning. In contrast, there were times when parents would choose not to intervene. For example, when Olivia made play money when playing store with a friend, her mother suggested that she could have intervened and helped her make more “realistic” money (her daughter made a $1 000 000 bill), but she simply chose to observe.
Seo (2003) suggested that when observing mathematics during play (as was the case with Olivia), adults should consider whether or not it is appropriate to intervene or simply let the mathematical exploration continue. Seo added, “When we do intervene, what interventions are appropriate?” (p. 28). It seemed as if Olivia’s mother was also grappling with this question.

Seo suggests that we need to be mindful when intervening so as to not undermine the child-centred mathematics exploration. Hence, in addition to establishing a level of accountability to identify and expand on home numeracy experiences, parents may also need to be aware of what interventions are appropriate. This leads me to question, what does Seo mean by appropriate interventions? If becoming more aware of mathematics in the home establishes a level of accountability, what are parents accountable to do to expand on home math experiences? How are parents to know if they should or should not intervene?

From the photo interviews, parents seemed to follow their intuition in expanding upon mathematical experiences. For instance, Jack’s mother felt compelled to expose her son to the language associated with the activities and concepts he was exploring. In the same way, Max and Lily’s parents shared that they find themselves using the language of fractions especially within the context of baking but were unsure whether their children really understood the concept of fractions. Nevertheless, they noted it was valuable to use the language, to get them used to it. Seo (2003) suggested that “teachers enhance children’s mathematics learning when they ask questions that provoke clarification, extension and development” (p. 33). I would argue that this also pertains to parents (since they are, after all, their child’s first mathematics teachers).

Vandermaas-Peeler, Nelson, and Bumpass (2007) note that “parent-child interactions related to numeracy in free play focused on supporting cultural, conceptual, and procedural understanding of numeracy” instead of “direct teaching of number skills such as adding and
counting” (n.p). Recall how Olivia’s mother identified the math in her daughter’s request that every person in their family should have a pet and reframed it in the question “if all of us had two pets, how many pets would we have?” In doing so, she clarified her daughter’s request, extended upon it by reframing it as a question, thus developing her daughter’s idea of problem solving.

All parents suggested that being more aware of the mathematics in the home encouraged them to “take it further”. I speculate that parents have various means of expanding upon everyday numeracy experiences and they use their astute knowledge of their child to use appropriate measures when intervening. Furthermore, I argue that parents already have a natural sense of when and when not to intervene in their children’s mathematical explorations.

5.2.2 Photography Challenges Parents to Search for Deeper Math

Seo (2003) indicates that “young children’s mathematics is not limited to counting, simple sorting, and identifying simple shapes, although there is a tendency to reduce it to these skills” (p. 31). Corresponding to this notion, parents in this study suggest that certain types of math are more apparent than others. Counting, for example, was the most prevalent mathematical activity identified by parents; as the study progressed, some shared that they were encouraged to look beyond the obvious and to seek out deeper mathematical concepts and processes such as problem solving and estimation. This seems to suggest that if mathematics is so embedded in our day-to-day routines, some math processes such as problem solving and estimation are rooted even deeper in our daily experiences.

Babbington (2006) suggested that young children may engage in deeper mathematical processes, specifically problem solving more often than we think. She noted that “young
children have an innate desire to explore their worlds and as they do so encounter many ways that may assist them in their knowledge and skills” (n.p.). Problem solving development occurs through exploring their environments with and without the help or presence of others (i.e., parents, older siblings, and teachers). Hence, it seemed as if the act of photography and the photo interview helped parents begin to gain awareness of the problem solving experiences their children already engaged in.

In their conversation on parental socialization of children’s numeracy, Benigno and Ellis (2008) suggested that there are numerous opportunities for parents to involve their children in meaningful mathematics in the home. However, they noted that “even when parents do make active attempts to engage in numeracy activities, they tend to focus on basic procedures such as rote counting to the relative neglect of more complex concepts” (p. 304). However, this study suggests once parents are aware of the more complex concepts in which their children are engaged (e.g., problem solving and estimation) and feel a sense of accountability to “take it further,” they may engage their children in deeper mathematics in the home.

5.2.3 Photo Interviews Help Parents Gain a Greater Appreciation of Children’s Mathematical Understanding

When Ginsburg, Inoue, and Seo (1999) observed children in day-to-day play, they noted that the children engaged in various and “surprisingly advanced mathematical activities” (p. 92). Recall how Max and Lily’s mother was surprised to see that her son was able to help his father add parking receipts with a calculator. It seemed as if she didn’t think her son was capable of understanding addition of several numbers. Indeed, when parents were given the opportunity to discuss and reflect on the mathematical events captured in the photographs they discovered that their children were engaged into more advanced math than they had previously thought.
Drawing from an early childhood education context, Barnes (2005) emphasizes that the more time she takes to play with her students the more she realizes they have already grasped many of the concepts and mathematical language she was planning to teach them. It seems that focusing on the mathematics embedded in play helps early childhood educators gain a greater appreciation of children’s mathematical competencies. This current study suggests it is also reasonable to assume this is the case for parents.

During the exit interview, Amber’s father mentioned that his daughter engaged in math quite frequently and it involved much more than numbers. Ginsburg et al. (1999) indicated they, too, were surprised to discover that counting occurred rarely in children’s play. Instead, they observed that children “engaged heavily in pattern analysis and geometric thinking in their free play” (p. 96). In the case of this study, parents most easily identified the counting aspects of a mathematics event, but when pressed to review the photo for additional math activities they discovered that their children were engaged in more than just counting. This was the case with Amber’s counting stars on her chore chart. Recall that when encouraged to look for other math happening in the photograph, her parents identified the graphing aspect of the activity. Hence, although parents did identify counting as the main activity, they were pressed, as Jack’s mother indicated, “to look beyond the obvious.”

In previous studies on mathematics and play, children were documented to be frequently engaged in classifying and sorting objects; comparing shapes and sizes; investigating symmetry; recognizing and creating patterns and rhythms; counting and recognizing money; and exploring spatial relations (Babbington, 2006; Clements & Samara, 2005; Ginsburg, Inoue, & Seo, 1999; Ginsburg, Lin, Ness, & Seo, 2003; Kirova & Bhargava, 2002; Lee-Babbington, 2007; Seo & Ginsburg, 2004; Vandermaas-Peeler, Nelson, & Bumpass, 2007). A similar array of
mathematical activity was identified by parents in this study. This suggests that children are engaged in more complex mathematical explorations than we may assume at first glance. When parents are encouraged to place math in the foreground (by capturing an event and sharing it in a photo interview), they become more aware of it and gain a greater appreciation for the mathematics their child engages in.

5.2.4 Photo Interviews Help Parents Identify How Math Is Woven into Their Daily Routines

“Young children do not perceive or act in their world as if it were divided into separate cubbyholes” (Clements, 2004, p. 58), whereas adults often do. Yet in this study parents spoke to how math was everywhere, but sometimes hidden in day-to-day interactions. As detailed earlier, in both the initial and exit interviews, Jack’s mother noted that “[math is] so embedded in everything that we do that we don’t always see it… or don’t realize its math when we do see it.” This declaration perfectly echoes the words of González, Andrade, Civil, and Moll (2001), who maintained that “mathematics is so embedded within the home culture that it is often problematic to see it unless armed with a lens to focus on mathematics within households” (p. 120).

Likewise, Amber’s mother mentioned “you don’t realize how math is brought into the home, even in the simple things.” Therefore, parents in this study reveal that compartmentalization is not as prevalent, at least in how they view their children’s mathematics, than might be expected.

Benigno and Ellis (2008) noted that parents may not be as engaged in their children’s homework tasks but “are able to build mathematics within the everyday contexts their children enjoy” (p. 303). All parents highlighted that they were not as keen on more formal types of math in the home (i.e., homework, worksheets, and math specific computer games) but were more comfortable in weaving it into common practice.
Civil (2002) highlights that mathematics outside of the school “often involves mathematics that is hidden – that is not the center of the attention” (p. 43); hence, it was no surprise that mathematics exploration and instruction was most often a by-product of another activity. For example, parents often used the context of cooking and baking to introduce their children to measurement concepts and the language of fractions. Likewise, mathematics was also embedded in the direct teaching of other values such as chore charts, which provide an authentic use of data management but were intended to teach about household responsibilities and the value of money.

Mathematics is often a hidden component in our day-to-day lives (as indicated by literature and parent accounts). In the case of this study, it seems that the act of photography and photo interviews helped to place math in the foreground, thus making it easier for parents to “see” it.

What most parents found valuable about the study is that it made them even more aware of how math was embedded in their daily interactions. With this heightened awareness, they indicated that they felt even more compelled to expand upon these authentic experiences to help deepen their children’s understanding of mathematics. Instead of having to introduce more mathematics into their daily routines, they realized that they simply had to deduce the mathematics that was already happening and bring it to the forefront of their child’s attention.

5.3 Reflections and Reconsiderations

In addition to gaining a greater understanding of some of the ways in which photography and photo interviews help parents gain a greater awareness of home numeracy practices, this study also points towards valuable considerations toward future research.
5.3.1 More Parents = More Data = Better Conclusions

Although all of my parents were from different communities in the Lower Mainland, they were from a similar SES and cultural background. This leads me to consider how the data would change if I had a wider variety of participants from a wider range of cultural backgrounds. Also, how would the data look if I had worked with parents from a different region or even a rural community? I have reason to believe that photography and the photo interview does help parents develop a greater awareness of the math that happens in their home life, but additional research drawing from different cultures, regions and SES is needed to uncover any differences attributable to these considerations.

5.3.2 How Can We Measure Parental Awareness?

Although parents shared that they experienced a greater sense of awareness of mathematics in the home, I wanted to investigate if this shift was actually documented in the photographs. Hence, a critical component of the study included a thematic analysis of the photographs separate from the photo interviews. The purpose of this analysis was to determine whether the photographs verified a shift in parental awareness of mathematics in the home. The analysis suggested that parents were not necessarily depicting different mathematics events from the first to second set of photographs. Nevertheless, there was some evidence to suggest that they were seeing these activities happening in different domains. Therefore, were parents not becoming more aware of the mathematics happening in the home environment?

This leads me to question, how do we measure parental awareness of mathematics in the home? Do we simply ask them or do we require another means of supporting their claims? For example, from the photo interviews, parents shared that they were intentionally seeking out math
in the home. Similarly, they noted that they were more confident in facilitating math discussions and taking mathematical explorations “to the next step”. Indeed, it seems that parents were becoming more aware of mathematics in the home. How then, can we find supporting evidence of this heightened awareness? Moreover, it seems that the idea of parental awareness of mathematics in the home has not been sufficiently examined and that further research is needed to understand what it is and how to measure it.

5.3.3 Considering the Voice of the Researcher

Emerging from this study was the critical question regarding the voice of the researcher. At numerous times throughout the study, I struggled with finding my voice in the process. As indicated in describing my research methods, the utmost care was taken to not impose my views or perceptions of the types of math that could be happening in the photographs. Now, on the other side of the research process, I consider how my voice, as the math educator/researcher, could be used to help co-construct the notion of mathematics in the home. It seems as if the idea of “interventionist” has a negative connotation – as if the researcher somehow possesses a more “sophisticated” understanding of mathematics in the home. However, could the researcher insert his/her voice into the discussion of the types of math happening in the photographs while keeping the relationship between research and participant as equal?

Perhaps researchers might engage parents (in fact any stakeholders) in a honest, "egalitarian" way, through promoting authentic conversations or collaborations whereby all individuals bring strengths to the "table" and each engages from their position of "expertise" to contribute to a dialogue which will benefit all members. In this model, no particular person is seen as the "authority" or power broker. Those with "perceived authority" (i.e., researchers,
teachers, etc.) need to work even harder to build the rapport and trust of participants so they see that their expertise and knowledge is valued, and that the voice of the researcher is but one of many in the conversation surrounding home numeracy practices.

5.3.4 Considering the “Invisible”

Reflecting on Hamilton’s (2000) framework for photo analysis (Table 3.1), I consider how I could better assess the “invisible” aspects of the photos. In my photo analysis, I realized that my ability to evaluate the numeracy events were restricted by my limited knowledge of the underlying numeracy practices, which parallels what Hamilton (2000) would refer to as the non-visible constituents of literacy practices. If each picture is worth a thousand words, what words are they trying to say? What notions of family numeracy are they implying? It seems reasonable that the best method for addressing these questions would be to ask the parents. Hence, for future research, I consider how might the ‘invisible’ be included as part of the photo interviews.

This leads me to contemplate whether parents should be encouraged to share all photographs in the photo interview. This practice would not only provide evidence of the non-visible numeracy practices alluded to in each photograph but it would make it easier for the researcher to understand the message behind the photograph.

Likewise, there are other aspects of the “invisible” included in Hamilton’s (2000) analytic framework that could be explored more deeply. For example, the notion of structured routines and pathways (i.e., rules of eligibility and who can and cannot engage in particular activities) and the hidden participants (others who are involved in the social relationships regulating the mathematical activity) may shed more light on how numeracy is embedded in the home environment.
Furthermore, how should the researcher address what the parents may not have seen in the photograph? Would it be useful for the researcher to share a perspective on what’s happening in the photograph? How could the researcher share these perspectives while still keeping most of the focus on parent voices? In other words, how can parents and researcher co-construct a notion of mathematics in the home?

5.3.5 There’s Strength in Numbers (Of Interviews, That Is)

Interestingly, with two photo interviews parents revealed that they had noticed a deeper awareness. Yet we presume that awareness continues to evolve over time. Thus, would more interviews and thus a longer duration provide different insights into ways in which photography and photo interviews assist parents in developing awareness of home numeracy practices? It is recommended, then, that future research might vary time frames for such engagement with parents.

5.3.6 The Value of Parents Sharing with Parents

As this study evolved, it was clear that the photo interviews served as settings for parents to generate ideas. Based on previous experience with focus groups, it seems that parents sharing with other parents (and not just a researcher) would yield valuable insights. Conducting future research with group photo interviews may point to “sustainable” activities in which educators might support parents’ math lens. The researcher would assume the role of a facilitator by asking questions (similar to those used in this study) to direct the discussion.

This may also help address some of the concerns surrounding the separate photo analysis and considering the invisible elements of the photographs (issues raised in previous sections). As an addition to the photo interview, parents may be asked to review and analyze photographs
taken by other parents to help bring the invisible elements of the underlying numeracy practices to the surface for discussion.

5.3.7 Photography and Photo Interviews in Numeracy Research

Although it has been used widely in the study of literacy (Cappello & Hollingsworth, 2008), literacy as a social practice (Hamilton, 2000) and family literacy (Moss, 2001), photography and the photo interview have rarely been used to research family numeracy. (At the time of this discussion, I could find no references of using photography as a means of research in the context of numeracy or mathematics). Hence, for the field of mathematics education, this study points to one way in which photography and photo interviews could be used as tools for researching family mathematics practices.

Furthermore, the value of photography and the photo interview for the study of family mathematics may stem from its potential to provide a space where researchers may engage parents at their level of understanding of home numeracy practices. I argue that the current study started within the family context to “build upon what [parents] already know as a way of developing what else they want to know” (Street, 2003, p. 85). It provided a starting point where parents were the experts, not the researcher. From this standpoint, parents and researchers share a sense of equality, and, work together to co-construct notions of home numeracy.

Indeed, the method of photography and photo-interviews could also be useful in other early childhood contexts such as literacy and social development. However, more research is needed to understand its effectiveness in any context.
5.4 Further Implications

5.4.1 Implications for Parents

Parents have voiced their concern and apprehension towards supporting their children in mathematics (Warren & Young, 2000). However, numerous studies have indicated that parents engage in a great deal of meaningful mathematics with their children (Anderson, 1997; Anderson & Gold, 2006; Benigno & Ellis, 2008), although they may not be aware of it (Civil, 2002). Hence, for parents directly involved in the study, I believe the study provided a means of realizing their valuable contribution to their child’s numeracy development, as well as a “natural” way to enhance their child’s numeracy experiences in the home.

A major criticism of current home-school partnerships is that they are often dominated by school perspectives and simply provide information regarding the school mathematics program (Goos, 2004). Likewise, Winter et al. (2004) critique home-school partnerships by suggesting that “it is not clear… how far such attempts actually engage with home mathematical practices or whether they merely remain as ‘school practices’ taking place in another location” (p. 60). It would seem as if parents have no voice in some current home-school math partnerships.

Merttens (1999) emphasizes that a child’s attitude towards learning mathematics and value of mathematics in general is a direct result of their parent’s attitudes and values. Hence, a greater parental awareness and subsequent extension of home numeracy experiences may in effect, support school math learning through fostering positive attitudes towards mathematics.

5.4.2 Implications for Practicing Teachers

For practicing teachers and early childhood educators, this study presents another method of connecting home and school numeracy practices. Many schools have helped bridge the gap
between home and school mathematics by engaging parents in outreach activities such as family math nights (Kyle, McIntyre, & Moore, 2001; Lachance, 2007; Schussheim, 2004). In most cases, these activities help to link school-like math practices to the home, a phenomenon that is often criticized (see Goos, 2004; Winter et. al., 2004). Alternatively, teachers could use photography and the photo interview as a means of linking home mathematical practices to the school.

As an alternative to a traditional family math night, parents could bring photos of their children and discuss the math they see. This may not only provide teachers with another means of understanding the numeracy practices of the home but give parents an opportunity to share ideas with other parents and the teacher. In this scenario, already established home numeracy practices could be highlighted.

Encouraging parents to take photos of and discuss home numeracy experiences could also be used to complement a school-wide family math program, thus resulting in two-way communication. This also supports a view upheld by Warren and Young (2002), who suggest that schools need to enter into a two-way dialogue where the influences and knowledge of both parties are acknowledged and valued, thus creating a stronger home-school numeracy connection.

On another note, it seemed that photography and the photo interview drew parents’ attention to how mathematics was embedded in everyday activities, including play. If this process assists parents in identifying numeracy in play, how might it also help early childhood educators?
5.4.3 Implications for Students of Mathematics

For students of mathematics I hope to provide a means of mediation between home and school numeracy practices. Recall Anderson and Gold’s (2006) notion of mathematical identity which suggests that children develop identities as learners of mathematics. Anderson and Gold suggest that a range of potentially positive social influences may come from acknowledging home numeracy experiences. When we revisit the results of the study through the lens of mathematical identity, the findings suggest that there may be a positive effect on how the child identifies as a mathematics learner.

Although the study did not initially seek to examine how engaging parents in photography and photo interviews affected the child’s math identity, there was evidence to suggest that children’s confidence and interest in math activity also increased. Recall how Jack’s mother revealed how she began to highlight the mathematics in which her son was engaged. She mentioned that by drawing Jack’s attention to the fact that he was doing math gave him the confidence that “I can actually do this!” Thus, whether it is through finding opportunities to encourage, support, or expand upon math experiences or adding value to math in the home by photographing it, parents may help children form positive mathematical identity. This, in turn, may make children more confident to engage in school-based math explorations.

5.5 Closing Thoughts

This study has demonstrated that parents are able to identify, report and expand upon everyday numeracy experiences when they are encouraged to view everyday events through a mathematical lens. As illustrated by this study, the act of photography and the photo interview were a successful means of placing home mathematics in the foreground so that parents were
able to see it and talk about it. As we continue to search for ways to support parental awareness of numeracy in the home, this research provides a valuable foundation from which to build.
References


