

AN INTERPRETIVIST APPROACH TO UNDERSTANDING HOW NATURAL
SCIENCES ARE REPRESENTED IN A REGGIO EMILIA-INSPIRED PRESCHOOL
CLASSROOM

DISSERTATION

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By

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ABSTRACT

This ethnographic study explores aspects of how the natural sciences are represented in a Reggio Emilia-inspired laboratory preschool. The natural sciences as a discipline, a latecomer to preschool curricula, and the internationally-known approach, Reggio Emilia, have interested educators and researchers, but there is little research about Science in Reggio Emilia. The current research aimed to gain insight into natural science experiences in a Reggio Emilia-inspired classroom. To gain in-depth information, this inquiry-based study adapted a research design with ethnographic data collection techniques (i.e., interview, observation, document/artifact collection, and field-notes). The data were analyzed from an interpretive perspective using multiple lenses. These lenses included classroom culture, the Reggio Emilia approach, and Early Learning Content Standards. Several theories guided the study design, including data gathering and analysis. These theories included Spradley's (1980) Developmental Research Sequence Method, which is a well-known ethnographic method, and Corsaro's (1997) peer culture theory. The study involved 18 preschoolers, 10 teachers, and a program director. The results indicated that the Reggio Emilia-inspired preschool offered a science-rich context that triggered and supported preschoolers' inquiries, and effectively engaged preschoolers' hands, heads and hearts with science. The Reggio

Emilia-inspired preschool classroom in this study even exceeded the pre-K standards for natural sciences. The results showed that the Reggio pedagogy, which is grounded in inquiry, is very compatible with science education goals.

Dedicated to my family

&

ALL children on the world

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FIELDS OF STUDY

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LIST OF ABBREVIATIONS

AAAS: *American Association for the Advancement of Science*

CCIE: *Child Care Information Exchange*

CFE: *Center for Education*

D.R.S.: *Developmental Research Sequence*

ELCS: *Early Learning Content Standards*

MELC: *Model Early Learning Center*

MSEB: *Mathematical Sciences Education Board*

NAECS/SDE: *The National Association of Early Childhood Specialists in State
Departments of Education*

NAEP: *National Assessment of Educational Progress*

NAEYC: *National Association for the Education of Young Children*

NCATE: *The National Council for Accreditation of Teacher Education*

NRC: *National Research Council*

NSF: *National Science Foundation*

NSES: *National Science Education Standards*

ODE: *Ohio Department of Education*

PrePS: *Preschool Pathways to Science*

ST: *Student Teacher*

UCLA: *The University of California at Los Angeles*

CHAPTER 1

INTRODUCTION

1.1 Statement of the Problem

In recent years, increasing importance has been given to early childhood education philosophies in the world, and early childhood education is recognized as a significant agent in the development of young children. The Reggio Emilia approach, which originated in Italy, caught the attention of many educators and researchers in terms of its unique philosophy and social-constructivist approach to early childhood education, and it has served as an inspiration to the staff in different preschools (e.g., the Model Early Learning Center- Lewin-Benham, 2006). Throughout the US and other countries (e.g., Sweden and Thailand), many educators and researchers are actively involved in teaching/learning and applying the Reggio Emilia approach (REGGIO CHILDREN S.r.l., 2000).

In U.S., preschool teachers began to study Reggio Emilia thinking more deeply in the early 1990s. Even though the field has been inspired by the Italians' pedagogy, U.S. schools have moved quickly to a standards and discipline-based educational paradigm, even in preschools around 2000. Preschool teachers have started including a wide variety of disciplines in their classrooms, such as literacy, mathematics, art and social sciences,

and natural sciences. Among all the disciplines, the history of studies for inclusion of natural sciences education and related standards into preschool settings does not go back too far.

The natural sciences discipline refers to physical science, life science, and earth/space science (e.g., National Research Council [NRC], 1996; Ohio Department of Education [ODE], 2004). Integration of natural sciences education into early childhood curricula shows an evolution over the last few years. Studies were started in the late 1900s in some states, such as Texas and Georgia, to include the natural sciences discipline into early childhood education curricula, and educators have started moving to a standards and discipline-based educational paradigm in preschools around 2000. Policy makers have pressed preschool teachers to teach natural sciences in early childhood education settings (Bennett, 1978; Hankla, 1975). McIntyre states, “science was a latecomer to early childhood education” (1976, p. 22). The interest in teaching natural sciences and integrating the natural sciences discipline in the early years of a child’s education has increased over the years among educators and researchers. In the 21st century, they have even published teachers’ guide and packet curricula related to natural sciences, such as the “ScienceStart!” curriculum funded by the National Science Foundation [NSF], U.S. Department of Education (Conezio & French, 2002).

Even though the natural sciences discipline is a relative newcomer to preschool curricula, natural sciences are not new to preschool settings. Since the term “discipline” came along with the recent standards, the disciplinarian framework claims that natural sciences are a latecomer to preschool education. However, preschoolers have been involved in natural sciences for years in Reggio Emilia-inspired preschools in the US,

even before inclusion of the natural sciences as a “discipline” into the preschool curriculum. Some of the science projects typical in Reggio and Reggio Emilia-inspired schools are the Long Jump (Forman, & Gandini, 1991), the Light in the Room (Cadwell, Geismar-Ryan, & Schwall, 2005), Everything has a Shadow Except Ants (REGGIO EMILIA S.r.l., 2000a), Forces and Motion (Desouza & Jereb, 2000), and the Water Wheel Project (Forman, 1996). The Reggio pedagogy is grounded in inquiry and thus is very compatible with science education goals. However, there is not much research that can provide information about how science is constructed in Reggio Emilia-inspired preschools to prove to early childhood educators that moving to a standards and discipline-based educational paradigm in preschools is not necessary.

Recent studies in America suggest that educators spend more time on incorporating natural sciences and related standards into their curricula in early childhood centers than what is widely realized. There even has been some research done on natural sciences education in early childhood centers (e.g., Conezio & French, 2002; Gelman & Brenneman, 2004; Howley-Pfeifer, 2002) but not in Reggio preschools. The Reggio Emilia approach has been included in some prominent science forums, such as that of the American Association for the Advancement of Science [AAAS] (Johnson, 1999), as one of unique early childhood education philosophies which lead to good practices in early science education. However, there is a gap in the literature about how natural sciences education appears in the preschools inspired by the Reggio Emilia pedagogy. The aim of the current ethnographic study is to address this gap by examining how science is expressed in preschools inspired by the Reggio Emilia pedagogy, and specifically

focusing on how the Reggio pedagogy integrates quality science experiences and meets pre-K science standards in a preschool setting.

As the current study is an inquiry-based study, it adopted a qualitative interpretivist paradigm (i.e., ethnographic approach) to describe, examine, and define explicit and implicit natural sciences education in a Reggio Emilia-inspired preschool classroom. The setting for this study was a laboratory preschool at a major university in the Midwest working on the application of the Reggio Emilia approach in an American context. Before stating the purpose of this study more in depth, it is essential to state the importance of natural sciences in preschoolers' lives.

Research results indicate that children can benefit from science education in early years of their age (e.g., NRC, 2001; French, 2004). Evidence shows that science education in preschool settings contributes to children's learning and development (e.g., cognitive, social and emotional development), their skills (e.g., exploratory, inquiry, and self-regulation skills) (Conezio & French, 2002; Eshach & Fried, 2005; French, 2002; French, 2004; Gelman & Brenneman, 2004; MSEB/CFE, 2005; NRC, 2001), their future success in science, and their attitudes toward science and confidence in science (Conezio & French, 2002; Eshach & Fried, 2005; Gillingham, 1993; Mullis & Jenkins, 1988; NAEYC & NAECS/SDE, 2002). Children do not only learn about "science content" but also gain the "tools and skills" which are essential for scientific reasoning. Today it is well-known that science is an indispensable part of life and the educational experience. Science is considered to be important for not only scientists but also other people for both personal and societal reasons. As stated by Grieshaber and Diezmann (2000), "scientific literacy is a goal not just for scientists, but for all citizens" (p. 88) including little

preschoolers. The components which constitute the importance of having natural sciences education in pre-K is examined more in detail in Chapter 2.

More importantly, the natural sciences is an essential component of preschoolers' education, because children find a chance to pursue individual interests in science, learn about the real world for their own personal fulfillment and excitement, and establish themselves as competent learners (Conezio & French, 2002; Cummings, 2003; Eshach & Fried, 2005; French, 2004; NRC, 2001). French (2004) also stresses the importance of quality in programs and settings so that children can benefit more from science education.

In the current study, the assumption is that the Reggio pedagogy, which is grounded in inquiry, has already provided preschoolers with a high quality early childhood education that includes science, and thus the preschool educators do not need to move to a standards and discipline-based educational paradigm in preschools. Since there is little research about science in Reggio Emilia, the current research aimed to gain insight into natural science experiences in a Reggio Emilia-inspired classroom and show how preschoolers construct their knowledge of science and meet pre-K science standards successfully.

1.2 Purpose of the Study

The Reggio Emilia approach uniquely contributes to the philosophy of the child's image, the teacher's role, the environment, the projected curriculum, collaboration and cooperation among children, teachers, parents and community, and basically to the early childhood education which is based on relationships. It is this unique understanding of these issues that interests educators and researchers. Malaguzzi (REGGIO CHILDREN S.r.l., 2000b), who is the founder of the Reggio Emilia approach, used the term "the

Hundred Languages of Children” to indicate that there are many ways for children to express themselves, and art, which is one of those hundred languages, is the one most emphasized. The literature shows that much research has been done on issues related to art in Reggio preschools but not science. In the literature, activities and applications in Reggio Emilia classrooms are examined more from the point of view which emphasizes art directly or indirectly.

There are very few studies about the integration of natural sciences in Reggio Emilia classrooms although the Reggio philosophy is very compatible with natural sciences education in terms of both science content and skills. Since this approach encourages young children to engage with natural sciences, it is worth examining and exploring it in more detail. I hope to demonstrate that the Reggio Emilian emergent curriculum can be science-rich and can be in line with standards. Since more states are including preschools in their natural sciences standards (e.g., Ohio and Virginia), documenting natural sciences in preschool settings can help inform the practices of science teacher educators and science educators in general. Accordingly, the objectives of this study were to explore, examine, describe, and document the appearance of natural sciences in the Reggio Emilia-inspired preschool classroom and present how natural sciences are explicitly or implicitly embedded in activities and the physical context of the classroom.

The school where the study took place was a Reggio Emilia-inspired preschool, which also places emphasis on various theorists such as Dewey, Vygotsky, and Piaget, and embrace social-constructivist theory. The preschool staff began to study Reggio Emilia thinking more deeply in the early 1990s. As opposed to the original Reggio Emilia

classes in Italy, this American preschool was much more diverse, serving children with a wide variety of background, ethnicity, nationality, religion, and language. Within this diversity, the research examined the appearances of natural sciences in this Reggio Emilia-inspired preschool and analyzed it in terms of the Early Learning Content Standards [ELCS], which was developed for preschool children by ODE. Specific questions generated for this site-based study are stated in the following section.

1.3 Research Questions

In this ethnographic research, natural sciences education in a Reggio Emilia-inspired preschool classroom within the laboratory school at a major research university in the Midwest were defined, described, examined, and documented. The participants were the preschool children, a program coordinator, lead teachers, and student teachers. Specially, the study focused on the following questions:

- 1) *How are natural sciences socially constructed and integrated into this classroom's daily life curriculum in the preschool classroom?*
- 2) *How does the science constructed in this classroom reflect the Reggio pedagogy?*
- 3) *How does the science constructed in this Reggio Emilia-inspired preschool classroom address the science standards?*

1.4 Research Design

This ethnographic study explores aspects of how the natural sciences are represented in a Reggio Emilia-inspired laboratory preschool at a Midwestern research university. The natural sciences as a discipline and Reggio Emilia of Italy, an internationally-known early childhood education approach, have interested educators and researchers, but there

is little research about science in Reggio Emilia. The current ethnographic research aimed to gain insight into natural science experiences in the Reggio Emilia-inspired classroom.

As the research context was inspired by the Reggio Emilia approach, the current research benefited from the Reggio Emilia approach as a theoretical framework to make meaning of the context, which was a preschool classroom. As Reggio became a lens for this ethnographic study, the current study focused on the components and theoretical sources of Reggio. The current study also took into consideration the uniqueness of the Reggio Emilia-inspired preschool classroom selected for the current study, since every classroom context has its own culture that is reflected in the customary actions, knowledge, beliefs and attitudes of the children and teachers as they engage in the everyday life of the classroom (Green, Dixon, & Zaharlick, 2003).

The theoretical sources of the Reggio Emilia approach include some of the theories of child development and education (e.g., Piaget's cognitive development theory and Vygotsky's sociocultural theory), and the extraordinary history of how the Reggio Emilia approach was born (including war and family influences, and the actual experiences of Reggio children had) (Malaguzzi, 1998). The current research also focuses on the following components of the Reggio Emilia approach:

- The new image of the child, who is intelligent, strong, beautiful, and ambitious (Malaguzzi, 1994);
- the role of the teacher, which is observer, listener, learner, nurturer, partner, and provocateur (Rinaldi, 1993);
- the education philosophy based on strong relationships (Rinaldi, 1998);
- the new idea of curriculum called *progettazione* (Rinaldi, 1998);

- rich documentation of children's work and progress (Gandini, 2004); and
- the role of the well-planned environment and materials (Gandini, 1998).

As the methods employed by the research must be consistent with the theoretical paradigm of the study (Glesne & Peshkin, 1992), this interpretive study opted to utilize an ethnographic design, qualitative data collection methods (i.e., interviews, participant observations, document/artifact collection, and field-notes), and interpretive data analysis methods. This ethnographic study involved a Reggio Emilia-inspired preschool classroom, which included 18 preschoolers, 10 teachers, and the program director. The researcher had a participant observer role and benefited from various data collection tools (e.g., audio-recording, video-recording, and digital pictures).

To collect data considering the whole context and to conduct more focused research and to obtain rich data, Spradley's Developmental Research Sequence [D.R.S.] Method (Spradley, 1980), an ethnographic method, was utilized. In this study, data collection was conducted in multiple contexts within two main phases with sub foci. The data collection was messy and conducted more in a spiral process, but the phases were basically as follows:

Phase 1. Individual Cases (i.e., the Program Coordinator, Lead Teachers)

Phase 2. Preschool Classroom (i.e., Lead/Student Teachers, Preschoolers)

2.1 Physical Environment, People, and Events (Grand Tour)

2.2 Whole Class Science Culture

2.3 Focus and Selective Groups/Events

2.4 Follow-Through

During the first phase of data collection, rapport was built with participants, issues of access to the field were addressed, relevant documents were collected, and semi-structured, open-ended, individual interviews were conducted with lead teachers and the program coordinator in a quiet office setting. During the second phase, data was collected in the classroom context, including the playground and other places visited as a class, as well as through the Internet.

In the current study, the data analysis occurred throughout the study and helped shape how the study proceeded (Glesne, 1999). As the first step of the data analysis, all data were transformed into computer documents in various ways (e.g., interviews were transcribed verbatim). The data were analyzed from an interpretive perspective using multiple lenses. These lenses included classroom culture, the Reggio Emilia approach, and pre-K science standards (i.e., ELCS). Several theories guided the study design, including data gathering and analysis. These theories included Spradley (1980)'s D.R.S. Method, which is a well-known, pioneer ethnographic method, and Corsaro (1997)'s peer culture theory. Spradley helps to set the cultural tone, which is the heart of ethnography. Coding and diagramming was facilitated by software programs called *NVIVO* and *INSPIRATION*.

1.5 Professional Significance of the Study

The significance of this study has two facets. The first importance emerged from the critical place of natural sciences in preschoolers' experience, and the second importance emerged from the lack of research and studies on the place of natural sciences in a well-known and distinguished early childhood education philosophy, the Reggio Emilia approach and its preschools. The Reggio Emilia approach is examined in Chapter

2 along with the main components related to this study. The importance of incorporating natural sciences education into preschool settings is also discussed in Chapter 2, in terms of its benefits and positive contributions to preschoolers. Since more states are integrating natural sciences and related standards into the classroom life of preschool settings (e.g., Ohio and Virginia), the current research can contribute to educators' understanding of how natural sciences appear in a Reggio Emilia-inspired preschool classroom and help inform the practices of science teacher educators and science educators in general.

Although there are some recent studies on early childhood natural sciences education in different preschool settings (e.g., Conezio & French, 2002; Gelman & Brenneman, 2004; Howley-Pfeifer, 2002), there were just a few which focused on the Reggio Emilia preschools. There was a minimal amount of information available in the literature about natural sciences education in the Reggio Emilia schools. It is essential to conduct research to understand this less-examined topic in Reggio Emilia preschools through more exploratory techniques. Accordingly, this research project was designed to address this gap by focusing on how natural sciences are represented in a Reggio Emilia-inspired preschool classroom and by comparing it with state standards for science education, namely the ELCS of Ohio.

1.6 Delimitations

My prior beliefs and ideas about the Reggio pedagogy in general and the nature of applications of natural sciences at this Reggio Emilia-inspired preschool might have an impact on my research. Goldbart and Hustler (2005) state, "Much ethnographic work is concerned with developing theoretical ideas rather than testing out existing hypotheses, but it is silly to imagine that you should (or could) 'enter the field' with a blank mind"

(p.18). I believe that the Reggio pedagogy itself, which is grounded in inquiry, is very compatible with science education goals. My prior experiences in this classroom led me to believe that the Reggio philosophy created a very science-rich context for children and encouraged science experiences explicitly and implicitly.

Moreover, since Reggio Emilia preschools are located in Italy, it was difficult for me to conduct research in those schools. By taking into consideration its unique context, I studied a Reggio Emilia-inspired preschool in this study. The Reggio Emilia-inspired preschool classroom provided a rich, diverse context where I can study how science is constructed and integrated in a Reggio Emilia-inspired preschool. I avoided generalizing my findings by keeping in mind the study's unique setting and conducting a qualitative study. However, since the literature indicates that the Reggio schools in Italy are inquiry-based and thus encourage scientific investigation, I believe that the Reggio Emilia-inspired preschool is rich with investigative science, too, and can provide information about how science represented in a preschool which is inspired by the Reggio Emilia approach.

CHAPTER 2

REVIEW OF LITERATURE

2.1 Introduction

This chapter begins broadly with a discussion on the importance of natural sciences in children's lives, moves on to the general topics related to the natural sciences in preschools, and then discusses the Reggio Emilia approach, and then finally focuses specifically on the natural sciences in Reggio Emilia preschools.

Chapter 2 is organized into three parts. In Part I, the importance of natural sciences in preschoolers' lives is discussed in detail. In Part II, the current applications in preschools are stated along with developmentally appropriate approaches and different pedagogies applied in preschool science education (e.g., play, active learning, scaffolding), science curricula specifically developed for preschoolers, and pre-K science standards. In Part III, the Reggio Emilia approach is discussed in terms of its theoretical sources (e.g., Piaget, Vygotsky, war and family influences, children's experiences), the principles of the Reggio Emilia approach (e.g., child image, teacher role), and then the practical background of Reggio in natural sciences education (e.g., examples of science projects from Reggio preschools).

PART I. Importance of Natural Sciences for Pre-K Children

2.2 Children's Interest and Curiosity

First and maybe the most important reason for including science in the preschool settings is the strong “interest” of preschoolers in science (e.g., Conezio & French, 2002; Cummings, 2003; French, 2004; NRC, 2001). The NRC (2001) indicates that science is one of the domains in which “children have a natural proclivity to learn, experiment, and explore” (p. 9). Children are so curious about the world, and tend to ask lots of questions about it. The National Science Education Standards [NSES] (NRC, 1996) emphasize that science literacy is essential for all people because of the personal satisfaction and excitement they derive from science and being able to make an informed decision when they are scientifically literate.

Cummings (2003) indicates that children ask science related questions constantly because of their interest and excitement in science. She indicates that even less talkative children tend to ask questions related to science. Because there is an innate curiosity, wonder, enjoyment and fun in science issues like “how the world works”, it is essential to include science into the preschool curricula (French, 2004). Accordingly, children can pursue their interests in science with personal excitement and curiosity, and begin real science through more advanced discoveries and explorations with adults’ help and encouragement (Conezio & French, 2002).

Science is a natural part of the real world and children are curious about the world most of the time (Conezio & French, 2002). Science activities are exemplars of “how the world works” (French, 2004). Eshach and Fried (2005) state that children’s inquiry is considered inherent to science itself and “science is about the real world” (p. 316).

Accordingly, science is natural part of children's life and, therefore, it should be a natural part of their education.

2.3 Self-Regulative Skills

Second reason for including science in preschool settings is that science helps children gain or improve self regulative skills, such as attention regulation skills (French, 2004). NRC (2001) reports that preschoolers can learn to regulate their thinking and lengthen their attention span, while developing science process skills, such as observing, predicting, and measuring. This is basically related to the first reason, children's innate interest in science. Since young children's attention span is usually shorter than older children or adults (Santrock, 2001), it is difficult for young children to keep their attention on something for a long time. This is, however, possible through the ways in which they are interested and enjoy being involved. French states that science activities consistently engage young children's interest and participation. Their inner tendency and enjoyment in science helps children become more attentive and gain self regulative skills.

2.4 Social-Emotional, Cognitive and Language/Literacy Development and Learning

The third reason to include science in preschool settings is its contribution to children's learning and development. French (2004) states that because science is so engaging for young children, it serves as an ideal context for supporting their learning, use of cognitive skills (e.g., predicting, planning, and drawing inferences), language development (e.g., acquisition of science related vocabulary, using science language in daily life, exchanging information, and asking questions), and literacy skills (e.g., reading aloud, making charts and graphs, and consulting books for information). Science education contributes to children's learning and development as they practice science

process skills (Eshach & Fried, 2005), such as predicting/hypothesizing, observing, recording data, sorting/classifying, measuring, inferring, communicating results, controlling variables, graphing and problem solving (Harlen, 2000).

A focused and structured preschool science program called ScienceStart!, for example, was found to be very effective in terms of contributing to preschoolers' knowledge of science, cognitive skills and language and literacy development (Conezio & French, 2002; French, 2004). French utilized both narrative and statistical methods to analyze the data. She states, "Children in ScienceStart! classrooms are regularly evaluated for their mastery of science content in the areas of color, shadow, and air using narrative assessments" (p. 146). The data showed that science education contributed to children's cognitive, language, and literacy development while children were learning about such science content (i.e., color, shadow, and air) and gaining science process skills. French also utilized parents' reports related to children's understanding of science. French gives an example of a parent's reports stating "one mother reported that while playing in the back yard, her 3-year-old son asked, 'What do you think would happen if we put water in this dirt? What do you think we will get?'" (p. 145). She states that their science program – ScienceStart!- helps children develop language skills and transfer those skills to other contexts This shows that even young children can gain science process skills, and use these skills in different contexts with their richer vocabulary.

Another preschool science program entitled "Preschool Pathways to Science" (PrePS), which serves to a group of 4- and 5-year-old preschoolers, is also found successful as creating a context in which children's learning and development is supported, nourished and enhanced (Gelman & Brenneman, 2004). For example, several

days after introducing a science reasoning skill “observing”, a child approached teachers with a Lego block saying, “It’s green, It’s rectangle. I cannot *observate* anymore” (Gelman & Brenneman, 2004, p. 153). This shows that a child not only gained science process skills, but also he was able to use them in daily life and communicate his ideas to others.

In addition to cognitive, language, and literacy development and learning, science integrated curricula can contribute to preschoolers’ social and emotional development through creating an environment where children can interact, communicate, and cooperate with each other, and have a productive time together (Conezio & French, 2002; University of California at Los Angeles [UCLA], 2005). For instance, UCLA Early Care and Education (UCLA, 2005) center reports that the PrePS curriculum provided preschoolers a context for mastering social and emotional skills and building self confidence and self esteem.

Accordingly, including natural sciences into a preschool setting is beneficial to children’s development and learning. However, this is possible only in the context of high quality preschool programs (NRC, 2001). Having a science program is not enough. For example, the NRC reports that it is difficult for children to gain social skills during direct instruction than during play. Accordingly, it is essential to be cognizant of what approaches, such as direct instruction, are used to provide young children educational possibilities in natural sciences.

2.5 Prolonged Engagement with Science in Future & Positive Attitude Development

Another reason to include science in the preschool classroom is the positive attitudes of children toward science and possible prolonged engagement with science in

the future. Eshach and Fried (2005) indicate that science should be taught in early ages, because children develop positive attitudes when they are engaged in science in early years. They state that engaging children with science leads them to develop positive attitudes towards science.

Real science begins in the early years through discoveries and explorations which are based on children's curiosity, and children develop the attitude of being a scientist at that time (Conezio & French, 2002). Gillingham (1993) states that lack of self-confidence in science is one of the reasons for failing in science in school or real life. Some students have the idea of "I cannot do it" and do not have self-confidence in science. Children can gain positive attitudes toward science and self-confidence through engaging with science and science materials with enthusiasm, curiosity, and joy in early years of age.

Moreover, in the National Assessment of Educational Progress [NAEP] Science Card Report, Mullis and Jenkins (1988) stress the importance of developing positive attitude towards science and its positive impact on school achievement in later times of schooling. They state that there is a strong relationship between attitudes toward science and proficiency in it. They indicate that this might be just because children enjoy science, believe that science literacy has practical applications and will be a part of their life. Mullis and Jenkins indicate that those children with positive attitudes are more likely to have higher proficiency than students with less positive attitudes toward science. Accordingly, children should be exposed to science in their early ages so that they can develop positive attitudes which might have positive impact in the short term (e.g., affecting school achievement) or long term (e.g., affecting their future life decisions).

Similarly, National Association for the Education of Young Children [NAEYC] and the National Association of Early Childhood Specialists in State Departments of Education [NAECS/SDE] (2002) report that inclusion of science in the preschool curricula can provide children both short and long term benefits, such as school readiness and school success. For example, a “layer-cake curriculum” (Mullis & Jenkins, 1988), which is framed by the science standards, will be sequential and upgraded for each grade level and, therefore, children can build their scientific skills and content knowledge and more likely be successful in later schooling. Providing children this kind of appropriate and educationally beneficial curriculum in early years of age can make children more ready for science in later schooling (NAEYC & NAECS/SDE, 2002).

2.6 Modern Research on Child Development and Learning in Terms of Children’s Competency in Science

The next reason for engaging preschoolers with science comes from the findings of the modern research on young children’s competency in science. Based on Piagetian framework, previously people thought that children have to pass some developmental stages so that they can have more abilities and better understanding. However, now it is believed that children are more competent than what Piaget stated. Current research critiques some developmentally appropriate practices as “simplistic conceptualizations” of child development and reveals many unexpected competencies in young children (NRC, 2001). Working within a Piagetian framework, for example, it is believed that preschool children’s learning focuses on here and now and mostly perceptible (NRC, 2001) and engaging young children with complex science tasks is inappropriate and fruitless (the Mathematical Sciences Education Board [MSEB] and the Center for

Education [CFE], 2005). However, research shows that children are more competent having more complex and abstract thinking other than only perceptual so that science education and instructional interventions are appropriate and essential for their development and learning (Gelman & Brenneman, 2004; MSEB/CFE, 2005; NRC, 2001).

NRC (2001) states that based on modern developmental psychology children appear to have more competencies, which appear to be universal, than that some stage theorists believed. When young children have accumulated substantial knowledge through engaging with science actively, gaining more knowledge in time and asking in-depth questions, they can abstract well beyond what is usually observed. The NRC also stresses individual differences in young children and the importance of Vygotskian notion relationship of adults with children in promoting and supporting children's competency in science as opposed to the stage theory, which sometimes underestimates children's competencies and claims that children need to reach a certain developmental stage to accomplish certain tasks. Briefly, recent research shows that engaging children with science would be appropriate.

In Part II of this chapter, the natural sciences education in general, some research-based effective teaching/learning pedagogies and science curricula for preschoolers are discussed respectively. Then content standards for pre-K science are stated and discussed in terms of benefits and drawbacks in the education of young children.

PART II. Natural Sciences Education in Preschools

2.7 Introduction

According to Armga, Dillon, Jamsek, Morgan, Peyton, and Speranza, “For young children, science is discovery” (2002, p. 2). Defining science as discovery might imply inquiry-based science education, where children take an action, such as doing experiments and exploration. Armga et al. state, “The word *discovery* evokes an image of children using all five senses-sight, hearing, touch, taste, and smell-to actively explore their surroundings” (p. 2, italics in original). They clearly state that science is an active engagement and exploration done with children’s five senses. According to Conezio and French (2002), “Real science begins with childhood curiosity, which leads to discovery and exploration with teachers’ help and encouragement” (p. 14). This suggests that the way natural sciences are integrated in classrooms requires children to inquire about the world and be active in their discoveries and teachers to be a guide for them.

According to Conezio and French (2002), there are three components which young children engage in during their discoveries in science. Those are content, process, and attitude. *Content* refers to “what to cover”, the information, which is constantly changing as new discoveries are made. *Process* refers to the skills that children need to have as a scientist, such as making observations, predictions, classifications, and hypotheses. Lastly, *attitude* refers to children’s curiosity and desire to create new ideas and challenge the existing ones.

Moreover, according to Tsitouridou (1999), the natural sciences education often has two primary components: *What to teach* and *how to teach*. What to teach involves the content and process components of science which are just stated. In terms of what to

teach, Bredekamp and Rosegrant (1992) point out the big mistake that often appears in early childhood curricula; that is underestimating content over process or process over content. Huffman (2002) indicates that in the 1960s U.S. reforms emphasized much science process skills (such as, observing, inferring, controlling variables and experimenting) at the expense of content. However, both are equally important for effective science education and should be covered properly (see Figure 2.1).

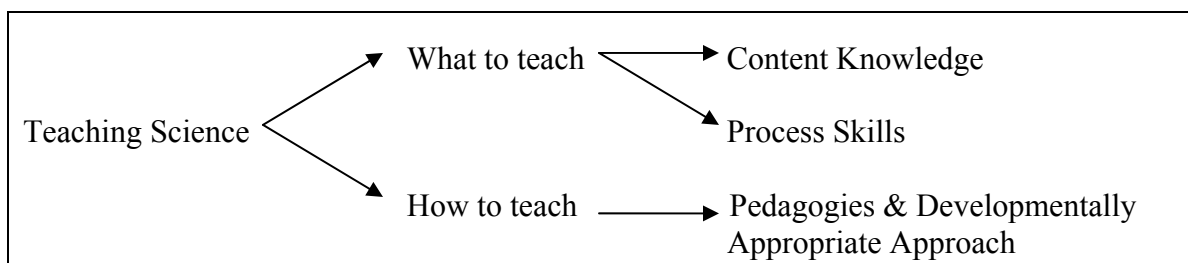


Figure 2.1. Components of teaching science.

Science content includes the *subject matter* (e.g., insects and plants) and *science concepts*, which apply to principles of subject matters (e.g., shapes of insects and colors of plants) (Hoorn, Nourot, Scales, & Alward, 1993, pp. 102-103). Helpful information about science contents can be easily found in early childhood science activity books or from other resources, such as the Internet. Content standards for science can also provide teachers a general framework for the content. The way of choosing the content is another issue and might differ depending on the educational philosophy. For example, Kallery and Psillos (2002) state that they choose the content of the science activities from units of the curriculum called *cycles of knowledge and experiences* (p. 51), whereas Reggio Emilia teachers consider children's current needs, interests, questions, confusions, and

inquiries as reference to what to teach (Rinaldi, 1998a). This shows that, in contrast to many other science curricula, the Reggio Emilia approach focuses on children when selecting the content for science education. In terms of process, Figure 2.2 summarizes basic science process skills for young children identified by Kilmer and Hofman (cited in Armga et al., 2002, p.3).

Skill	Definition
Observing	Noticing, gathering information about the world
Identifying	Labeling the information with a name that has a meaning shared with others
Comparing	Pointing out similarities and differences between objects and events
Classifying	Organizing information into meaningful units based upon comparisons
Communicating	Sharing information with others and explaining information to others
Utilizing	Generalizing information from one experience to another

Figure 2.2. Basic science skills for young children.

On the other hand, in terms of “how to teach” there are several pedagogies that are found to be as developmentally appropriate and effective at engaging preschoolers with science in school. Some of those are discussed one by one in the following section. It is essential to note that there might be some overlaps between those pedagogies. For example, play itself can also cover active learning, hands-on experiences.

In the following part of the literature review, first, preschool science education pedagogies, which are the ones most emphasized in the literature (i.e., active learning, play, and scaffolding), and the whole child perspective in science education are discussed. Then three science curricula, which are developed specifically for preschools, are stated. Lastly, a discussion on preschool science content standards is conducted. Those should not be considered as separate from each other but complete each other.

2.8 Current Pedagogies for Pre-K Science

Over the years, educators and researchers have been looking for effective pedagogies to engage young children with science. A short glance at history might help to understand the movements generally. Back in the 80s, Linn (1987) pointed out the changes in educational philosophy by stating, “We have become an ‘information society.’ Available information doubles every 2.5-years. Skill in locating and utilizing information to solve problems has become far more critical than skill in memorizing information” (p. 193). With the big revolution – moving from memorization of information to utilization of information, educators and researchers have started looking for different pedagogies other than the old strategy, memorization. The focus has become much more on helping children develop an inquiring mind and scientific approach to problems. This has brought new pedagogies and approaches to teaching and learning science.

Evidence shows that there are several pedagogies that can work well for preschoolers. For those who are looking for the best technique for effective science teaching in a preschool setting, NRC (2001) states that the best technique is to select “the right tool for the right task at the right time” (p. 11). While discussing effective pedagogies, it is also important to keep in mind that:

There are no magic bullets, no right curriculum or best pedagogy. We know that children can learn a great deal in the care of an adult who is tuned into the child's current level of development and his or her developmental challenges. We know that when carefully supported or scaffolded, children can be happily engaged in relatively complex thinking and problem solving. (NRC, 2001, p. 232)

Instruction must be flexible and responsive to diversity addressing all children, since different cultural groups have distinct formal and informal learning experiences (Katz, 1999; Linn, 1987). Accordingly, the analysis of current pedagogies and the Whole Child concept in pre-K science must take into account that no one strategy or curriculum fits every culture or every child.

2.8.1 Active Learning: Hands-on Pedagogy

Active engagement has become the focus of many curricula and science education standards and is being used as an effective way of learning science over years (e.g., Linn, 1987; Piscitelli, 2000; Rakow & Bell, 1998). Even back in the late 1980s, Linn stated that there was a widespread agreement at the meeting at Berkeley with distinguished mathematicians, scientists and curriculum technology experts that the learner actively constructs a coherent worldview based upon his/her personal observation and experience and responds to formal instruction in terms of his/her preexisting intuitive knowledge. Piscitelli (2000) states that an active-learning approach can be traced back to Dewey (1859-1952) as well as Piaget (1896-1980) and Montessori (1870-1952). They all indicated that a child actively constructs his/her own knowledge. Piscitelli also stresses that Montessori supported active and self-directed learning and development with materials specially created for young children as well as interactive strategies for the tenets of active learning (see Table 2.1).

The active learning-philosophy holds that learning
• is a process of engagement with resources and ideas, • involves people solving problems and discovering new things, • contributes to personal development and social change, • occurs sometimes in isolation but more often in collaboration with others, • ignites creativity.

Table 2.1. Tenets of active learning (Piscitelli, 2000, p. 40).

As seen in Table 2.1, the active learning strategy involves using materials/resources, manipulating, experimenting with them, working with others or alone, asking, thinking, answering and so on – similar to NAEYC and NCATE ’s (2001) depiction of science education for young children (see Figure 2.3).

NAEYC and NCATE (2001) report that young children’s investigation may not be systematic or their ideas may be scientifically inaccurate. They indicate that although their investigation may not be systematic or their ideas may not be accurate, young children’s intense curiosity, interest and love of hands-on exploration lead them to engage with science like more mature scientists do, so that they should be supported and encouraged in their active engagement with learning and doing science (see Figure 2.3 for the science related experiences suggested for young children by NAEYC & NCATE).

Mullis and Jenkins (1988) explain this in *NAEP Science Report Card*:

The brief analysis of the scientific pursuit of learning also suggests the value of providing students with greater opportunities for observing natural phenomena both within and outside the classroom, and engaging them in measuring, experimenting with, and communicating data from the surrounding world. As active rather than passive participants in the learning process, students can strengthen their full range of mental process, from formulating hypothesis,

explaining observations, and interpreting data to other thinking skills used by scientists in their efforts to build understanding. (pp. 13-14)

Science. Although their investigations may not be systematic and their ideas and questions may not be scientifically accurate, young children's intense curiosity and love of hands-on exploration give them much in common with more mature scientists. Early childhood offers unique opportunities to explore phenomena using skills of scientific inquiry, cultivate scientific dispositions, and build a foundation for understanding core scientific concepts. Candidates are able to articulate priorities for high-quality, meaningful science experiences in early childhood, across a developmental continuum. Focused exploration of meaningful content (for example, the growth and development of a plant over time, or investigation of the properties of water at a water table) supports early scientific understanding. Depending on children's ages and other characteristics, those experiences should help children to, for example:

- Raise questions about objects and events around them
- Explore materials, objects, and events by acting upon them and noticing what happens
- Make careful observations of objects, organisms, and events using all their senses
- Describe, compare, sort, classify, and order in terms of observable characteristics and properties
- Use a variety of simple tools to extend their observations (e.g., hand lens, measuring tools, eye dropper)
- Engage in simple investigations including making predictions, gathering and interpreting data, recognizing simple patterns, and drawing conclusions
- Record observations, explanations, and ideas through multiple forms of representation
- Work collaboratively with others, share and discuss ideas, and listen to new perspectives

Figure 2.3. NAEYC & NCATE's report on teaching children science (2001, p. 22).

In their chapter *A Constructivist Perspective on Teaching and Learning Science*, Julyan and Duckworth (2005) indicate the way that children construct their understanding of how things work is similar to the way that adults build their own understanding. They state, "our beliefs about how the world works are formed around the meanings we

construe from the data of our experiences” (p. 63). Accordingly, active engagement gives children much in common with more mature scientists (The National Association for the Education of Young Children [NAEYC] and the National Council for Accreditation of Teacher Education [NCATE], 2001). The work of children involves similar *process of making meaning*, and they construct their own understanding from their own experiences and from those meaning making processes (Julyan & Duckworth, 2005).

Moreover, Julyan and Duckworth (2005) indicate that during that meaning making process, children deal with some conflicts, contradictions, conundrums, puzzlements, and confusions. They state that by encouraging children to express feelings related to their work, the teacher can encourage children to consider the whole learning process. They indicate that the atmosphere of playfulness is most likely to encourage children to express feelings and release frustration that is inherent in constructing one’s own understanding.

Briefly, active learning theory in science education proposes children’s active participation. Accordingly, this constructivist view of teaching and learning science implies that teachers should allow children to have some direct “experiences” with science. Ritz and Von Blum (2000) state that teacher education programs can prepare teachers to be more confident in teaching science and using more hands-on science experiences in their classrooms. The results of their research on the teacher training program (hands-on education) show “a marked improvement in the quality and quantity of science experiences children received” (p. 1).

2.8.2 Play

In early childhood science education literature, play is cited as one of the contexts in which children can take control of their actions, have hands-on experiences, and have fun while learning science. Play is defined as a pleasurable, enjoyable, spontaneous, choiceful and voluntary activity (Garvey, 1990). Wolfinger (2000) indicates that young children cannot be taught with direct instruction methods, such as formal explanation. Instead, teachers should create a context in which preschoolers can have worthwhile, meaningful and cooperative science experiences, and play is one of such contexts (Fromberg, 1999; NRC, 2001).

In *Science in the Play-Centered Curriculum*, Hoorn, Nourot, Scales, and Alward (1993) state that children's inquiries and interests which are relevant to science occur in play naturally. According to Hoorn et al., children have a natural curiosity about concepts that are milestones in the evolution of science itself, such as the laws of floating, the relationship of time, and distance and velocity. They indicate that play creates a context in which children can engage with science as they work with and explore varied materials and pursue individual interests. Besides science content, a play-centered curriculum also provides children opportunities to get involved in some *science processes*. Hoorn et al. describe science processes as "the ways children seek answers to their questions" (p. 101). They give an example of how a preschooler gets actively involved in science during play:

We notice that three-year-old Rosa is investigating floating and sinking. At first she pushes the boat down slowly and watches the water enter the boat drop by drop. When it is almost full it sinks quickly, listing a bit to the right side. Later, when Rosa adds the bark chips and rocks, she selects the chips first and appears to notice that the boat lowers in the water only slightly. At this point she adds the three rocks and watches as the water begins to come in. She appears [to] be trying to make the boat sink. She picks up two rocks together and puts them both in. The

boat sinks. As the bark chips float to the top, she imitates the popping sound they make as they break the surface of the water. (p. 96, parenthesis added)

Hoorn, Nourot, Scales, and Alward (1993) state that teachers can observe children's play to figure out their interests, so that they can create more opportunities and structured activities drawing upon children's expressed interests. Irving (2000) states, "observing children has served as the foundation for curriculum planning and has enabled teachers to center their programs on the specific needs of individual children" (p.77). Accordingly, by observing children during play, teachers can also collect information on their interests and then use this information to frame the future structured activities or to make plans to furnish their on-going play.

Teachers can also support children's science play some other ways too, such as by organizing a rich environment for exploration and social interaction, and introducing age-appropriate science activities related to children's current play (Hoorn et al., 1993) and by *modeling*, which helps young children a lot (Fromberg, 1999). In short, a play-centered curriculum is one way for teachers to include natural sciences in classrooms, so that children can engage with natural sciences through play, which is natural for them.

2.8.3 The Role of the Teacher and Scaffolding

Although play creates an engaging context for children to work on science, teachers' roles in the learning processes remains important. Based on various research, NRC (2001) stresses the importance of the role of the teacher for effective science teaching. NRC states, "If there is a single critical component to quality, it rests in the relationship between the child and the teacher/caregiver, and in the ability of the adult to be responsive to the child" (pp. 20-21). It is stated that other components of education,

such as the environment, family, and the community, can become more effective only with the help of good teachers. Teachers' role in providing quality education is often stressed by NRC, such as in a way of organizing the classroom environment, planning child-initiated and teacher-initiated activities, and pursuing specific educational goals for each child. Briefly, teachers play an important role in making education more effective.

Teachers make decisions depending on the unique context of their classrooms and unique situations of each child (NRC, 2001). Grieshaber and Diezmann (2000) state that teacher training programs should be *dynamic*, *flexible*, and *sensitive* so that teachers can be responsive to “the challenge of developing more effective ways to teach and learn science with young children” (p. 93). There is not a single curriculum or strategy that fits every teacher, every classroom or every child.

Scaffolding stresses the relationship between the child and the adult/peer in terms of providing help, and suggests gradually giving the child a more active role. It is based on a socially constructed view of teaching and learning. The NRC (2001) often suggests teachers use scaffolding and apply it to early childhood science education.

Based on Vygotsky's idea of Zone of Proximal Development, NRC (2001) defines scaffolding as “an image that suggests a support to help one work where one could not reach if unsupported” (p. 220). The NRC report indicates that, “the adult provides just enough but not too much support, matching the amount of support to the skill level the child displays, providing more support if the child falters and decreasing support just enough to challenge the child to move ahead” (p. 220). Grieshaber and Diezmann (2000) state that adults provide children conceptual support through stating what is known, paraphrasing, redirecting, questioning ideas and approaches, providing

information and assisting with problem solving. Based on her observations in a Head Start classroom, Mooney (2000) states that scaffolding, interaction, conversation, and experimentation helped children learn about both science processes and contents. She states that those children increased their skills gradually and accomplished their goals in science.

Fleer (1991) points out socially constructed scientific knowledge and states, “it is not the scientific knowledge, but the whole science genre in which this ‘content’ knowledge is placed, that must be taught to children. In sharing this cultural knowledge with children, emphasis must be placed on the social context through giving attention to the interactions between the adult and the child” (pp. 16-17). Fleer indicates that this socially constructed way of learning is more meaningful to children and transferable to everyday language. Based on the research conducted with 4 year-old children, Fleer states, “Within a framework which started with the children’s questions, children were moved towards scientific understanding. The teacher modeled the investigation process (based on the children’s questions), and over time, the children took on the investigation process themselves. The children connected up the circuit, initially in collaboration with the teacher, but after a period of time, less teacher assistance was given” (p. 20). Those children were able to easily connect up the circuit and express the scientific way of current flow even after three months later in the study. This supports creating a social context in which a child learns about science with the assistance of a teacher or a competent peer through scaffolding.

Moreover, Grieshaber and Diezmann (2000) state that teachers provide children materials and equipment as well as conceptual support during a scaffolding process. NRC

(2001) states that children learn from interactions with the physical environment as well as from adults and from each other. Accordingly, it is essential to be aware of both sides of the environment -social and physical.

2.8.4 Providing Hands-on, Minds-on, and Hearts-on Science Experiences

This is a different perspective on the science education of young children. Previously, teaching and learning science was discussed in terms of the developmentally appropriate practices and pedagogies which are often cited in science literature. Here, science education will be discussed in terms of the whole child perspective.

Csikszentmihalyi and Hermanson (1995) state that the most effective teaching occurs when learning happens in a way that children are engaged *cognitively*, *motorically*, and *emotionally* (cited in Sinker & Russell, 1998). Minds, hands, and hearts, which make a human being whole, are connected to each other so that they all should be considered for effective science education (Russell, 1997) besides the notion of “whole child” within the larger physical and social environment in which children have a constant interaction (New, 1999).

The importance of hands-on, heads-on, and hearts-on experiences for effective science education is often emphasized under various practices, such as hands-on experiences in the active-learning theory (e.g., French, 2004; Gillingham, 1993; Grieshaber & Diezmann, 2000; Hoorn, Nourot, Scales, & Alward, 1993; Russell, 1997). Referring to Bredekamp’s Developmentally Appropriate Approach, Gillingham (1993) states that hands-on science activities are developmentally appropriate for preschool children because hands-on activities allow children to construct their own knowledge at their own cognitive and knowledge level as well as individual interests.

While minds-on refers mostly to children's innate curiosity, wonder, and inquiries about the world (Russell, 1997), hearts-on refers to children's feelings and attitudes including their interests, enjoyment and love of science experiences (e.g., Cummings, 2003; French, 2004; Hoorn, Nourot, Scales, & Alward, 1993). Ginsburg and Golbeck (2004) state that although emotions cannot be separated from science learning, they are not emphasized as much as hands-on and heads-on experiences. *Heartless science* might suffer as handless and headless science might suffer (Russell, 1997). Russell states, "We are body, mind and spirit." Accordingly, any pedagogy should target all those components for effective science teaching.

National Research Council (2001) points out Katz's concepts of four dimensions of growth, namely, *knowledge, skills, feelings* and *dispositions*, which constitute the whole child and cannot be separated from each other. The council report stresses the importance of supporting all those dimensions in creating effective strategies for children's science education. It indicates that knowledge and skills, which refer to science content and scientific processes, can be gained through effective instruction, but positive feelings and dispositions can be constructed only through positive relationship between the teacher/caregiver and children during the instruction.

In addition to all those pedagogies, developmentally appropriate practices and the whole child perspective in early childhood science education, it is essential to specifically discuss the science curricula developed especially for preschoolers. Three curricula, which were stated in the literature, will be discussed briefly.

2.9 Preschool Science Curricula

2.9.1 PrePS Curriculum: Conceptually-Connected Experiences

Pathways to Preschool Science [PrePS] is one of the few curricula that are developed specifically as a pre-K science and math program. It is developed by some developmental psychologists with the help of UCLA early childhood care professionals and staff, and applied in UCLA Early Care & Education center. PrePS proposes conceptually-connected experiences for children, based on the idea that a concept in a domain does not stay alone but connects to other concepts (Gelman & Brenneman, 2004).

Teachers' role is to design new learning experiences, organize these experiences around a central concept and then to be responsive to individual interests and needs of children within their group (UCLA, 2005). The key finding from Gelman's research is that children are capable of scientific thinking far more complex than scholars such as Piaget had considered possible (MSEB & CFE, 2005). This suggests that young children are much more competent than was believed before.

Rochel Gelman (2000), who is a developmental psychologist, theorizes that children learn through *domain-specific* instead of *domain-general*. She states that the Domain-Specific theory assumes that different areas of knowledge are organized into separate mental structures as opposed to domain-general theories like Piaget's concrete operations, which proposes the concept of universal structures of mind. A domain of knowledge is defined as *a set of interrelated principles*. For example, science domains are biology, space, entomology and so on. Gelman states "core domains constitute a small universal class of knowledge structures" (p. 855) but show variation in displaying the principles because of the individual and cultural variations among children. Accordingly, the principles cannot be considered as universal but flexible showing variations in different cultures.

Gelman (2000) also states that children acquire knowledge with or without the explicit help of others. She stresses the importance of the environment. Gelman and Brenneman (2004) state that children can master their skills and assimilate knowledge in specific domains when conditions are met (like adequate environment). They advise teachers to enrich the environment with some materials called *observation tools* (e.g., magnifying glasses and light tables) and *measuring tools* (e.g., tape measures, measuring spoons, and balance scales). They also emphasize the importance of using correct language/vocabulary because “the language of a domain and its concepts go hand in hand, it follows that scientific terms and the processes to which they refer should be paired with concept learning material from the start” (p.153).

Macdonald, the director of UCLA Early Care and Education center, states that teachers themselves build PrePS curriculum science plans around a central science concept and integrate it across with various disciplines, such as literacy, math, social skills, communication, and art (Child Care Information Exchange [CCIE], 2004). Accordingly, building conceptually connected experiences happens across disciplines.

The PrePS curriculum is based on the concept that learning is progressive and continues throughout a lifetime. Children and adults are all seen as learners who “think,” “talk,” and “work,” and it is stated that the PrePS curriculum fosters their critical thinking, ability to ask questions and the experience of having pleasure in the finding of new things. It is also stated that PrePS helps children and adults practice science reasoning skills, such as observing, predicting, measuring, testing, documenting and communicating (UCLA, 2005).

Gelman and Brenneman (2004) indicate that understanding of new concepts takes time, because it is not simply memorizing the new words but understanding how to use them in relative contexts. In order to create conceptually-connected experiences, the teacher introduces preschoolers to a new concept, for example, “observation” along with some examples for that new concept. Gelman and Brenneman state that PrePS helps children use new acquired scientific concepts even several days after they are introduced. They indicate that vocabulary is just one of the tools to create domain-specific knowledge; there can be other tools, such as science notebooks.

It is stated that PrePS is a research-based science and math curriculum that supports children’s in-born urge to explore, investigate and discover through five senses, and to make connections between what is familiar and what is new, to build new theories, to construct knowledge from experience and to master new science skills.

2.9.2 The Interactive Approach to Science Education

The Interactive approach, which is developed by Biddulph and Osborne for science education, focuses especially on “what is in children’s heads” (Kirkwood, 1991, p. 13). Kirkwood indicates that this approach supports children’s discovery, interaction with teachers, and using scientific methods in learning science. In contrast to PrePS, the Interactive approach supports building a strong interaction between children and teachers. Figure 2.4 displays the cycle of science education for young children which the Interactive approach proposes.

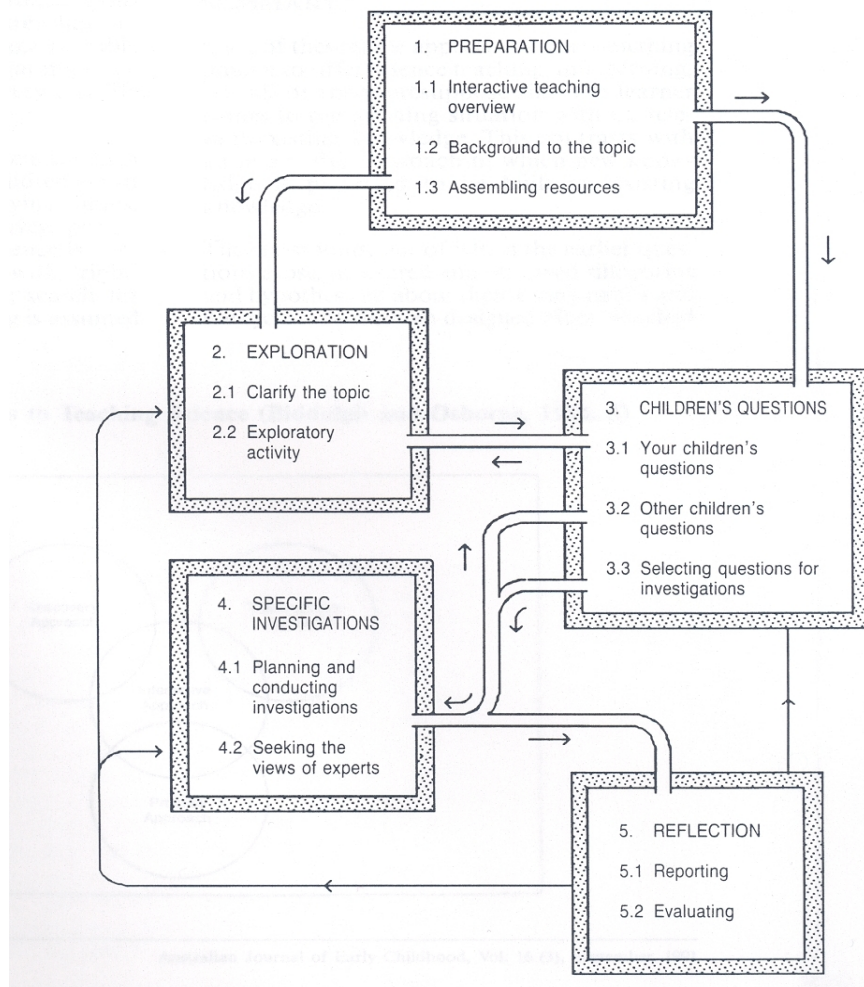


Figure 2.4. Biddulph & Osborne's Interactive approach (cited in Kirkwood, 1991, p. 11)

Findings of the research conducted in a preschool classroom by Kirkwood (1991) show that the Interactive approach successfully encouraged 4-6 years-old children in engaging with science. They did brainstorming, pursued their own interests and questions (such as, "What do silkworms eat?", "What will happen to the silkworms as they grow bigger?"), conducted discovery, used scientific methods (such as, designing an experiment, measuring, hypothesizing), and engaged in more teacher-guided activities

(such as, bringing a silkwormery into the classroom, making bird nests and exploring eggs). Kirkwood states that the Interactive approach pays much attention to children's own questions related to science and leads them to pursue their own interests with help from teachers.

There is not much research-based literature on this approach, but it was essential to state it here because of its principles, especially teacher-child interaction, importance of inquiry and discovery, and using science process skills.

2.9.3 ScienceStart! Curriculum: The Cycle of Scientific Reasoning

ScienceStart! is a long-term research-based science curriculum for preschool-age children and is widely applied as part of many Head Start programs in America (NRC, 2001). It was developed by Lucia French, colleagues, some classroom teachers, and doctoral students especially for children from low-income families attending Head Start programs, but it can be also applied in preschools with other programs (French, 2004; NRC, 2001). French (2004) suggests teachers use a simple form of the cycle of scientific reasoning as part of the ScienceStart! curriculum. She indicates that children follow the following steps of scientific reasoning in the ScienceStart! program:

- Reflect and ask
- Plan and predict
- Act and observe
- Report and reflect (see Appendix A: Examples for each step).

French (2004) indicates that this strategy is supported with read aloud sessions, some props, and math and social studies integrated activities. She also stresses the importance of hands-on active engagement with science, and the role of an adult in

children's learning. Parents also are involved to recognize and foster their children's intellectual development (NRC, 2001). In the National Research Council report book *Eager to Learn* (NRC, 2001), the key attributes of ScienceStart! are discussed. It is stated that generally the ScienceStart! program addresses "science topics and concepts that the child can experience in the immediate environment" (p. 209). It is coherent, because "each day's activities building on those of the previous day and providing a foundation for those of the next day" and also "activities are organized into units" (p. 210) (see Appendix B for an example subunit). It is also integrated, open-ended (inclusive) to accommodate diversity among children, and language-rich.

The research on ScienceStart! showed that this focused and structured program helps children practice science reasoning skills, be highly engaged with science, gain in science related vocabulary and language competency, interact with each other as well as show less disruptive or off task behavior behaviors (French, 2004). Moreover, it is also essential to point out that ScienceStart! is a science program that is already prepared by teachers.

The three curricula (i.e., PrePS, the Interactive curriculum and ScienceStart!), different pedagogies used in preschool science education (i.e., active learning, play, scaffolding), and the whole child concept with heads-on, hands-on, and hearts-on science is discussed. In order to have a better idea of the current preschool science education in schools, it is also essential to examine preschool science standards in terms of what they are, how to use them in the curriculum, and their risks/limitations and benefits.

In some states, there are content standards that teachers benefit from in early childhood science education. Since one of the aims of current research is to examine

natural sciences education in a Reggio Emilia-inspired preschool in terms of the state standards, it is essential to discuss content standards, specifically ELCS, in this part of the literature review.

2.10 Standards for Pre-K Science

Standards for early childhood years, which are usually called *early learning standards*, are defined as expectations for learning and development of young children (NAEYC & NAECS/SDE, 2002). Those standards do not only consist of expectations but also values and outcomes of education (NRC, 2001, p. 278). The term “content standards” is defined as “a general statement of what all students should know and be able to do” (ODE, 2004, p. 57). Accordingly, a standard for pre-K science involves a science concept that a preschool age child should know about and a science skill that a preschool age child should have.

NRC (2001) indicates that specific standards of learning for children ages 2 to 5 are not well developed in the science area. However, in recent years, incorporation of the natural sciences discipline into the early childhood curricula have led to a growing need for standards for pre-K science, because standards serve as a framework for children’s development and learning relevant to the natural sciences discipline (NAEYC & NAECS/SDE, 2002).

In some states (e.g., Ohio and Virginia), preschool educators benefit from pre-K science standards, while some preschool educators in other states benefit from standards that are developed for older children, such as the AAAS benchmarks (French, 2004) or NSES content standards (Rakow & Bell, 1998). Rakow and Bell state that using kindergarten or later grade standards for preschools, however, should not occur like

“simplifying classroom methods, diminishing content areas or reducing school experiences to paper-and-pencil exercises” (p. 167). Instead, teachers should be sure that they are developmentally appropriate, scientifically sound and sequenced (Rakow & Bell, 1998).

In this study, specifically ELCS (ODE, 2004) is chosen as early content standards to compare and contrast with theoretical assumptions and practical applications in the current preschool classroom. There are two reasons for this. The first reason is that the staff at this school indicated that they use specifically ELCS in their curriculum. A second reason is that ELCS provides standards and matching indicators/benchmarks which are developed especially for preschoolers.

ELCS (ODE, 2004) provides educators a framework for preschoolers’ science education covering the science content standards that provide a general statement of science knowledge and skills. ELCS is categorized under six separate sections, namely, *earth and space sciences*, *life science*, *physical sciences*, *science and technology*, *scientific inquiry*, and *scientific ways of knowing* (see Appendix C for standards in each section). Each section has different units, which are called “Pre-K – Grade 12 Organizers”, and the matching “pre-K indicator/s”. Each indicator is “a specific statement of knowledge that all students demonstrate at each grade level” and serves as a checkpoint to monitor a child’s progress toward the benchmarks (ODE, 2004, p. 54).

A benchmark, on the other hand, is defined as “a specific statement of what all students should know and be able to do at a specified time in their schooling” (ODE, 2004, p. 52). For example, the benchmark under the Life Science section would be as follows: “Explain how organisms function and interact with their physical environments”

(see Appendix D for the benchmark, ODE, 2003). The matching pre-K indicator for diversity and interdependence of life organizer under the Life Science section would be as follows: “Observe and begin to recognize the ways that environments support life by meeting the unique needs of each organism (e.g., plant/soil, birds/air, fish/water)” (ODE, 2004, p. 38). Those pre-K indicators and benchmarks are used to assess an individual child’s progress toward meeting the each standard.

It is important to clarify more the relationship between standards and the curriculum. While content standards provide teachers a framework of concepts about what children should know and be able to do, a curriculum is the way teachers organize and accomplish this. It is stated, “Curriculum is the way content is organized and emphasized; it includes structure, organization, balance, and presentation of the content in the classroom” (NRC, 1996, p. 111). Accordingly, a curriculum might change from classroom to classroom, school to school depending on children’s interests, needs, and diverse backgrounds, and specified standards provide a general framework for that curriculum. As stated by NRC (2001), establishing standards for quality education does not necessarily mean insisting on *uniformity* (p. 29). Otherwise, as stated by Hatch (2002), “Substituting a narrow, skills-based approach for a dynamic, child-responsive curriculum will rob young children of the joy of discovering how much they can learn and just how fulfilling school experiences can be” (p. 459). Accordingly, it is essential for teachers to use standards properly.

On one hand, standards have some risks and limitations (see Appendix E). A first risk is related to individual differences of children. Since standards are designed to consider a particular group of children, standards often do not apply to children’s

different learning styles (Rakow & Bell, 1998) and children with varied backgrounds (Scott-Little, Kagan, and Frelow, cited in NAEYC & NAECS/SDE, 2005). Although the issue of developmental appropriateness of standards is emphasized a lot in NSES (Rakow & Bell, 1998), in order to reach “all” children teachers should also pay attention to individual differences including cultural, social and historical differences among children. NRC (2001) cautions teachers by stating, “There is the danger that attempts to set common standards, or even to formulate what children need, may reflect the preferences of a particular group rather than the American population as a whole” (p. 277). Teachers should conduct necessary accommodations in the classroom to meet individual differences, needs and interests.

Moreover, Hatch (2002) indicates that standards create the risk of labeling children as “failed” and causing, therefore, negative consequences of this label, which may last their whole life. Furthermore, standards are mostly related to the cognitive domain, because they usually focus on what children “know” and what children can “do” instead of how children “feel”. A survey on the applications of early learning standards in 40 different states of America shows that “social-emotional development and ‘approaches to learning’ are the areas least commonly included in standards” (Scott-Little, Kagan, and Frelow, cited in NAEYC & NAECS/SDE, 2005, p. 1).

Another limitation is lack of connectedness to the children’s experiences and their learning and activities. If teachers focus solely on achieving those standards, they might push children to achieve them without paying attention to the meaningfulness of experiences for children. This is one of the possible risks, because early learning standards focus on “the desired outcomes and content of young children’s education”

(NAEYC & NAECS/SDE, 2005). If teachers give attention to only the outcomes of learning, there will be a risk of ignoring and understanding a valuable part, which is “process” of learning, and children will feel rushed and pressured to achieve standards. However, it is believed that learning is a process with possible outcomes.

Schuler (2000) indicates that the topic, outcomes, and process of learning all are important parts of the project curriculum, and he used the project approach while meeting the state (Illinois) standards. He states, “the process of learning, practicing, and meeting the state learning standards become an interactive, purposeful, and enjoyable experience” (p. 23), and he continues, “Children enjoy learning on their own and from each other. The teacher enjoys watching, listening, collaborating, facilitating, and participating in the learning process” (p. 23). In this paper, it is suggested that not only the outcomes but more importantly the process of learning should be valued, supported, documented and assessed.

In terms of the limitations of standards, Elmore indicates that standards might become superficial, irrelevant, and narrow (as cited in NAEYC & NAECS/SDE, 2002). It should be noted that having high quality education does not necessarily mean achieving those standards. Standards are not assessment tools to judge children either. Elmore (2004) stresses the importance of using standards to enable “all schools to become competent and powerful agents of their own improvement” instead of affirming “the self-fulfilling prophecy that some schools and the students in them are ‘better’ than others” (p. 132). Educators should not use standards as assessment tools to judge schools or students. In order to benefit from standards, improvement in their own (school or class or of an individual) should be emphasized and valued.

On the other hand, there are some benefits of standards as stated in the joint position statement by NAEYC and NAECS/SDE (NAEYC & NAECS/SDE, 2002) (see Appendix E). In general terms, challenging and achievable standards in early childhood education might have both immediate and long term benefits for children.

In terms of long term benefits, NAEYC and NAECS/SDE (2002) report, “Clear, research-based expectations for the content and desired results of early learning experiences can help focus curriculum and instruction, aiding teachers and families in providing appropriate, educationally beneficial opportunities for all children” (p. 4). Accordingly, “these opportunities can, in turn, build children’s school readiness and increase the likelihood of later positive outcomes” (p. 4). This suggests that school readiness and being prepared for later schooling is one of the important long-term benefits of standards for preschoolers.

In terms of immediate benefits, NAEYC and NAECS/SDE (2002) state that standards can help educators create a more coherent and unified approach to curricula. Moreover, this coherent and unified approach also makes transition to upper grades easy and smooth as follows:

A developmental continuum of standards, curriculum, and assessments, extending from the early years into later schooling, can support better transitions from infant/toddler care through preschool programs to kindergarten and into the primary grades, as teachers work within a consistent framework across educational settings. (NAEYC & NAECS/SDE, 2002, p. 4)

Besides their direct potential benefits for young children, early learning standards may also carry some other indirect advantages. NAEYC and NAECS/SDE (2002) stress the possible advantage of standards, which is fostering communication and discussion

among educators, families, and the community in terms of children's education. Those discussions can contribute to reciprocal relationships among them. It is stated:

The process of discussing what should be included in a standards document, or what is needed to implement standards, can build consensus about important educational outcomes and opportunities. Strong reciprocal relationships with families and with a wide professional community can be established through these discussions. Families can expand their understanding about their own children's development and about the skill development that takes place in early education settings, including learning through play and exploration. Teachers, too, can expand their understanding of families' and others' perspectives on how children learn. (NAEYC & NAECS/SDE, 2002, p. 4)

Standards will be beneficial for children and teachers only if they are used properly. The problems, which are given under limitations of standards, need to be considered by teachers so that high quality education can be achieved.

The importance of natural sciences in children's lives, natural sciences education in preschools and related science pedagogies for preschoolers, whole child concept, preschool science curricula, and the preschool science content standards have already been reviewed to give a general perspective of science education in current preschools. Since the focus of the current study is the Reggio Emilia approach, it will be examined in terms of its theoretical sources and principles and illustrated with some Reggio Emilia-inspired science projects from the literature.

PART III. The Reggio Emilia Approach

2.11 Introduction

Throughout the United States, many researchers, educators and professionals are actively involved in teaching, learning, and applying the Reggio Emilia approach, which is an early childhood education approach originated in Italy in the community of Reggio Emilia. There are many childcare centers in America inspired by the Reggio Emilia approach, such as the Model Early Learning Center [MELC]. There are conferences, seminars, electronic mailing groups (e.g., REGGIO-L@LISTSERV.UIUC.EDU), and the traveling exhibits (e.g., the Hundred Languages of Children exhibit) happening throughout the country. Schools in different countries, such as Sweden, Albania, Thailand, and USA, have started working along the same lines with the Reggio Emilia Approach (REGGIO CHILDREN S.r.l., 2000b).

Many people have written about how amazing the Reggio Emilia schools are. As many other scholars and professionals, Lewin-Benham, who is the founder of MELC in America and received the first *Reggio Children* certification in 1994 as a school applying the Reggio Emilia Approach, put into words how amazing Reggio is:

The beauty of their environments was overwhelming; the teachers' and children's competence was powerful; the purposefulness of each item and action was evident. I had never seen or imagined such schools before. There, theories we only espoused were robustly practiced. (Lewin-Benham, 2006, p. 11)

The preschool classroom in the current research was one of those Reggio Emilia-inspired preschools. To understand this preschool's philosophy more in depth, it is essential to examine the Reggio Emilia approach. Following is an explanation of how the review of the literature related to Reggio is organized. First, the Reggio Emilia

philosophy is described with the theoretical sources along with the history and parents, and then its basic components, namely the image of the child, education based on relationships, the role of the teacher, *progettazione* (the emergent/projected curriculum and project approach) and inquiry based curriculum, documentation, and the role of the environment and materials, and lastly the projects.

2.12 Theoretical Sources of the Reggio Emilia Philosophy

The theoretical sources of the Reggio Emilia approach include an extraordinary history, the desire and dream of the parents for a new type of education for their children, and the new theories of child development and education. Before discussing the contribution of theories, it is essential to explain how the history and parents shaped the philosophy of education and created Reggio Emilia.

2.12.1 Impact of the History, Reggio Community, Parents, and Reggio Children

Educational principles and practices do not derive only from “official models or established theories” (Malaguzzi, 1998, p. 58) but the history and the past experiences as well. In the Reggio Emilia approach, the experiences of children, the extraordinary history and the community including parents are considered equally important as are the theories from various areas. Accordingly, Malaguzzi stated that examining those helps understand “the intuitions, the ideas, and the feelings that were there at the start and that have accompanied us ever since” (p. 57). It is essential to stress again that the Reggio Emilia approach is not solely theory-based. This suggests that Reggio Emilia can be better understood after explaining its history, including parents’ perspectives, and the experiences of the community and children.

Malaguzzi (1998) stated that the history of the Reggio Emilia schools in Italy goes back to 1945, just after the end of the Second World War. In the village called Villa Cella, which is a few miles away from the town called *Reggio Emilia*, citizens of Reggio Emilia including parents volunteered to build the first Reggio school. Reggio was built on that great community action. They got the bricks from bombed buildings, the sand from the river, and the land from a farmer as a donation. They sold the stuff, such as tanks left from the war, to run the school. They worked nights and weekends to build the school. Loris Malaguzzi, the teacher and founder of the Reggio Emilia, joined this voluntary community action. Many more *parent-run* schools were built around the city, as stated by Malaguzzi.

Rankin (2004) indicates that in the first Reggio Emilia schools teachers used traditional teaching methods (i.e., direct-instruction) and it was the teacher who decided what children would learn. However, with Malaguzzi's leadership, teaching and learning began to carry new meanings in the parent-run schools. Malaguzzi was determined to break traditional patterns in education, and teachers were enthusiastic and highly motivated to learn (Malaguzzi, 1998).

Malaguzzi (1998) stated, "We wanted to recognize the right of each child to be a protagonist and the need to sustain each child's spontaneous curiosity at a high level" (p.52). He also stressed the concept of "learning *from* children" instead "teaching children." The old traditional patterns in early childhood education were being replaced with the new ones. At that time, social movements, such as migrations from the South to the North, and the baby boom led to an increasingly high need for more social services. Malaguzzi states, "From all this emerged the need to produce new ideas and to

experiment with new educational strategies, in part because the municipal government was increasingly determined to institute more schools to satisfy the emerging needs of children and families” (p. 53).

Malaguzzi (1998) indicated that in the year 1963, the first *city-run* school with two classrooms for young children was built of wood. In 1967, all the parent-run schools joined the municipality of Reggio Emilia. Until the 80s, they organized many meetings and seminars for teachers from all over the country, published books and journals, implemented new models, and had a lot of debate on the traditional education monopolized by certain groups. Malaguzzi wanted to bring those city-run schools far beyond the old and outdated traditional approach in spite of the pressure and *defamatory campaign* against their schools. He stated that the extraordinary history of Reggio Emilia confirms, “A new educational experience can emerge from the least expected circumstances” (p. 57). In spite of the tough circumstances, such as poverty and pressure of certain groups toward new ideas in education, they created *Reggio Emilia*.

Referring to the history of the Reggio Emilia schools, Malaguzzi (1998) stated, “the first philosophy learned from these extraordinary events, in the wake of such a war, was to give a human, dignified, *civil* meaning to existence, to be able to make choices with clarity of mind and purpose, and to yearn for the future of mankind” (p. 57, italics in original). This philosophy triggered educators’ desire to create a new early childhood education along with the new image of the child and to break the old traditional patterns in education by emphasizing the rights of the child.

As being part of the history, the parents of the Reggio kids also made a valuable contribution to the Reggio Emilia philosophy. It was the parents who built schools by

their hands literally and also wanted their children to be educated differently than before. Malaguzzi (1998) pointed out the strong desire of the parents to change the educational system and stated the parents' thoughts: "The equation was simple: If the children had legitimate rights, then they also should have opportunities to develop their intelligence and to be made ready for the success that would not, and should not, escape them." (p. 58). Malaguzzi stated that those parents declared that they are against *the betrayal of children's potential* and want their children to be believed in and taken seriously (p. 58). Malaguzzi also indicated that parents' desire of that kind of education best fitted Reggio teachers and had implications for their emerging philosophy.

As Millsom (1994) stated, the philosophical and pedagogical foundations of the Reggio Emilia approach have evolved under the leadership of Loris Malaguzzi based on "continual, at times contentious, dialogue among teachers, parents, and community" (p. 287). Reggio was born out of many contemporary theories of child development and education, as well as the events following the war and parent/community action under the leadership of Malaguzzi.

2.12.2 Impact of the New Theories of Child Development and Education

Another source of the philosophy of Reggio Emilia is the theories and perspectives related to education of young children. Malaguzzi (1998) stated that after 20 years under the fascist regime they were meeting the works of John Dewey, Jean Piaget, Lev Vygotsky, Erik Erikson, Urie Bronfenbrenner, Henri Wallon, Edward Chaparede, Ovide Decroly, Anton Makarenko, Pierre Bovet, Adolfe Ferriere, and Celestine Freinet and so on. While the Reggio Emilia teachers were benefiting from the ideas of those distinguished people, they were also strengthening their belief in *active education*,

pluralism among children, and an education which is free from dominance of the Fascist regime.

Malaguzzi (1998) stated that in the 1970s they met some other scholars, including psychologists Wilfred Carr, David Shaffer, Kenneth Kaye, Jerome Kagan, Howard Gardner, and philosopher David Hawkins, and theoreticians Serge Moscovici, Charles Morris, Gregory Bateson, Heinz Von Foerster, and Francisco Varela as well as some neuroscientists. The creators of Reggio Emilia approach have been inspired by many scholars from various disciplines and credit all of them.

In terms of the theories of learning and development, Malaguzzi (1998) particularly stressed Piaget's and Vygotsky's works. Both Piaget's and Vygotsky's works have contributed to the Reggio Emilia approach. In this part of the literature review, Piaget's and Vygotsky's theories are discussed briefly with some related key points. We discuss first Piaget and then Vygotsky in terms of the impacts of their theories on the Reggio Emilia approach.

Piaget's Fingerprints in Reggio Emilia

Mooney (2000) states that learning comes from neither the child nor the outside world according to Piaget's theory. Instead, all children construct their own knowledge by interacting with and giving meaning to people and things in the world. Like Montessori, Piaget built his theory on the idea that meaningful work is important to children's learning and development. That meaningful work starts with children's *curiosity* and becomes shaped as children interact with the environment. According to Piaget, the best way to engage preschoolers in natural sciences is to provoke their

curiosity and wonder about the world and then challenge them with rich problem-solving situations (Mooney, 2000).

Mooney (2000) indicates that according to Piaget preschoolers are developmentally in the preoperational stage. The preoperational stage is a time for “the development of symbolic abilities: language, imitation, symbolic play, and drawing. While much learning is involved, it takes place in the here and now and focuses largely on the perceptible” (NRC, 2001, p. 5). According to Piaget, children at the preoperational stage (18 months- 6 years) can “focus on one variable at a time”, “form ideas based on their perceptions” and “overgeneralize based on limited experience”, but they cannot form their ideas based on reasoning until the stage of concrete operational (6-11 years) (Mooney, 2000, p. 64).

One of the criticisms toward Piaget’s theory is about the limited ability of abstract thinking of preschoolers. New (1998) indicates that the Reggio Emilia teachers do not place preconceived limits on children’s capacities but even challenge them in some ways such as encouraging children to deal with some abstract concepts. For example, in a project entitled the *Long Jump*, children dealt with an abstract concept, *gender*. They placed girls back and forth to balance the unequal situation because of gender difference. In that project, New states, “teachers encourage children to debate, hypothesize, and test the merits of their beliefs, whether it is with regard to a special handicap for girls in ‘The Long Jump’ project or the proposition put forth by a group of 3-year-olds that gender identity is a function of clothing” (p. 273). Children successfully dealt with that abstract concept. Gelman (1999), who is the theorist of concept development, also supports this as

opposed to Piaget, and states that preschoolers are “capable of reasoning about non-obvious, subtle, and abstract concepts” (p. 50).

Malaguzzi (1998) stated that the Reggio Emilia teachers in the beginning were inspired by Piaget’s work and exercised some of the Piagetian concepts, such as classification, measurement, and conservation. He stated that they were, then, convinced that directly working on those concepts with children is so artificial because those concepts are already embedded in everyday life. Moreover, there were some criticisms toward Piaget’s theory in terms of the preconceived limitations of children’s abilities that Piaget considered. Malaguzzi indicated that they, however, continue to maintain their interest and sense of gratitude toward Piaget, because “the richest potentiality of Piagetian thought lies in the domain of epistemology” (p. 81). Malaguzzi stated,

Barbel Inhelder, Piaget’s most devoted disciple, told friends after the death of the Maestro: “Write freely about his work, made corrections, try to render his thought more specific; still, it will not be easy for you to overturn the underlying structure of his ingenious theories.” We in Reggio have followed her advice. (p. 82)

As many of others, Mooney (2000) also states, “to dismiss his work because of its flaws would be a mistake” (pp. 60-61). In spite of all the criticisms toward Piaget’s theory, Malaguzzi (1998) stated that the Reggio teachers became interested in Piaget’s theory one more time when they realized his contributions to epistemology. Malaguzzi stated, “we understood that his concern was with epistemology, and that his main goal was to trace the genesis of universal invariant structures” (p. 82).

Vygotsky's Fingerprints in Reggio Emilia

Vygotsky was interested in children's learning in terms of the relationship between language and cognitive development (Mooney, 2000). Malaguzzi (1998) stressed the importance of language stating, "Vygotsky reminds us how thought and language are operative together to form ideas and to make a plan for action, and then for executing, controlling, describing, and discussing that action. This is a precious insight for education" (p. 83).

Moreover, Vygotsky believed that social and personal experiences cannot be separated from each other, and learning/construction of knowledge happens in the context of interaction with teachers and peers (Mooney, 2000). Accordingly, as opposed to Piaget's sole focus on the child's *internal development* (Rankin, 2004, p. 31) and Piaget's constructivism that isolates the child (Malaguzzi, 1998), Vygotsky's focus on social interaction and culture suggests that children should be encouraged to interact, discuss, and argue with each other and adults.

According to Vygotsky (1978), children can go beyond their independent capabilities with the help of an adult or more competent peer, which is called Zone of Proximal Development (ZPD). ZPD is "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 86). By ZPD, Vygotsky implies that teachers can challenge children's competence and scaffold their learning, so that children can go beyond their independent capabilities but only if they are ready for and interested in that thing at that time (Mooney, 2000). Mooney states that Vygotsky has

helped teachers see that children learn by talking, discussing, working with peers, and persisting at a task to accomplish with the help of their teachers.

Reggio teachers pay much attention to social, cultural, and historical background of children that Vygotsky put much emphasis on. Rinaldi (1993), who worked with Malaguzzi in Reggio Emilia schools over years, states, “It is our belief that all knowledge emerges in the process of self- and social construction” (p. 105). Rinaldi indicates that Reggio teachers believe that children co-construct their knowledge through personal relationship with other children and teachers. Moreover, they believe in Vygotsky’s idea that “more advanced functioning can best be strengthened when teachers pay attention to and use the prior knowledge and beliefs of children as the foundation on which to invite more advanced abilities” (Rankin, 2004, p. 31). Rinaldi summarizes the impact of Vygotsky on Reggio by saying, “the emphasis of our educational approach is placed not so much upon the child in an abstract sense, but on each child in relation to other children, teachers, parents, his or her own history, and the societal and cultural surroundings” (p. 105).

On the other hand, while crediting Vygotsky’s approach to teaching and learning, Malaguzzi (1998) also stated his concerns about returning to the *old ghosts of teaching* that Reggio teachers tried to chase away, and stressed children’s potential development with the help of adult/more advanced peers. He cautioned people about the old idea of the teacher role, which is passing information to students, and asked not to mix it with Vygotsky’s idea of the teacher role. Hill, Stremmel and Fu (2005) explain this controversy with Rogoff’s understanding of Vygotsky. They indicate that children are not passive recipients of knowledge from the teacher and the teacher is not a model or expert

of knowledge, either. They state that children and the teacher are “participants in joint problem solving, sharing information and responsibility” (p. 16). Hill et al. call this joint activity *negotiation*, which is transferring more responsibility to children gradually.

To make Vygotsky’s idea of teacher role and its reflections on Reggio clearer, it is important to cite what Malaguzzi (1998) said:

I would not want to minimize the determining role of adults in providing children with semantic structures/systems of meaning that allow minds to communicate. But at the same time, I would like to emphasize children’s own participation: They are autonomously capable of making meaning from their daily life experiences through mental acts involving planning, coordination of ideas, and abstraction. Remember, meanings are never static, univocal, or final; they are always generative of other meanings. The central act of adults, therefore, is to activate, especially indirectly, the meaning-making competencies of children as a basis of all learning. They must try to capture the right moments, and then find the right approaches, for bringing together, into a fruitful dialogue, their meanings and interpretations with those of the children. (p. 81)

This suggests that both teachers and children are participating in children’s meaning-making processes, which is different from the old idea of teacher passing information to students.

Part of the Reggio Emilia approach evolves from Piaget and Vygotsky’s theories. In short, Malaguzzi (1998) created a new approach based on *theories*, which are helpful in dealing with the real issues/problems, and the *extraordinary history* of the Reggio community including the dreams of the parents and the ideas, that came from the experiences with children. In order to understand the Reggio Emilia approach more in depth, it is essential to examine its components.

2.13 The Reggio Emilia Approach as a Sociocultural System

The essence of the Reggio Emilia approach can be better captured through examining some of its basic components, namely, the image of the child, the education based on relationships, the role of the teacher, *progettazione* (the emergent/projected curriculum & the project approach), inquiry-based education, documentation, and the role of the environment and materials. In order to understand the Reggio Emilia approach, it is essential to examine those components, because it is not possible to focus on one aspect of the Reggio Emilia approach (e.g., the image of the child) without also including other aspects (Lewin-Benham, 2006). Since this research focuses on how natural sciences are represented in Reggio Emilia inspired classrooms, the basic components of Reggio philosophy are examined more in relation to natural sciences.

2.13.1 The Image of the Child

If somebody wants to study an approach to early childhood education, s/he should first ask the image of the child that approach holds, because it is the image of the child that shapes that educational approach. Rinaldi (1998a) states, “the cornerstone of our [Reggio] experience, based on practice, theory, and research, is the image of the child as rich in resources, strong, and competent” (p. 114, parenthesis added). The Reggio Emilian image of the child is very impressive, because Reggio teachers see children as “unique individuals with rights rather than simply needs” (Rinaldi, 1998a, p. 114). Since the Reggio philosophy to early childhood education is not a need oriented one, the image of the child is not weak at all, but very strong. Moreover, as McCarthy (1995) reveals, “teachers no longer view the children as empty containers to be filled” (p. 141). This

implies that the Reggio Emilian image of the child does not confirm the idea of transmitting knowledge from teachers to students.

Malaguzzi (1994) points out the *hundreds of different images of the child*, and states that they see the child as being very intelligent, strong and beautiful, and having ambitious desires and requests. In Reggio Emilia schools, the child is considered to be capable, powerful, and curious, and interested in research, investigation and exploration (Donovan, 1997). Moreover, the child has strength, potential, plasticity, openness, curiosity, and the desire to grow and relate to other people (Rinaldi, 1998a). The child is interested in social interaction, actively constructing their own knowledge, and directly dealing with opportunities the environment provides (Gandini, 1997). All those features and skills suggest that the child is naturally a young scientist, who wonders about the world around him, explores, investigates, interacts and constructs his/her own knowledge. The child image in Reggio Emilia naturally fulfills the profile of the child as a scientist.

Palestis (1994) also indicates that early childhood education in Reggio Emilia schools is much more than day care. Instead, early childhood education in Reggio schools contributes to the cognitive skills of children, such as thinking, observing, remembering, and forming opinions as happened during the “Long Jump” project conducted by Reggio children at Diana School. Those are some of the process skills that are considered essential in natural sciences.

Malaguzzi (1994) stressed the social dynamics among children, adults and the environment while explaining the image of the child. He described the child within his/her own context. For example, the child poses questions about the world and people around him/her. The people around the child also pose questions about the child as well.

The image of the child, therefore, refers to a very dynamic system which has more than one dimension, so that it is difficult to put it into a few words. Moreover, Malaguzzi stated that the child has an unpredictable nature, so that education cannot be fixed or predetermined either. This might suggest that natural sciences education in Reggio Emilia schools should be flexible in order to fit this unpredictability feature of the child.

Malaguzzi (1994) also stressed the importance of supporting the whole child by stating, “The important aspect is not just to promote the education of the child but the health and happiness of the child as well” (p. 54). Accordingly, the image of the child involves feelings, health, and social and cognitive development and so on. Malaguzzi stated that the child brings a particular reality, such as his/her experiences, feelings, and relationships, into school with him/her.

Nimmo (1998) examines the image of the child that the Reggio teachers hold, compares it with the ones that many American and Australian teachers hold, and stresses how different and complex the Reggio Emilian child image is. Nimmo points out the basic difference of “we and I” between an individualistic society and a collectivist one, and different child images seen in those societies accordingly. The child in Reggio Emilia schools is considered not just as an individual but beyond that as a social being. The child as a member of the community is interested in having complex relationships with others and contributing to the community through collaborating, caring, as well as negotiating. This analysis done by Nimmo helps us understand Malaguzzi’s idea of collectivist community (see the section entitled Education based on Relationships).

The image of the child is also discussed in terms of differences and diversity among children. The Reggio Emilia philosophy sees every child as a learner and a

valuable contributor to the community. All children in Reggio Emilia have rights.

Malaguzzi (1994) stated, “Children have a right to a good school- a good building, good teachers, right time, good activities. This is the right of ALL children” (p. 61). No matter what difference/s a child has, the image of the child is always strong. For example, in some communities, economically disadvantaged children are stereotyped as deficient, but in Reggio schools, all children are considered to be rich, strong, and powerful (Lewin-Benham, 2006). According to Malaguzzi (1998), all children have potential and competencies even though they may have differences. Palestis (1994) states that in Reggio schools he did not observe any labeling of children or rigid grading practice, but the value given to all children as they are all considered to be learners. In a nurturing family atmosphere, teachers work with the same group of children and families for three years (Palestis, 1994). Accordingly, this leads teachers to know each child’s strengths and weaknesses and how to guide them accordingly.

Children with specific disabilities in Reggio schools are not considered as deficient but different. Historically this differs from perception in U.S. that you focus on only weaknesses of children with specific disabilities without focusing on any strength. Now this perception is changing in U.S. emphasizing more strengths (e.g., Fielding, 1995; Sellars, 2006) but the ideal is not accomplished yet. Reggio teachers seek maintaining a balance between bringing strengths of children with specific disabilities into day light and providing support for their weaknesses. Instead of stigmatizing them, Reggio teachers call their special situation to be one of the differences among many differences in a community. Soncini states that Reggio teachers make some accommodations (e.g., using high-contrast paint colors in the classroom for children with

visual impairments) and give priority to children with special needs (e.g., first priority for admission to the school), because they think that those children have *special rights* (Smith, 1998).

In Reggio schools a support team of teachers, a pedagogical coordinator, a local health unit representative, and the child's parents design an educational plan that focuses on strengths and motivations of the child within the context of other children (Magrini & Gandini, 2001). Smith (1998) interviewed Soncini, who is the *psychologist-pedagogista* working for the municipal early childhood system of Reggio Emilia. Soncini says, "Our basic theoretical approach is to value differences and to bring out as much potential as we can. Each of us is different; this is considered positive. We acknowledge that a handicap brings with it a difference, but that it is just one of many differences" (p. 205). Soncini indicates that no matter what kind of differences s/he has, the child with special needs is considered to be a natural part of that community and collective achievement is valued instead of individual achievement. Gandini (1997) indicates that when the society realizes that high quality care and education are indispensable rights of every child, it may then create an environment where children's potential can develop and be nourished.

2.13.2 Education Based on Relationships

Cooperation and collaboration happen among children, teachers, and parents as well as within the whole community of Reggio, because schooling for them is "a system of relations and communications embedded in the wider social system" (Rinaldi, 1998a, p. 114). Gandini (1997) indicates that in the Reggio Emilia community everybody works collaboratively and cooperatively for the wellness of the children. For example, Spaggiari (1998), the director of Reggio schools after Malaguzzi, states that parents work in the

Advisory Council of the Reggio Emilia Municipality (see Appendix F for the Network of Educational Services of the Reggio Emilia Municipal Administration) to contribute to the administrative planning and decision making processes in education.

Without such commitment to collaboration and cooperation, the Reggio approach could not have existed (Donovan, 1997). In Reggio, children, teachers and parents develop a real sense of community while working together (Neugebauer, 1994). Participation of everyone from the community in the system is encouraged, and the well-being of families, educators and children is aimed, because well-being of each of those three protagonists depends on the well-being of the other protagonists (Rinaldi, 1998a). The dynamic nature of education based on relationships is best explained by Edwards and Gandini (2001) as following: “Stable over time and coherent in its principles, the system still strives to be open to change and dynamic in its forward movement” (p. 198).

The concept of “Io Chi Siamo” [I am who we are] (New, 1998), which is found in the Reggio Emilia philosophy, truly reflects how an individual person is embedded in a social context. This also stresses the image of the child in Reggio which is described within the context of relationships because that image of the child reflects the whole community effort including parents, teachers and other citizens to “maximize the salience of selective traditions and values drawn from the larger sociocultural context” (New, 1998, p. 269). It is that strong community idea that makes Reggio Emilia unique and different than many other early childhood education approaches.

Moreover, as a community of learners, they all learn from each other, because Reggio Emilia teachers believe that *reciprocity*, *exchange*, and *dialogue* among children, teachers and the community lie at the heart of successful education (Edwards, Gandini, &

Forman, 1993). During the learning process, conflict, discussion, and negotiation are common in Reggio schools and considered *driving forces* for growth (Rinaldi, 1993, p. 106). Accordingly, the idea of cooperation and collaboration in Reggio schools approves and supports different thoughts as well as agreements. This can be easily seen in both long-term and short-term projects that children conduct together (e.g., Long Jump or Amusement Parks for Birds). New (1998) states that having multiple points of view develops during the activities that require children to rely on one another's competences or knowledge, whereas cooperation and collaboration skills develop during the activities that require children to have common goals.

2.13.3 The Role of the Teacher including Pedagogisti and Atelierista

It can be said that the image of the child shapes the role of the teacher in Reggio schools. Malaguzzi (1994) explains this clearly by stating, "each one of you has inside yourself an image of the child that directs you as you begin to relate to a child. This theory within you pushes you to behave in certain ways; it orients you as you talk to the child, listen to the child, observe the child" (p. 52). Edwards (1998) states that the teacher is a partner, nurturer, and a guide to children in their excitement and curiosity. She indicates that more importantly the teacher listens to children and enters into an *intellectual dialogue* with them. Referring to Malaguzzi's saying, Edwards states that through those dialogues, the teacher can pick up some ideas and then return them to the group for revisiting. Accordingly, the teacher can reflect children's ideas and help children represent what they know and imagine, and work cooperatively with other children in a team (Gandini, 1997). This kind of partner and nurturer role of the teacher

also implies provoking discovery through listening to the child and stimulating children's dialogue, and co-constructing knowledge (Edwards, 1998).

Edwards (1998) summarizes the role of the teacher with some key points (see Table 2.2), but she also points out Rinaldi's description of the teacher role, which is not *segmented* or *linear*, but *holistic* and *circular*. It is circular, because there is a reciprocal connection among the three protagonists (i.e., educators, children, and parents) and a temporal dimension.

The Role of the Teacher	
(a)	promoting children's learning in cognitive, social, physical, and affective domains;
(b)	managing the classroom;
(c)	preparing the environment;
(d)	providing nurturance and guidance;
(e)	communicating with important constituencies (parents, colleagues, administrators, the public);
(f)	seeking professional growth;
(g)	engaging in political activism to defend the cause of public early education;
(h)	conducting systematic research on daily classroom work for purposes of curriculum planning, teacher development, and professional dissemination.

Table 2.2. The role of the teacher (Edwards, 1998, p. 180).

Malaguzzi (1994) states, "we need to define the role of the adult, not as a transmitter but as a creator of relationships- relationships not only between people but also between things, between thoughts, with the environment" (p. 56). The concept of "relationships" is the central point again; just like describing the image of the child within complex relationships, the role of the teacher is described within relationships. This might suggest that the teacher in Reggio schools is seen as a guide who leads children to

be active agents in their own learning within complex relationships, but it is not only interpersonal relationships. While doing that, the teacher might play two kinds of roles. One is more observer, listener, and learner, and the other is more nurturer, partner, and provocateur (Rinaldi, 1993). Rinaldi states that the teacher might be present in the class without being intrusive but observing, listening and learning, or step in as a nurturer, partner or provocateur when necessary.

New (1998) explains the role of the teacher from a social constructivist perspective by stating, “The socially mediated construction of knowledge is perhaps the most distinctive of Reggio Emilia’s interpretation of teacher as learner and researcher” (p. 276). Unlike the traditional role of the teacher (who is an expert), the teacher is considered as a learner and researcher in Reggio Emilia schools. In *Teaching as Inquiry* by Hill, Stremmel, and Fu (2005), it is stated, “when teachers see themselves as researchers in the classroom they have the opportunity to consider hypotheses and to test theories. These highly reflective experiences are important professional development moments” (p. 44). Accordingly, the teacher as a learner and researcher can work for his/her own professional growth.

Malaguzzi (1994) states, “Both children and adults need to feel active and important” (p. 54) and indicates that this is essential for their learning. This statement suggests teachers as active learners, like children. Moreover, Neugebauer (1994) states, “teachers are fully engaged *with* the child in the process of learning” (p. 69, italics in original). Similarly Palestis (1994) after visiting Reggio schools states that Reggio Emilia teachers talk *with* young children not *at* them. This implies that Reggio teachers give

great importance to ideas of the children, and the conversation between them, which occurs quite interactively.

Gandini (1997) indicates that cooperation and collaboration is the backbone of the Reggio approach. She states that a pair of teachers works as a team in each Reggio Emilia classroom. Those teachers do not work like a head teacher and an assistant but work cooperatively and collaboratively at the same level. They spend at least six hours extra each week at in-service training and meetings with other teachers and parents (Gandini, 1997). This cooperative team of teachers, who often have no more than a high school education (Palestis, 1994) is also supported by *pedagogisti*, a team of pedagogical coordinators.

Filippini (1998), who is a *pedagogista* since about 1978, states that a pedagogista, as a member of the pedagogical team of seven in the network of educational services of the Reggio Emilia Municipal Administration (see Appendix F), has a complex and multifaceted task of promoting cultural and social growth for the well-being of young children. *Pedagogisti* support cooperation not only among teachers, but also among teachers, parents, city administrators, and community members (Gandini, 1997). All seven pedagogisti meet once a week with the directors to discuss problems, to exchange information about what is happening in the schools, and to talk about the advances in childhood theories, practices, and policies (Filippini, 1998).

Gandini (1997) indicates that in each Reggio Emilia school, different than traditional schools, there are teachers called *atelierista*, who work closely with other teachers and the children and deal with visual arts in a special workshop/studio, called an *atelier*. Moreover, *mini-ateliers* in each classroom exist to support education. Vecchi

(1998), the *atelierista* of Diana School, states that visual languages are used as a “construction of thoughts and feelings within a holistic education” (p. 139), so that the *atelier* helps children master different symbolic languages, such as painting, drawing, and working in clay. It is essential to state that what is done with materials and media in an atelier is not regarded as art per se, but an inseparable part of the curriculum and whole cognitive/symbolic expression involved in the process of learning (Gandini, 1997). Accordingly, the *atelier* is a place where both children and adults make meaning related to all kinds of disciplines as lifelong learners (Cadwell, Geismar-Ryan, & Schwall, 2005) and where thoughts, feelings and hands find each other and work altogether (Malaguzzi, 1998; Vecchi, 1998). For example, when a child is painting, he brings his feelings, sense of what he is drawing, and what is in his head.

2.13.4 Progettazione: Emergent/Projected Curriculum & Project Approach

Rinaldi (1998a), who spent years with Malaguzzi in Reggio schools, states that the Reggio Emilia approach has created a flexible curriculum planning called *progettazione*. She indicates that the process of creating the curriculum is a dynamic and spiral kind of process bouncing among children, teachers, and parents, not a linear and staged kind of way. She also states, “our *progettazione* must involve multiple actions, voices, times, and places” (p. 119, italics in original). The curriculum concerns many aspects of the school life (e.g., preparation and organization of materials, space, thoughts, and occasions for learning) and also the school life’s connection with the community. Teachers, parents and administrators formulate some hypotheses of what could happen on the basis of their previous experiences and of their knowledge of children as a group or as an individual and formulate some general educational objectives within a flexible plan.

After that, they formulate specific objectives through documentation and listening to children's own immediate needs, interests, questions, confusions, and inquiries about the world (Rinaldi, 1998a). This might be why Malaguzzi (1994) stated that teachers create a curriculum not *for* children but *from* the children.

Rinaldi uses the term *emergent curriculum* in 1993 version of "100 Languages" book and then the term *projected curriculum* in 1998 version of "100 Languages" referring to *progettazione*. Katz and Chard (2000) use the term *project approach*, which proposes a curriculum; which is based on project work grounded on children's interests and needs; which is driven with intrinsic motivation, not extrinsic; and where the children choose from a variety of activities and learning opportunities provided by the teacher. It is more child-oriented and teacher is not the authority but conductor. Emergent curriculum let teacher to support young children with enough amount of scaffolding depending on their age and developmental level.

A *project work* is described as an in-depth investigation of a topic (Katz, 1998) that involves children in seeking answers to their own questions or the questions they formulate in cooperation with their teacher (Katz & Chard, 2000). Unlike traditional schools, which tend to isolate subjects, Reggio Emilia schools focus on more integrated projects, which involve a small group or a whole class and take days or even months to complete (Gandini, 2004). Such kinds of inquiry based education keeps children interest and motivation alive and strong, as stated by Hill, Stremmel, and Fu (2005) in *Teaching as Inquiry*. However, that project work emerged from children's inquiries is not considered as a *teaching technique* but *a way of teaching and learning* (Katz & Chard, 2000, p. 3).

2.13.5 Inquiry-Based Education

Lindfors (1999) introduces a theoretical framework for understanding children's inquiry language, which is a communication act, and indicates that inquiry contributes to children's learning and constitutes the base for making sense of the world. She states that inquiry stands at the "border of knowing and not knowing." Accordingly, inquiry can be used by teachers as a pedagogical approach in which children move from *not knowing* to *knowing* by acting on their own initiative to gain a deeper understanding of the world.

Gandini (2004) stresses the importance of inquiry in developing projects and curriculum. She states the fact that in Reggio Emilia schools, no prepared curriculum exists; instead, projects are developed over time. In order to describe the process of inquiry, Rinaldi (1998a) uses the metaphor of "taking a journey, where one finds the way using a compass rather than taking a train with its fixed routes and schedules" (p. 119), so that the project, which is based on inquiry, does not solely follow the initial hypotheses and objectives of teachers, but develop as an ongoing work. Accordingly, projects are the backbones of learning experiences as they are providing children opportunities to identify themselves and pursue their own needs and interests (Gandini, 2004).

Gandini (2004) states, "Ideas for projects originate in the continuum of the experience of children and teachers as they construct knowledge together following the inquisitive minds of children" (p. 23). She also indicates that those projects might start from an event, an idea or a problem which is posed by children, or an experience initiated by the teacher. The term "inquisitive mind" reflects the central starting point of projects as well as what Burrington (2005) calls the *provocation* for children to pursue an encounter with imagination and interest.

Katz and Chard (2000) state that during projects children engage in the processes of deciding, arguing, explaining, predicting, hypothesizing, checking, interviewing, initiating, drawing, recording, reporting, making suggestions, encouraging each other, trying things again, and accepting and carrying responsibility for what is accomplished. Those inquiry processes show, apparently, that in the Reggio Emilia schools, teachers encourage children to engage with some science processes as natural parts of the curriculum.

However, Huffman (2002) states that inquiry-based education could be beyond having or applying those process skills. According to Huffman, inquiry has three levels, and the third level, which is the highest level of inquiry-based education, is a philosophical way of operating. Those levels are: 1- Process skills and abilities; 2- Incorporating those skills into a series of procedures or steps; and 3- Having a philosophical orientation of living through inquiry (Huffman, 2002) (see Figure 2.5). In Reggio Emilia schools, inquiry-based education is more a philosophical orientation to the experiences held in the school according to Huffman's model.

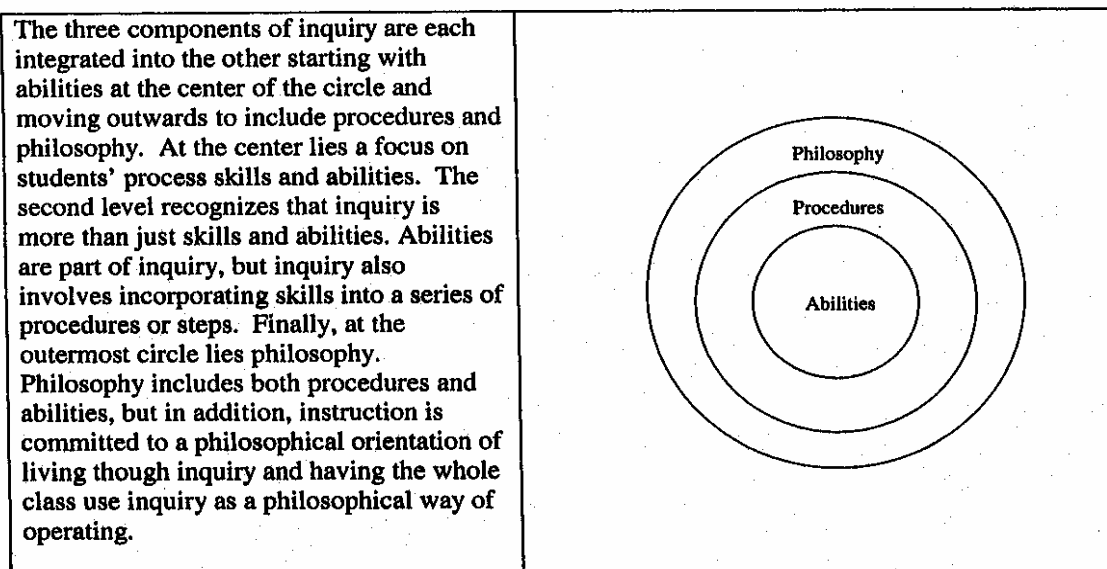


Figure 2.5. A model of science inquiry in the classroom (Huffman, 2002, p. 226).

Having a social constructivist perspective, Reggio teachers provoke conflict among children and within a child, because it might provoke children's inquiry (Rinaldi, 1998a). Rinaldi indicates that project works allow the child to construct his/her knowledge through working with other children and adults, so that different perspectives, conflicts, and negotiations can occur among them and provoke their inquiries. Hill, Stremmel, and Fu (2005) indicate that according to Dewey "inquiry arises from doubt, or cognitive dissonance or conflict, and coupled with reflection leads to meaning making and understanding" (p. 14) and knowledge comes from those kinds of everyday experiences. Accordingly, one of the roles of the teacher is to keep children's inquiries alive through fostering conflict by challenging the responses of children or stepping in when the topic is either beyond or beneath the children's present capabilities (Rinaldi, 1998a). Inquiry involves not only children but also teachers.

Another role of the teachers must be to keep their own inquiries alive, and make teaching and learning visible to other people in various ways, such as using panels to display; writing books, illustrated daily or weekly diaries, letters and messages; organizing small exhibits of children's artifacts; preparing slide or video documentaries and audiocassettes (Gandini, 2004). As stated by Rinaldi (2001), documentation is to make such teaching and learning experiences visible to others and themselves, so that documentation keeps experiences alive, sharable and open to the possible interpretations as well as multiple dialogues among children and adults.

2.13.6 Documentation

Documentation is another vital part of the Reggio Emilia approach. It is briefly described as follows: "Each step in documentation represents a process of inquiry that is based on the previous step and determines the following ones repeating itself in an outward spiral" (edited by Gandini, Hill, Cadwell, & Schwall, 2005, glossary/p. 197). Documentation as a cycle of inquiry is demonstrated in Figure 2.6. Rinaldi (1998a) indicates that documentation involves listening, observing, collecting documents and interpreting with the help of other colleagues. She indicates that documentation should not be seen as an end product but an ongoing procedure which is part of *progettazione* to sustain the process of reciprocal teaching and learning.

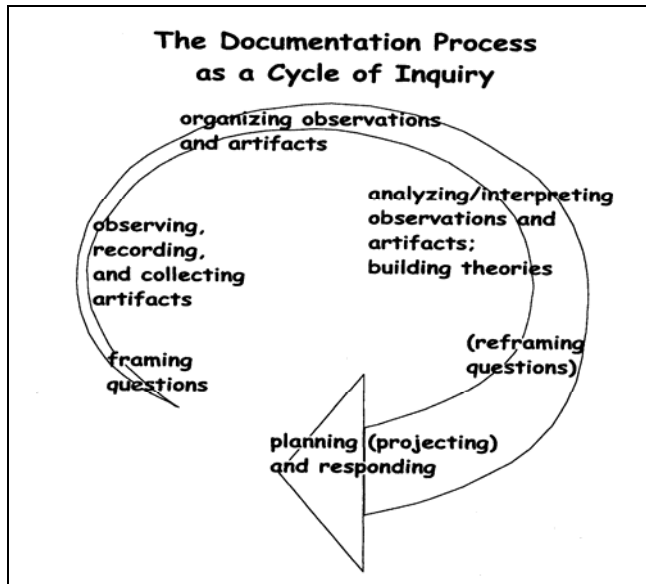


Figure 2.6. Documentation process (Gandini & Goldhaber, 2001, p. 124).

Gandini (2004) indicates that documentation exists for multi-purposes. It helps teachers to understand children better; to make plans; to promote their own professional growth through evaluation of their work; to maintain parents' participation by making them aware of their children's experiences; to facilitate the exchange of ideas among educators and visitors; to let children know that their efforts are valued; and to create an archive of learning experiences. Moreover, a careful documentation presents how powerful the child's thinking is (Katz & Chard, 2000). A child's documented conversations, arguments, hypothesis, and experiences might provide teachers ideas about how to stretch the ongoing project/s and how to support the child. Vecchi (1998) also indicates that another function of documentation is to inform people of the contents of the school as a "democratic possibility" (p. 141). Documentation, especially observation, can be done for reasons different than just collecting and exchanging

information. For example, Malaguzzi (1994) stressed that teachers should observe children to fulfill the desire of children to be observed by an adult and to feel important.

Rinaldi (1998a) describes the connection between theory and practice as a *reciprocal* and *complementary* process and states that it is mostly documentation that helps teachers reflect on practices as well as support practices. Rinaldi states that logical reasoning should be used to infer connections between events that have taken place, not to deduce “what is the theoretically correct action to take” (p. 119). She states, “When theory takes over, when it controls and commands what teachers may do and think, then teachers no longer have the duty to reflect, reason, and create for themselves” (pp. 119-120). Rinaldi recommends teachers to listen to the children all the time as part of a documentation process and not to be occupied with theory too much. It is essential to note that listening is used as a metaphor for “all the processes of observation and documentation” (Rinaldi, 1998a, p. 120).

2.13.7 The Role of the Environment and Materials

Reggio teachers create amiable schools where everybody feel at “ease” and children have maximum movement, interaction, and interdependence (Malaguzzi, 1998). The environment is stimulating with enriched materials, equipment (Rinaldi, 1993), and resourceful teachers, so that children can explore, invent, test hypothesis, think in depth, play, and have fun as well (McCarthy, 1995). Moreover, the physical environment helps create conflicts, confusion and disturbances, and challenge children’s thoughts and skills so that children can challenge one another’s views, revisit and review their theories and hypotheses (New, 1998). Rinaldi states that through constructing and organizing spaces they aim to help children and teachers in various ways (see Table 2.3 & Table 2.4) as

well as increase parents' involvement and collaboration with teachers and other parents. To stress the importance of the environment including materials and tools, Gandini (1998) states that the environment supports the learning processes of children as if the environment is a teacher.

The Construction and Organization of the Space should enable *Children*:

- 1-to express their potential, abilities, and curiosity;
 - 2-to explore and research alone and with others, both peers and adults;
 - 3-to perceive themselves as constructors of projects and of the overall educational project carried out in the school;
 - 4-to reinforce their identities (also in terms of gender), autonomy, and security;
 - 5-to work and communicate with others;
 - 6-to know that their identities and privacy are respected.
-

Table 2.3. The construction and organization of the space 1 (Rinaldi, 1998b, p. 120).

The Construction and Organization of the Space should enable *Teachers*:

- 1-to feel supported and integrated in their relationships with children and parents;
 - 2-to have appropriate spaces and furnishings to satisfy their need to meet with other adults, both colleagues and parents;
 - 3-to have their need for privacy recognized;
 - 4-to be supported in their processes of learning and professional development.
-

Table 2.4. The construction and organization of the space 2 (Rinaldi, 1998b, p. 120).

Gandini (1998) indicates that the beauty and harmony of design and the welcoming atmosphere in Reggio schools interest visitors. For example, Donovan (1997)

states, “Walking into a school in Reggio Emilia, I was immediately struck by the beauty, comfort, warmth, color, and light” (p. 182). This implies that it is a very attractive place as a school environment. Gandini (1998) also adds, “one of the aspects of space that strikes visitors is indeed the quantity and quality of the children’s own work exhibited all around the schools” (p. 175). Petrillo (1998), who is an architect, describes the Reggio environment as “balanced, rich in perceptions of colors and materials, but without that over-emphasis with which we often connote spaces for creativity and the free unfolding of the imagination” (p. 138). He also states that the coloring of the physical structure, such as walls and window frames, is rich but decidedly sober. The environment is not only beautiful but also highly personal (Gandini, 1997). Gandini states that there are personal boxes, for example, where teachers, parents and children can leave messages and little surprises for each other.

Gandini (1998) discusses with Malaguzzi and Vecchi about the physical environment, and they all conclude that spaces could look alike, but the cultures embedded within those spaces will be different, so that the culture and how spaces are used is also important. Gandini (1998) points out the strong relationship between the social-constructivist educational approach of Reggio and how Reggio teachers prepare the environment for children. She states that depending on children’s ideas and interests, teachers provide materials, tools, equipment and strategies thoughtfully; encourage choices and discoveries; and organize the space as it can foster social exchange and interactions between the things and the people (Gandini, 1998) as well as provide spaces where children can work alone if they want (Gandini, 1997). Reggio teachers make a careful selection of those materials and objects, which can contribute to the strong

connection between the school and the community (Gandini, 1998) and provide children *real-life experiences* (Palestis, 1994).

Reggio schools have classrooms, utility rooms, archives, rooms for music, the dining hall with the kitchen as well as an atelier and mini-ateliers where children manipulate and experiment with visual languages (Malaguzzi, 1998). Those schools also have a central space called *Piazza*, which is an open and shared area for children to gather, play games and do large projects (Malaguzzi, 1998). Rinaldi (1998b) states that the importance of continuity and transparency between all those spaces is always emphasized in Reggio. She also indicates that space is authentic and multisensory, and reflects the new image of the child. Even the bathrooms are considered to be part of children's learning (Gandini, 1998), because space is a language, too and whole school is considered as a "*living organism* that pulses, changes, transforms, grows, and matures" (Rinaldi, 1998b, p. 118, quotation marks removed, italics added).

Spaggiari (REGGIO CHILDREN S.r.l., 1997), the director of Reggio schools after Malaguzzi, cites Francis Bacon to emphasize the importance of hand-mind-tool working altogether by stating, "If the head and the hand act separately, they conclude nothing; if they work together they can accomplish something, but much more can be done when head and hand work together with a tool" (p. 10). Different materials can help children represent their thoughts in a variety of ways as they foster multiple symbols for the same concept (Forman, 2005). As stated in *Beautiful Stuff* (Topal & Gandini, 1999), "Children and adults become collaborators as they discover, collect, sort, arrange, experiment, create, construct, and think with materials. The goal is to allow children to become fluent with materials-as if materials were a language" (p. Introduction). Forman

(2005) indicates that children construct their knowledge by using different materials, such as clay, wire, paper, paint, markers, and flour. After spending weeks on some materials, children return to these materials as ready to use a *higher level of skills and understanding* (Gandini, 1998, p.175). All those materials are called *intelligent materials* because they invite questions, curiosity and experimentation; support children's different perspectives and languages; lead a sense of excitement; and involve "a balance of simplicity and complexity" (Krechevsky, 2001, p. 252).

The Reggio Emilia approach with all those components provides children a context with inquiry-based, social-constructivist science education. Although Reggio Emilian science education is stated as one of the best practices in preschool science education (Johnson, 1999), there is a gap in the literature in terms of specifically addressing science education in Reggio (except some science projects conducted in Reggio Emilia preschool or Reggio Emilia-inspired preschools). In the current research, we are specifically interested in the discipline of the natural sciences and how it is represented in the laboratory preschool, which appropriates the Reggio Emilia approach to the American context. In this last part of the literature review, some example projects are briefly described and examined to illustrate how science education has been experienced in Reggio and Reggio Emilia-inspired preschools.

2.13.8 Some of the Science Projects Conducted in the Reggio Emilia Preschools

There are many science projects conducted in the Reggio Emilia schools in Italy and in the Reggio Emilia-inspired preschools in other parts of the world. Some of projects were conducted with kindergarteners, such as "How do Caterpillars Make Cocoons?" (Clark, 1994), "Forces & Motion" (Desouza & Jereb, 2000), and "City in the

Snow” (Forman, Langley, Oh, & Wrisley, 1998). However, since the current study specifically focuses on preschoolers’ learning of science, here only the projects that were conducted by preschool-aged children are considered. In this part of the literature review, the following science projects are examined: “Light in the Room,” “Everything has a Shadow, Except Ants,” “Garden,” “Long Jump,” “the Water Wheel Project,” and “Fountains: The Amusement Park for Birds.”

Projects Starting with an Unexpected Event: “Light in the Room”

Cadwell, Geismar-Ryan, and Schwall (2005) indicate that in their Reggio inspired school, an unexpected event happened and the children became interested in light, color, shadow, the sun, and the moon. The whole project started with the following unexpected event: “As the children were sitting down for the classroom morning meeting, a few children noticed a circle of light reflecting onto the ceiling. The reflection was very animated; it jumped around the room from the ceiling to the walls, then to the floor” (p. 148). The children were so excited about this remarkable new counter, and the *atelierista*, Charles Schwall, started taking some notes as part of the documentation. As Gandini (2004) states, in Reggio schools a long-term project can start from an extraordinary event and continue as children’s interest continues.

Cadwell, Geismar-Ryan and Schwall (2005) indicate that after seeing this light in the room, the children started making *predictions* about what it was. Some of the predictions follow: “The flying thing,” “Tinkerbelle,” “Peter Pan,” “It’s a reflection,” and “It’s the sun” (p. 149). This excitement and inquiry evolved and transformed into a long-term project. Cadwell, Geismar-Ryan and Schwall state, “at the beginning of the project,

collaborative talk at morning meeting was the main vehicle the children used to introduce and shape their ideas” (p. 151).

During the project, the children created more extended hypotheses. For example, the teacher asked, “How did the circle of light get on the ceiling?” (Cadwell, Geismar-Ryan, & Schwall, 2005, p. 152). Different hypotheses came from the children, for example, “the watch makes it go up on the ceiling,” “the light is reflecting through the hole, reflecting onto the watch, and reflecting onto the ceiling,” “maybe it climbed up there,” and “it’s a reflection. It goes from the window to the wall” (p. 152). All those hypotheses, different ideas, and conversations are considered very important in children’s learning. Cadwell, Geismar-Ryan and Schwall state, “Collaborative thinking, where multiple perspectives are shared, is essential to the individual and collective growth of teachers who view the school environment as a learning organization” (pp. 155-156). Children discussed how light entered the classroom, wondered about light, and conducted observations on objects.

Cadwell, Geismar-Ryan and Schwall (2005) state, “in the weeks and months to come, the children and the teachers had many new ideas born out of their interest in the reflection on the ceiling, their strong relationship and knowledge of each other, and their established practices as a learning community” (p. 152). The parents, who are also protagonists in Reggio Emilia, were also informed of the children’s inquiry and asked to help their children in some ways, such as helping children find some objects that make a reflection. Louise Cadwell observed the children and then made some suggestions about how to expand the project. In addition to working on light, children also made predictions about the relationship between light and weather and reported their predictions to the

class. After that, children searched for some other reflective objects they found in the environment. They made their own mobiles with reflective objects with the help of parents and then brought those mobiles home.

As Chen (1998) states, “if a scientist is a person who wonders, who studies the world around her, and tries to figure out how it works, then young children are natural scientists. Children have abundant curiosity. This curiosity propels them into action—touching, tasting, weighing, mixing, pouring; from these experiences grows knowledge” (p. 51). Clearly, in this project children used some science skills, such as hypothesizing, predicting, observing, and reporting, as they involved in scientific processes.

The project did not end here. Cadwell, Geismar-Ryan and Schwall (2005) indicate that the children were divided into small groups and started working on some other inquiries that had emerged during the project. The focus of some of those small groups included light and colors. Cadwell, Geismar-Ryan and Schwall state, “Planned and unplanned conversations are essential to the evolution of the work. It is within the context of these encounters that we reflect on children’s learning, exchange ideas, create new understandings, and organize for new experiences” (p. 155). Small group work gave children a chance to work collaboratively and expand their understanding of light together.

Everything Has a Shadow, Except Ants

Questions lead children to engage with different science topics and conduct project work, as with the shadows project. The shadows project was a very interesting topic to young children. In *Everything Has a Shadow, Except Ants* book, it is stated that the shadows project created rich experiences and emotions in children at the Diana and

Gulliver preschools, in Italy, as children explored shadows (REGGIO EMILIA S.r.l., 2000a). This project includes encounters with shadows in many situations and provides a guide to working profoundly with children's understanding of science. Vecchi (1998), the *atelierista* of Diana School, states “shadows offer extraordinary educational possibilities” (p.147). She indicates that this project involves “an integration of acts of visual representation with scientific hypothesis testing. It goes far beyond the emphasis on aesthetic expression and perceptual exploration with which I began my work over 25 years ago” (p. 147).

The “Garden” Project

Life science, which is one of the main branches of the natural sciences, involves investigation of the forms and phenomena of living things including their origin, growth, and structure, as happened in the Garden project. Trepanier-Street (2000) presents the Reggio inspired “Garden” project conducted by 4 to 6 year-old children at University of Michigan-Dearborn Child Development Center. During the project, children constructed their knowledge about flowers, weeds, plants and gardening, and represented their thinking through discussions, drawings, signs, charts, paintings, and clay. Children focused on commonalities and differences among weeds and flowers, examined physical properties of weeds and flowers, and discussed what is edible and where seeds come from. They had many discussions and conversations, organized some field trips, revised and re-represented their thinking based on new observations and experiences, and did some actual gardening. Moreover, they studied symbolic meanings of some flowers (such as, love = rose). Through this Reggio inspired project, they constructed some knowledge of both concrete and abstract issues related to living organisms.

Small Group Work in Diana School: The “Long Jump” Project

The project called “the Long Jump” is a good example of small group work, which was conducted by Diana School preschoolers, ages 3 to 6, along with the help of parents and educators. The documentation as a video-clip (Forman & Gandini, 1991) presents the processes that children went through while reinventing the measuring tape and organizing a jump competition in their school of Diana. The project was conducted by four primary leader children over six weeks.

In the video created by George Forman and Lella Gandini (1991), they point out the importance of children working cooperatively in a way that either they both work together or a more competent child helps the other one. It is stated in the video that in Reggio Emilia, the child is considered to have potential, preparedness, curiosity and interest in constructing his/her own learning, interacting with others, and negotiating with what environment provides them (Forman & Gandini, 1991). Moreover, it is indicated that a curriculum develops as a project develops, and the teacher flows with children by doing documentation, conducting research, observing, and listening to the children in order to understand them and to provide them with more learning occasions. In the Long Jump project, children worked on some science and math concepts, such as speed and measurement.

In the video, Forman and Gandini (1991) indicate that the Long Jump project is a great example of two important features of Reggio Emilia: “Graphic representation” and “small group debate”. Graphic representation of “how to jump” helped children reflect on their own thinking. For example, after they discussed details of the competition orally,

they started drawing graphic representations and then realized that some points were missing or problematic (see Figure 2.7).

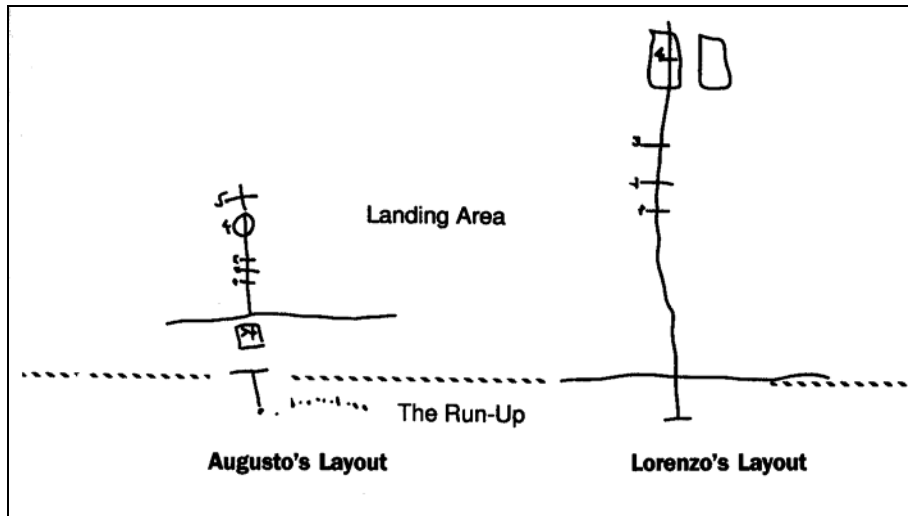


Figure 2.7. Children are comparing their drawings (Forman, 1993, p. 175).

Moreover, Forman and Gandini (1991) indicate that in addition to using graphic representations, literally going outside and practicing some jumping provoked children's inquiries. Those experiences brought them more questions and made them realize some other missing points in their theories and predictions. As problems or conflicts occurred, they were ready to solve through discussing, negotiating, searching and so on. For example, as stated in the video, children realized that if they use paper to make boundaries on the competition area (such as boundaries for where to start and land) the paper might trip them and make them fall. They decided to use chalk powder instead. Another example: When they were negotiating with the competition rules, they said that

4 - 5 and young 4 year-old children should be grouped separately; otherwise, it would not be fair. This might show their understanding of having differences and fairness.

Forman and Gandini (1991) indicate that in the Long Jump project, from classroom to the kitchen everything was part of the education. The children organized the whole event, considering all kinds of details, such as the rules for the competition (see Figure 2.8), the time left for the big competition (see Figure 2.9), what to eat before the competition (they decided on a macrobiotic diet including spinach), what to wear during and after the competition, how to register the competitors, how to advertise the event and so on. For example, the children decided to limit the competition to their own school. They said that if all children from Reggio Emilia join, the chances (probability) of a friend or a child from Diana school winning are diminished.

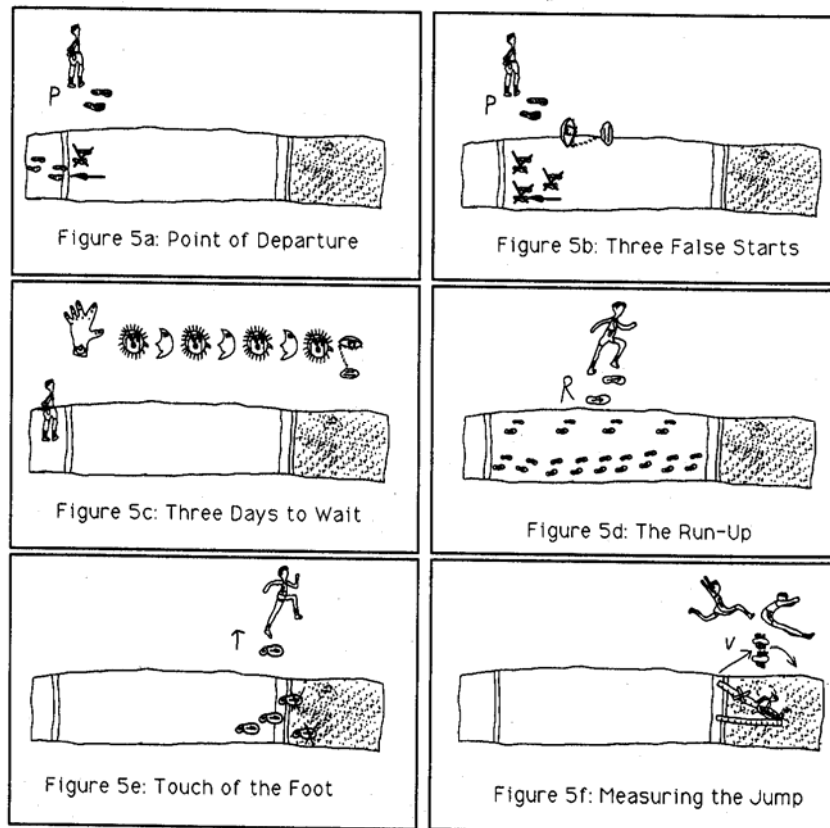


Figure 2.8. Graphic representations for competition rules. (Forman, 1993, p. 180)

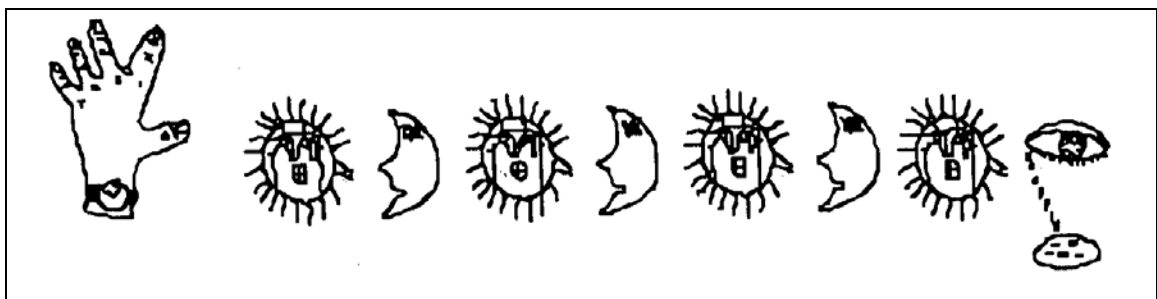


Figure 2.9. Symbol making: Three days & three nights are left for the competition.

(Forman, 1993, p. 188)

Moreover, Forman and Gandini (1991) indicate that the children thought about many possibilities, such as if two children have same number on the measurement strip. At first, they got confused about meter and centimeter. They thought that something was wrong with the strip so that they decided to correct the measurement strip. Forman and Gandini state that through working on representations of the measurement strip children came to understand standard notation of numerals which include both centimeter and meter in one notation. Forman and Gandini indicate that children's knowledge on a measurement strip came from three sources: (1) They used their intuitive knowledge about distance; (2) They experimented with a home-made one meter strip; (3) They transcribed the regularities from the tape (they used one representation to understand another representation).

In the video (Forman & Gandini, 1991), it is stated that small group debates were meant to help children find their own solutions and reshape their theories. As seen in Figure 2.10, children discussed where a jump starts and lands, the proportions of the competition area (such the length of the distance they need for running), the age appropriate rules for 4–5 years olds and young 4s. They made predictions, created hypotheses, checked their hypotheses (such as the longer the jump, the harder the fall) and then made appropriate accommodations (the landing area should be soft; otherwise, they might hurt themselves). Forman and Gandini (1991) indicate that good constructivism requires enough observation of what is there and a constructive conflict to occur.

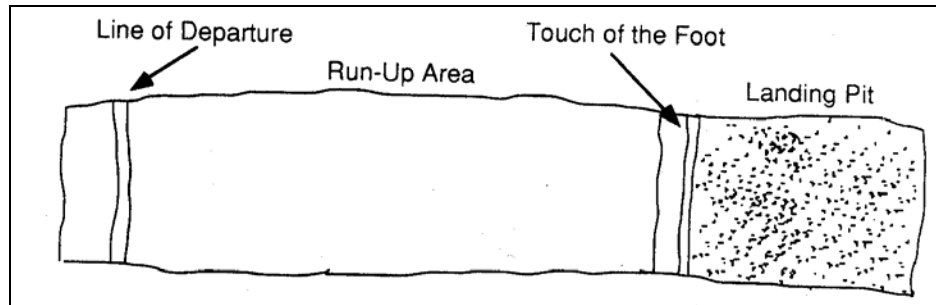


Figure 2.10. The layout of the track on the posters. (Forman, 1993, p. 176)

One topic of their debates started with Augusto's saying, "the faster children will always run the furthest." Sophie said that a friend of hers, Alen, is very fast but it is possible that even with a fast run he might have a short jump. This issue was not solved at the verbal level so children agreed to do an empirical test of their hypotheses. They made some successful jumps indoors and outdoors. However, they could not agree on one solution, because the relationship between speed and run and the link to the jump remained impressionistic. Forman and Gandini (1991) say that we should, however, credit children's use of "empirical test."

Forman and Gandini (1991) indicate that symbolic representations, small group conversations and debates became media to help young children builds upon, rather than replace, existing understanding of a complex Olympic-style athletic event. It is said that drawing helped children externalize their thinking. Children's understanding was practical at first, but when they went into the playground their understanding became more formal and conscious (Forman & Gandini, 1991). In his article called "*The Project*

Approach in Reggio Emilia,” Forman (2005) states the relationship between constructivism and group work as following:

Constructivism can be seen in the manner that these schools encourage children to dialogue among themselves, to experience one another’s perspective, and to build a group understanding of a theme. Teachers wait for the child to venture forth with an idea, a hypothesis, a conclusion and then encourage the children to scrutinize these initial propositions for coherence and feasibility. (p. 212)

As stated by Fosnot (2005), “Constructivism is a theory of learning, not a theory about teaching” (p. 290). Accordingly, it is important to look at how children construct their own knowledge while they are having conversations, debates, and discussions with other children.

Different Representations: The Water Wheel Project

Forman (1996) presents a case study examining how a child constructs an understanding of a water wheel, which is part of the “Amusement park for birds” project that was conducted by the Reggio children in Italy. He discusses how five types of media helped Filippo construct his own knowledge. Those five media from among hundreds are narration, drawing, a paper model, clay, wood and foil medium. Those media provided Filippo five different ways to express his ideas about how a water wheel works. Forman indicates that while the child was trying to represent it using different media, he was also trying to understand how it works. Forman states, “The media may maximize certain types of discoveries” (p.269) because each medium led the child to ask new questions and stretch his understanding.

Forman (1996) states that each medium gave Filippo another chance both to continue constructing his understanding of wheels and to struggle with the constraints of the media (see Figure 2.11). He states, “The learning grows from rich contexts that are

themselves systems of functional relations” (p. 273). Accordingly, each representation provided Filippo a prototype for the next one, so that he could continue to build his understanding by creating a new representation based on the existing experiences instead of dismissing earlier experience completely. Forman (2005) states, “as children compare these various representations, they confront new possibilities and generate new questions that would not have occurred had they used only one medium” (p. 212).

Through narration: Filippo considers how the paddles lift water (and fish).

Through drawing: He considers which side of the wheel would move something up out of the river, rather than back down toward the river.

Through a paper model: He considers how the central spokes must support the rim so that it will spin. He also considers how the paddles need a space (loop) in order to trap an object in the water.

Through clay: He considers the need to keep these loops straight out so that they can do their work of catching. He adds buttresses to ensure that the clay paddles stand up from the horizontal rim resting on the work table and do not fall (even though “falling” to the work table plane would have made them look more like a real paddle wheel).

Through the wood and foil medium: He considers both actions of catching water and being pushed by water, particularly with Georgia’s help. With this version, he also considers the small pans’ orientation to the water’s flow. He preferred to have the water splashing inside the pan instead of hitting the pan’s outside bottom.
(Forman, 1996, p. 273)

Figure 2.11. A child constructs an understanding of a water wheel in five media.

Fountains: The “Amusement Park for Birds” Project at la Villetta

Gandini (2004) indicates that the ideas for constructing “Fountains” were developed when children decided to build an amusement park for birds. She states that each spring the Reggio community usually builds an amusement park for birds at the outskirts of the town, and the teachers decided to discuss this with 5 and 6 year-old children at la Villetta School. Children became interested in the ideas of building fountains and water mills and started working on those ideas (Figure 2.12). Gandini states that the children built birds houses, an observatory and a small lake.

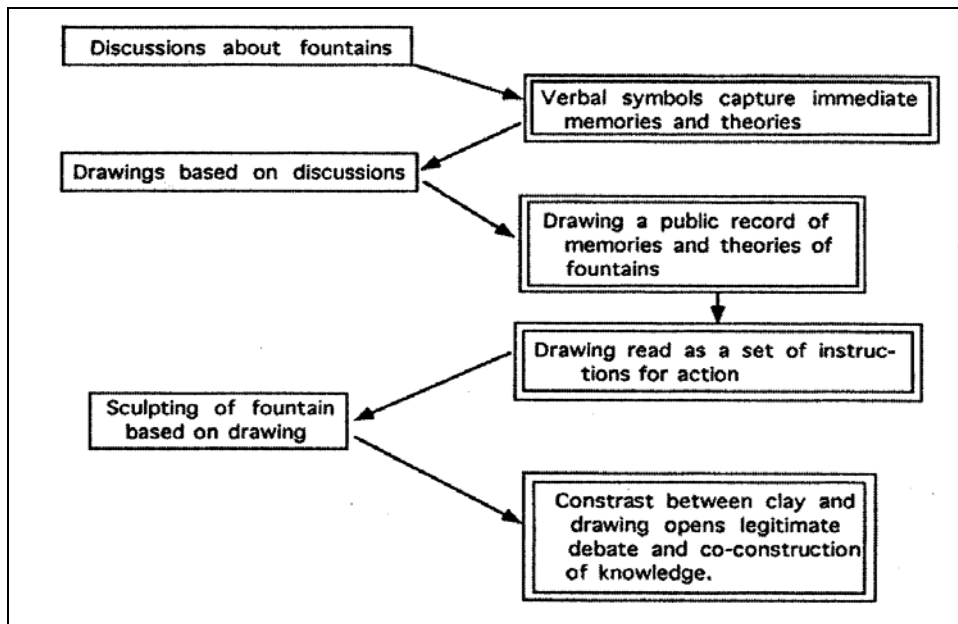


Figure 2.12. The children’s theory about fountainness. (Forman, 2005, p. 220)

Forman (2005) stresses the importance of projects in children’s construction of their knowledge of the world and indicates that the amusement park project let children

revisit their ideas as a group. Forman describes “revisiting” as recalling a prior event and then adding their collective memory to the “here and now as they talk” (p. 215). Children remembered some events of the past, such as the amusement park project and the “lake” done by the older children, and the big celebration with the families and teachers.

Children got excited when they remembered the older children’s excitement about this project. After they discussed those memories, they decided to work on “fountains.”

However, it should be noted first that in *Le Fontane: The Fountains*, Forman (1995) indicates that it is not simply remembering some facts. He states,

The social constructivism of this encounter rests in the manner in which the teachers respect the children’s need to generate their own questions and encourage the children to revisit their choices. This meta-cognitive perspective, at least as practiced in the Reggio schools, facilitates the construction of a system of implications among the remembered facts instead of simply a memory for the facts themselves. (p. 8)

Forman (2005) explains some points from children’s experiences to point out the importance of “the coherence of the relations among elements” and how Reggio Emilia uses this in every step of the life (p. 217). He states, “In Piaget’s research, it was the relation between water poured from a short container to a taller one... It is the relation between elements that children explore when they “play” with the facts. It is the teacher’s responsibility to facilitate this play by providing the appropriate spaces, materials, and group dynamics for putting things into relation” (p. 217). Accordingly, it can be said that the projects, which are constructed by children, are part of the big picture of relations, not isolated things (see the Figure 2.13).

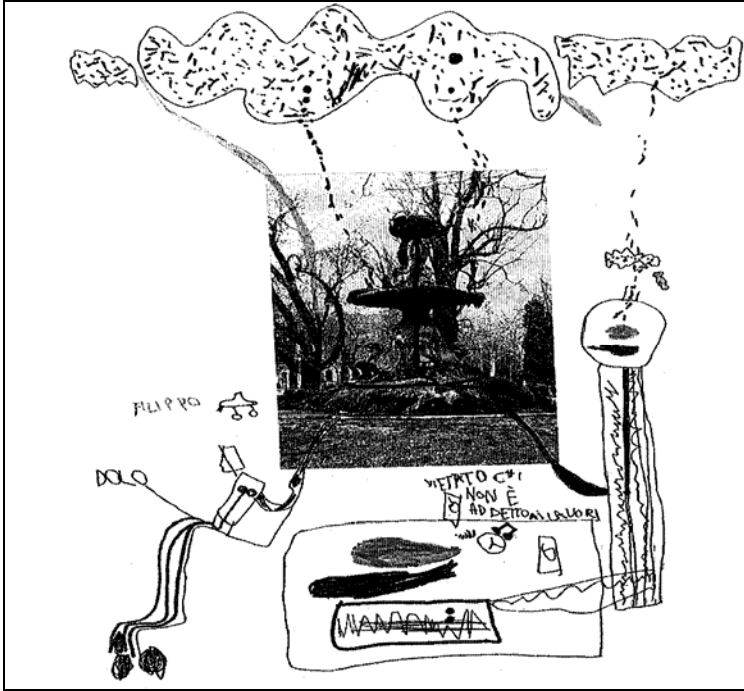


Figure 2.13. Filippo's theory on how fountains work from *Le Fontane: The Fountains*. (REGGIO CHILDREN S.r.l, 1995, p. 63)

Forman (2005) gives another example for coherence of relations: Putting leaves on a big tree shows the relations, instead of putting leaves isolated from each other with no connections among each other. Similarly, it can be said that the Reggio projects are always reflecting a web of relations and coherence in itself, and also connection to the community, and continuity over time. That makes Reggio Emilia unique, special and different from among other approaches to early childhood science education. In *Le Fontane: The Fountains*, Forman (1995) states,

It is only through a process of re-reading, reflection, and revisiting that children are able to organize what they have learned from a single experience within a broader system of relations. These processes are individually and socially constructed, and herein lies the image of the child as an active constructor of his

or her own knowledge, which is one of the fundamental premises of the philosophy and practice that has come to be known as the ‘Reggio Approach.’ (p.6)

Forman (1995) indicates that the Amusement Park for Birds project is a wonderful example of showing the idea of “reflecting on an experience” rather than “simply having an experience.” In *Le Fontane: The Fountains*, it can be seen how 5-6 year old protagonists reflected on experiences through verbal dialogue and discussions as well as other expressive languages, such as wire and clay. For example, Forman (2005) states that after discussions children made a trip to take some photos of fountains. They took photos of fountains, but experience did not end there. Children continued on the project by reflecting upon the photos they took.

In short, all those projects reflect preschoolers’ curiosity and interest in science related topics, as well as their collaborative work and active engagement with science work. However, they do not explicitly focus on science education in Reggio schools. Those research activities are valuable in terms of putting a light on projects related to science. They point out many principles of Reggio, such as multiple representations of ideas, though none of these addresses all principles or specifically and explicitly addresses science education. The current study will be the most comprehensive research that seeks information on science education in Reggio and compares it with standards and discipline-based science education.

In summary, science projects and Reggio principles show that there is a science-rich environment in Reggio schools with a strong belief in inquiry-based education, but there is not a specific research directly addressing science education in Reggio preschools. Accordingly, the current study aims to address this gap by asking the following questions:

- 1) How are natural sciences socially constructed and integrated into this classroom's daily life curriculum in the preschool classroom?
- 2) How does the science constructed in this classroom reflect the Reggio pedagogy?
- 3) How does the science constructed in this Reggio Emilia-inspired preschool classroom address the science standards?

In Chapter 4, findings for each question will be addressed under each layer of the data analysis.

In Chapter 3, first, the methodology of the current study is stated, along with the general research perspective, research site and participants, and research design of the study.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter describes the following aspects of the current study: The general research perspective, the site, participants (including the researcher), data collection, and the data analysis. The previous experience the researcher gained in the same setting, her general interest in the Reggio Emilia approach and the gap in the research literature on science in Reggio allowed her trace the topic of science in Reggio for this dissertation study. The researcher situated herself both substantively and theoretically instead of methodologically, because she was driven by the practical need for understanding the representation of natural sciences in the Reggio Emilia-inspired preschool.

Moreover, it is essential to note that the researcher already thought of Reggio Emilia preschools as being inquiry-based and able to provide very science-rich contexts, which encourage children's head, hand, and heart to engage with science. Accordingly, the researcher decided that the topic was worth studying. This ethnographic study was designed to answer the following questions, which were shaped as the study continued:

- 1) How are natural sciences socially constructed and integrated into this classroom's daily life curriculum in the preschool classroom?
- 2) How does the science constructed in this classroom reflect the Reggio pedagogy?
- 3) How does the science constructed in this Reggio Emilia-inspired preschool classroom address the science standards?

3.2 General Research Perspective

In early childhood science education, more qualitative research was needed to understand the complexity of natural sciences education in preschool settings, particularly the Reggio Emilia-inspired preschool. To gain in-depth information, this inquiry-based study adapted an interpretive approach. Consistent with the theoretical paradigm of the study, this interpretive study opted to utilize an ethnographic design with qualitative data collection methods and interpretive data analysis methods.

The current research utilized ethnography, which is a comprehensive research method in its design, data collection, and analysis (Spradley, 1980). Ethnography is defined as the work of describing and interpreting the culture of a particular case (Schwandt, 1997; Spradley, 1979). Culture has various definitions, and Spradley (1979) defined it as “*the acquired knowledge that people use to interpret experience and generate social behavior*” (p.5, italics in original). Basically culture is anything “shared,” “learned,” and “produced” by a group of people, and ethnography is pathway to understand the meaning constructed and shared by the people living within it (Spradley, 1979; Spradley, 1980; Spradley & McCurdy, 1972). It could be cultural behavior, cultural artifact, or cultural knowledge (Spradley, 1980).

The central concept of an ethnographic perspective is culture, “the notion that a group of people in prolonged interaction within a particular setting will construct a patterned way of conducting life together” (Ferne & Kantor, 2003, p. 6). The current study aimed to understand natural sciences discipline integration in preschool education and asked questions that pertain to the socially constructed nature of science education in the Reggio Emilia-inspired preschool classroom. An ethnographic method, Spradley’s D.R.S. method (Spradley, 1980), was utilized to set the cultural tone of the current study to account for the variance in classroom cultures, that is reflected in the customary actions, knowledge, beliefs and attitudes of the children and teachers as they engage in the everyday life of the classroom (Green, Dixon, & Zaharlick, 2003). Spradley’s D.R.S. method was used for the ethnographic design, data collection, and data analysis in the study. It was one of the lenses used in the current study to examine and explore how natural sciences appeared in the Reggio Emilia-inspired preschool context.

In the role of a participant observer or an observer participant, the researcher did not engage in a linear process; hers was “a dynamic, interactive-responsive approach to research, involving a reflexive disposition and a recursive process,” which is one of essential characteristics of an ethnographic study (Green, Dixon, & Zaharlick, 2005, p. 171). Informed by a preschool ethnographic perspective, this study reveals the “social processes” and “educational possibilities” on natural sciences that took place in the Reggio Emilia- inspired preschool classroom (Ferne & Kantor, 2003).

The current study, as a preschool ethnographic study, deals with aspects of life in the Reggio Emilia-inspired classroom by asking a variety of questions, such as “How are natural sciences socially constructed and integrated into the Reggio Emilia-inspired

classroom's daily life curriculum?,” in order to shed light on the appearance of natural sciences events. Moreover, as the current research benefited from the Reggio Emilia approach as a theoretical framework to make meaning of the context, the Reggio Emilia principles provided another lens for the current ethnographic study. Furthermore, Corsaro’s peer culture theory (1997) helped describe the dynamics of the peer culture within the classroom. In addition to those lenses, ELCS (ODE, 2004) was utilized to analyze natural sciences experiences of the preschoolers in terms of the natural sciences standards.

Using an interpretive theoretical paradigm as a big umbrella for the current study, this ethnographic study aims to understand natural sciences by examining, defining, describing, and documenting natural sciences education and children’s interest and love of the subject matter in the Reggio Emilia-inspired preschool classroom. In interpretive research, the process of education and the understanding of that process are more important than test results or products. Thus, the researcher focused on the processes and lived experiences of the classroom through an inductive mode of inquiry (e.g., Schwandt, 1997). Denzin and Lincoln (2003) state that the constructivist (i.e., interpretive) paradigm assumes a relativist ontology, a subjectivist epistemology, and a naturalistic set of methodological procedures. Similarly, this interpretive research was based on naturalistic methods and the following assumptions:

- (1) *There are multiple realities, which are constructed by people*
- (2) *Reality is subjective, and understandings are cocreated by knower and respondent*
- (3) *Patterns or theories are grounded through the research.*

Based on these assumptions, the researcher as a naturalistic inquirer conducted an inductive research study by exploring and documenting the natural sciences themes and cultural patterns that emerged from the naturalistic setting (Lincoln & Guba, 1985), which was the Reggio Emilia-inspired classroom in this study. Since the methods employed by the research must be consistent with the paradigm of the study (Glesne & Peshkin, 1992), this study opted to utilize ethnographic research methodology (i.e., ethnographic design, ethnographic data collection, and ethnographic data analysis) to explore, and explain the physical/social context and experiences related to the natural sciences in the context of the Reggio Emilia-inspired preschool.

The particular preschool classroom studied was appropriate for this research because its pedagogy was inspired by the Reggio Emilia approach, which was one of the interests of the researcher. Accordingly, in the current research, the preschool classroom became a representative case as appropriating the Reggio Emilia approach.

3.3 Research Site and Participants

3.3.1 Research Site, Selection and Issues of Access

This study involved a preschool classroom setting. The preschool classroom, which was the research site of this study, was part of a laboratory school at a major Midwestern research university. This laboratory school was located in one of the university buildings. As part of this laboratory school, the preschool classroom consisted of one computer room, one big room with an art studio, and a kitchen shared with an infant-toddler room. The site also had a playground.

To choose the research site, the researcher relied on what Patton (1990) calls “Theory-based Sampling,” which is a subcategory of the “Purposeful Sampling” method and involves selecting information-rich cases for in-depth research. The site was information-rich for the researcher to pursue her inquiries and a convenient place to access and conduct the current research. This was an ideal site for this study for three reasons: (1) The teachers were inspired by the Reggio Emilia approach, which was one of the central focuses of this research as “the theoretical construct of interest” (Patton, 1990, p. 183); (2) there was a heterogeneous population, which was an advantage for this study in terms of being representative and for transferability reasons; and (3) the researchers’ colleagues had some personal connections to the site, lead teachers, and the program coordinator, which made it easy for the researcher to access the context (i.e., accessibility criteria of ethnographic research by Spradley, 1980).

The Reggio Emilia-inspired preschool was located at a major research university in the Midwest and has served as an early childhood education center since 1923. The school’s goal is to offer an exemplary program for young children and their families and to provide university students with an opportunity to conduct research and learn strategies to promote cognitive, physical, social, and emotional development in young children. With its own faculty, staff, and students, it has dedicated itself to the best for children by “exploring new educational possibilities through existing frameworks” (Kantor & Whaley, 1998, p. 314). This laboratory school provided the current study rich context in which we could examine and understand how natural sciences are represented in a Reggio Emilia-inspired preschool classroom.

3.3.2 Participants

The current study included a preschool classroom, where there were 18 preschoolers, one program coordinator, two lead teachers, eight student teachers, and the participant researcher (see Figure 3.1). All participants (i.e., informants) are introduced with brief information in the following sections.

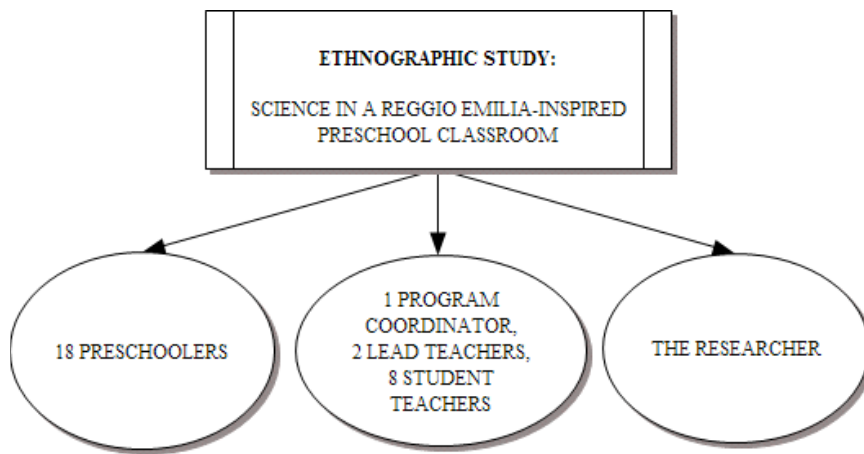


Figure 3.1. Participants of the ethnographic study.

The Preschoolers

In this preschool classroom, there were eight girls and ten boys whose ages ranged from three to five years. The children were selected for enrollment in this laboratory preschool in order to create a heterogeneous population in terms of the children's sex, age, and cultural/ethnic background. Six were Black African-American, ten were White Caucasian, and two were Asian. This sampling population was also heterogeneous in terms of their families' religious beliefs, which included Atheist, Jewish, Christian, and Muslim.

Ensuring that all participants were represented and their voices were heard was achieved in this classroom by including children with different sex, age, cultural/ethnic background. This was a general methodological principle of research to control bias and being democratic by ensuring the representativeness of participants (first articulated in House & Howe, 1999, cited in Howe, 2004). On the other hand, it is essential to note that there was no fund available to finance child care for low-income families at this laboratory preschool. As one teacher, Kathy, indicated, all of the children came from upper class families.

The Program Coordinator, Lead Teachers, and Students Teachers

The program coordinator, two lead teachers, and eight student teachers were also participants in the study, and they provided different perspectives on the classroom. All teachers, including the program coordinator, were White, female, and American. The lead teachers were all university faculty members holding Masters Degrees. Student teachers were actually undergraduate or graduate students studying early childhood education at the university. In the classroom, there were two or three student teachers at any time. They were present in the setting to receive training from the lead teachers and to serve as additional support staff (e.g., conducting some projects with preschoolers). Generally, examining different perspectives by including the preschoolers, the program coordinator and both lead and student teachers contributed to the trustworthiness of this research as they revealed confirmative information as well as disconfirmative information, which were also essential for findings (Stake, 1995).

The Researcher as a Participant Observer

The researcher was a White, female, international Ph.D. candidate in Early Childhood Education program. As the goal of ethnography is “to grasp the native’s point of view, his relation to life, to realise *his* vision of *his* world” (Malinowski, 1922, p. 25, italics in original), the researcher identified herself as a participant observer who was taking part in the research context by conducting direct observations and informal interviews, collecting documents/artifacts, and taking field notes (Patton, 1990; Spradley, 1980). Being a participant observer provided the researcher an opportunity to observe the preschoolers from the viewpoint of someone in the classroom rather than outside the classroom.

As a participant observer, the researcher stayed in the classroom context with the preschoolers and teachers instead of the observation site, which was isolated from the classroom with a wall and designed for non-participant observers. While the observers in the observation site were not allowed to interact with children or interrupt the class, the researcher in the current study was allowed to interact with the children and the teachers and participate in on-going activities. Among the levels of participation that were identified by Spradley depending on involvement (i.e., nonparticipation, passive participation, moderate participation, active participation, and complete participation), the level of the researcher’s participation could be identified as “moderate participation.” Moderate participation refers to maintaining “a balance between being an insider and an outsider, between participation and observation” (Spradley, 1980, p. 60). The researcher moved from being unobtrusive/passive observer, which refers to occupying a role of “bystander” or “spectator,” to more involvement during the study (Spradley, 1980).

Due to the heavy and busy work of data collection (Bottorff, 1994), she positioned herself as an unobtrusive participant observer. Patton (1990) stated that the extent of participation in the setting might show variation over time. The researcher remained mostly an unobtrusive passive participatory observer. However, her activities also included playing and having brief conversations with preschoolers, and joining the group during the circle time, but holding a video-camera and recording the conversations via a tape-recorder. She also responded especially when quick help was needed in the classroom.

The researcher meets the requirements of being a participatory observer, in other words, maintaining “some respectful distance from those studied- cultivating empathy but never sympathy, rapport but never friendship, familiarity but never full identification (i.e., ‘going native’)” (Schwandt, 1997, p.111). Moreover, as Halcolm’s Evaluation Laws indicate, a field worker should be able to help the people and be participant in different ways, such as by sweeping the floor or carrying out the garbage (Patton, 1990, p. 143). Accordingly, the researcher was ready to participate when a need arose or an interest occurred. For example, she helped carry children’s water bottles to the playground, and she made sure that the children were away from the busy street while walking toward the playground.

3.3.3 Confidentiality

All children, parents of each child, lead teachers, student teachers, and the program coordinator were informed about the research. The Institutional Review Board approval to conduct this study was sought and obtained. Permission was also obtained from the teachers, program coordinator, and the parents of each child (see Appendix G for the support letter, consent forms, and the recruitment letters).

Christians (2003) stresses the importance of confidentiality issues in working with human participants and states, “Professional etiquette uniformly concurs that no one deserves harm or embarrassment as a result of insensitive research practices” (p. 218). In this study, confidentiality of all participants in the preschool classroom was accomplished through concealing the real names by using pseudonyms, and no information that could be used to identify a participant was included. In order to maintain the confidentiality of the program coordinator, it was essential to give her an anonymous identity, like being a teacher. In later chapters of this study, the program coordinator is revealed as being a teacher. Moreover, hard copies of all documents pertaining to the study were systematically stored in a locked file cabinet at the university and at the home of the researcher. All computer-generated documents and data files were password protected and stored on computers belonging to the researcher.

3.4 Research Design

3.4.1 Data Collection

The current inquiry-based study of the implicit and explicit natural sciences education in the Reggio Emilia-inspired preschool benefited from multiple data collection methods (see Figure 3.2), conforming to one of the main characteristics of ethnographic

studies (Spradley, 1980). Table 3.1 shows the data collection methods and other related information employed in this ethnographic study (i.e., specific data sources, the place the data collected, the medium used to record the data, and the amount/length of data).

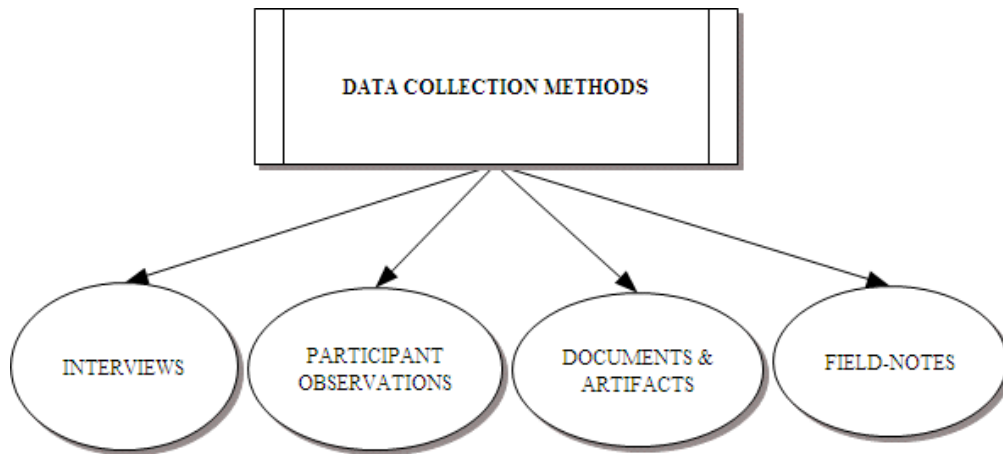


Figure 3.2. Data collection methods.

Method	Outside the Class	Inside the Class	Playground	Medium	Length
Interviews	> Semi-structured Interviews with Program Coordinator and Lead Teachers > Informal Conversations with Teachers	> Informal Conversations with Teachers	> Informal Conversations with Teachers	> Audio-recording > Video-recording > Electronic Mail	> 3 semi-structured interviews, $\cong$ 1 ½ hour each, 66 pages of transcription > Informal conversations, $\cong$ 5 to 15 minutes each > Emailing throughout the study
Participant Observations	> Observation of Physical Environment, People, Events	> Observation of Physical Environment, People, Events > Observation of Whole Class > Focus & Selective Observations	> Observation of Physical Environment, People, Events > Observation of Whole Class	> Audio-recording > Video-recording > Digital Pictures	> ½ day observations on selected days during 1 month, $\cong$ 3 to 5.5 hours each - 105 pages of transcription
Documents & Artifacts	- Collection of > Biographies of Preschoolers > Interest Inventories > Teacher Documentation as Pictures > Curriculum Guides > Orientation Packet > Parent Handbook	> Children's Past/ Current Projects > Physical Environment of the Classroom	> Physical Environment of the Playground	> Digital Pictures > Electronic Mail (e.g., Curriculum Guide) > Electronic Documents	> 440 pictures - Researcher's documentation > 1 Biographies > 3 Interest Inventory- 10 pages long each > 449 Pictures – Teachers' documentation > 75 Curriculum Guides from July 2005 to Dec. 2006 > 1 Orientation Book > 1 Parent Handbook
Field-notes	> Field-notes	> Field-notes	> Field-notes	> Paper & Pencil	> Brief field notes 1-3 pages long each

Table 3.1. Data collection.

The current research utilized various methods of evidence commonly used in ethnographic research: Interviews, observations, documents and artifacts, and field-notes, (Spradley, 1980). The use of qualitative data collection procedures and sources was intended to reveal different perspectives (i.e., teachers', coordinator's and preschoolers' perspectives), gain more insight of the context (i.e., physical and social context), and triangulate findings in a more interpretive, holistic way. Bringing different voices to the research and utilizing various data collection methods revealed a more accurate and holistic picture of the role of natural sciences education within the Reggio philosophy.

Data collection methods varied with the participants. The interview method was used with the adults, while the direct observation method was utilized with all participants, especially with the preschoolers. The semi-structured interviews with the lead teachers and the program coordinator were “friendly conversations”, conducted individually in a quiet office setting (Spradley, 1979; see Appendix H for the interview protocol), so that the participant could “put his or her own frame around the experience” and the researcher could “pursue each individual’s emerging thought as it unfolds” (Green & Stinson, 1999, p. 94). The interview questions were open-ended, clear, neutral, related to the research interest, and in a language familiar to the interviewees (Hatch, 2002). These individual face-to-face interviews were what Glesne (1999) called *topical interviewing*, because the interview questions were related to the topic of natural sciences education (see Figure 3.3). The interviews were recorded by both audio- and video-tapes, which were actual evidence that contributed to *confirmability* requirement of the trustworthiness in the research. Each interview lasted about one and half hour per participant.

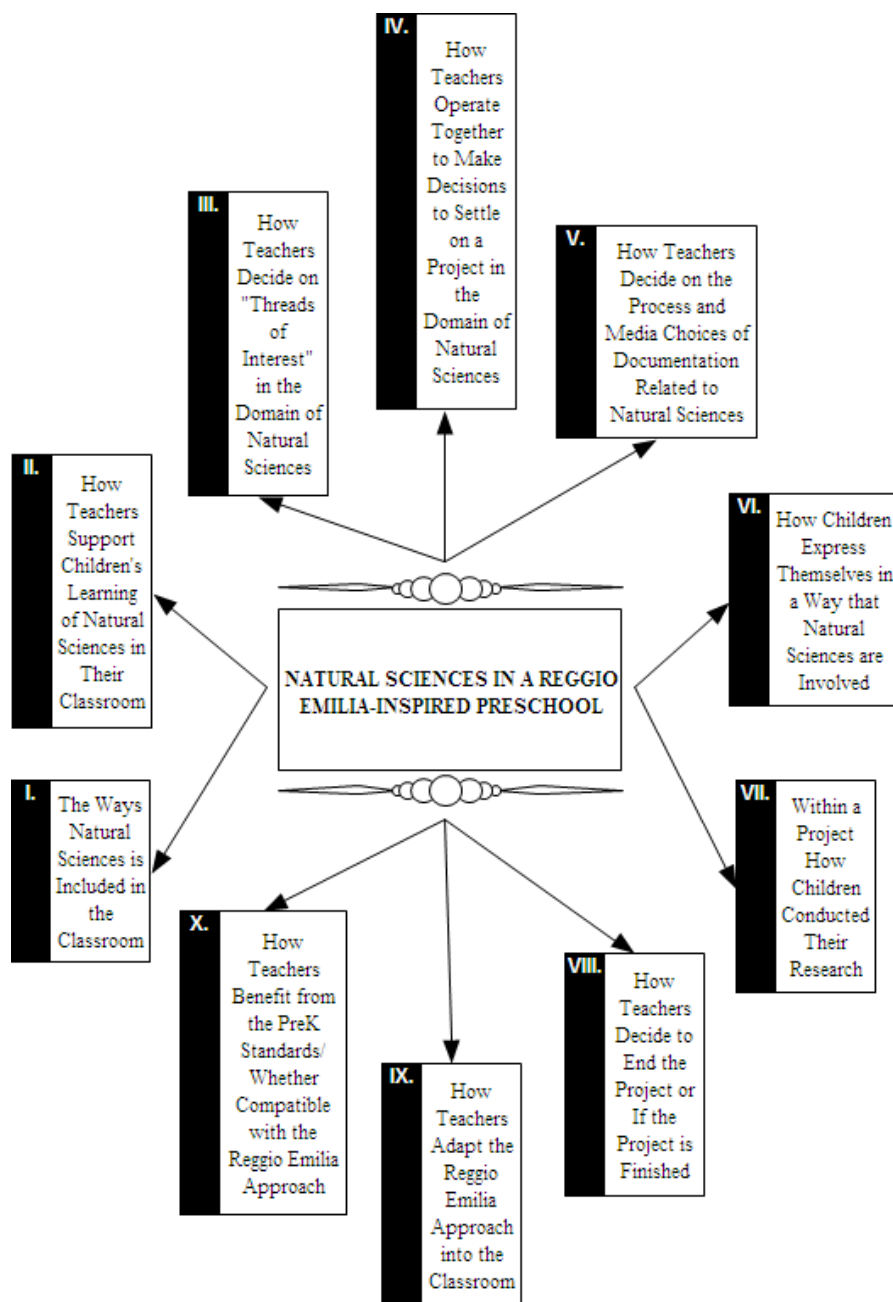


Figure 3.3. Basic themes that the researcher inquired about during the interviews.

After conducting interviews and collecting some documents, data collection continued in the actual classroom context through participant observations and documentation. As stated before, the researcher situated herself in the classroom as a participatory observer. Observations were what Patton (1990) called *overt observation*, because the participants knew that observations were being made and who the observer was. The researcher observed the teachers, program coordinator, and the preschoolers inside and outside the classroom during school time and took field notes in order to note basic details and significant facts. She recorded the observations with audio and video recorders, which helped her transcribe the conversations and experiences verbatim and also see what was missed during direct observations. Audio and video recording also provided verbatim accounts of the conversations, offsetting possible distortions in the field notes (Spradley, 1980). The researcher also captured the observations with a digital camera to compliment the audio and video recordings.

As a naturalistic inquirer, the researcher observed the dynamics in the classroom in terms of any verbal or nonverbal action, behavior, movement, and communication- all parts of the naturalistic setting. These participant observations covered events in real time, in context, and with insights into interpersonal behavior (Yin, 2003). The researcher also had some informal conversations with the teachers and preschoolers during observations. These informal conversations were documented in the field notes or recorded with audio-tapes.

Moreover, the researcher collected some documents (i.e., the children's biographies, interest inventories, curriculum guides, the orientation packet, and the parent handbook) and artifacts (i.e., pictures of children on action, which was teachers'

documentation). She also documented some information related to natural sciences (e.g., physical environment and children's past/current projects) through utilizing various media (e.g., digital camera or electronic mail/Internet). The sequence of the design was followed as planned at the beginning of the research, but changes occurred as well.

The Sequence of the Design

In order to collect data that considered the whole context, to conduct more focused research, and to obtain rich data, Spradley's D.R.S. Method (Spradley, 1980), an ethnographic method, was utilized. In this study, data collection was conducted in multiple contexts within two main phases: (1) working with the lead teachers and the program coordinator individually, and (2) working with the whole classroom together (all students, lead teachers, and student teachers). Before collecting data in the classroom context, which includes the playground and other places visited together (Phase 2), interviews with the lead teachers and program coordinator were completed individually in a quiet office setting (Phase 1). The phases of data collection are stated below:

Phase 1. Individual Cases (i.e., Program Coordinator, Lead Teachers)

Phase 2. Preschool Classroom (i.e., Lead/Student Teachers, Preschoolers)

2.1 Physical Environment, People, and Events (Grand Tour)

2.2 Whole Class Science Culture

2.3 Focus and Selective Groups/Events

2.4 Follow-Through

At the beginning of the research, the data collection was planned to be completed in those sequences of two phases, which included four sub-phases. Since the curriculum emerged on a daily basis and there was always data emerging from other focuses in

different parts of the classroom, the researcher was flexible in scheduling the data collection plan and to pay attention to emerging occurrences and to accommodate the modifications in the weekly Curriculum Guide (DePoy & Gitlin, 1998). For example, while the researcher was at Phase 2.3 videotaping an individual child in the art studio, she also audiotaped conversations among other preschoolers as they interacted at the sand table. The researcher worked strategically in order to catch multiple or unforeseen occurrences other than what was planned at the beginning of the week. The data collection was messy and conducted more in a spiral process, although the planned phases were sequential. This was because “fieldworkers routinely adjust their inquiry plans and strategies in response to what they are learning in the field site” (Schwandt, 1997, p.34). The following figure (Figure 3.4) shows the phases of data collection followed in this ethnographic study.

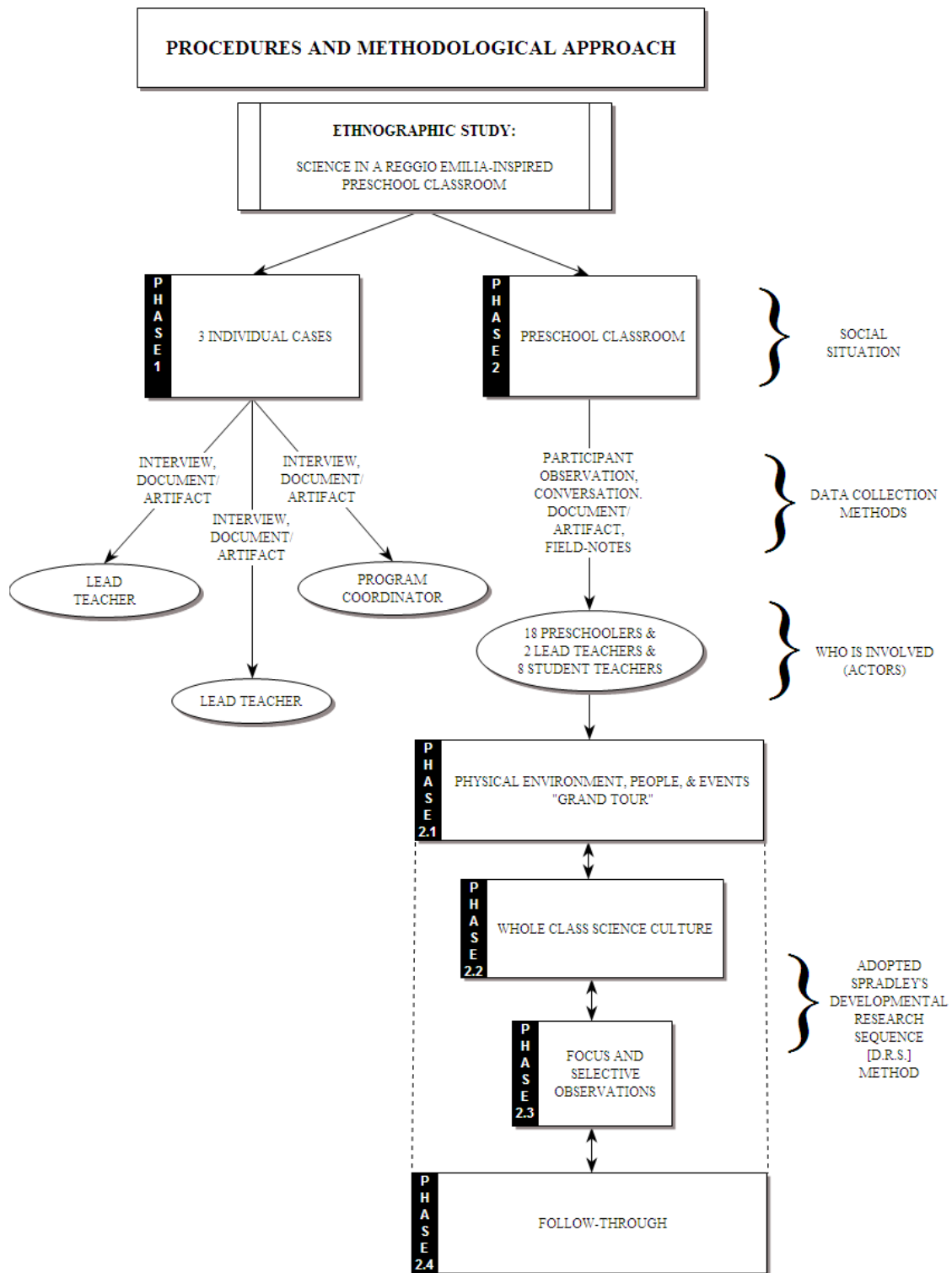


Figure 3.4. The procedures and methodological approach of the study.

3.4.2 Trustworthiness

In order to accomplish trustworthiness and accuracy in this study, the triangulation method was used. The triangulation of perspectives was used to “disclose as many different aspects as possible, increase the degree of proximity to the object in the way cases and fields are explored” (Flick, 1998, p. 51). Lather (1986) indicates that triangulation is more than measures stating that it includes “multiple data sources, methods, and theoretical schemes” (p. 270). In order to accomplish triangulation in this study, *multiple data collection methods* (e.g., interview, observation) were employed to access *multiple data sources* (e.g., people, physical environment, documents) and to raise *multiple voices* (e.g., preschoolers, teachers).

The researcher also accomplished the *fairness* criteria of authenticity of the research, which is defined as ensuring “all voices in the inquiry effort had a chance to be represented in any texts and to have their stories treated fairly and with balance” (Lincoln & Guba, 2003, p. 278). By getting different perspectives and collecting documents (e.g., past and current artworks of the children, the teachers’ weekly reports), the researcher contributed to the fairness of the research and raised multiple voices.

Triangulation of multiple data sources and methods was ensured through several strategies, such as audio-taping the interviews with teachers and classroom conversations among children and/or teachers; video-taping children inside the classroom and outside the classroom (such as playground) during individual, small group and large group activities; taking pictures of children and teachers as well as the physical environment of the classroom; taking field notes of natural sciences activities, materials, areas, and children’s works; collecting documents of children’s current work, old project works, children’s background information, and teacher reports; and getting weekly e-mails from

teachers about the emerging curriculum. Accordingly, triangulation of data was achieved both in terms of benefiting from different data collection methods and including different perspectives and data sources in the study.

3.4.3 Credibility

In order to increase the credibility of the study, the researcher employed “prolonged engagement” and “persistent observation” (Lincoln & Guba, 1985). The format of observation was persistent for a half day, either the morning class or the afternoon class depending on the curriculum. As for being persistent, each observation took either five and one half hours in the morning from about 7:30 am to 1 pm, or three hours in the afternoon from 2:30 to 5:30 pm. Persistent observation was especially important in this study because of the unstructured nature of the curriculum in the Reggio Emilia inspired preschools.

As for the prolonged engagement, data gathering (including the semi-structured and unstructured interviews, direct observations, document/artifact collection, and the field notes) started at the beginning of June 2005 lasted until December 2006. The semi-structured face-to-face interviews and direct observations lasted until the end of month July 2005 (i.e., One month was spent for interviews and some documentation. Another month was spent for persistent observations inside and outside the classroom during school time and for collecting documents and artifacts). Follow-up through unstructured interviews and collecting documents lasted until December 2006.

In order to establish trustworthiness of interpretations and data analysis to accomplish credibility of the findings, “peer debriefing” as well as “prolonged engagement” and “persistent observations” (Lincoln & Guba, 1985) were used.

Interpretations of the data were discussed with colleagues as *peer debriefing*. Since there

was no member checking with preschoolers, the transcripts of the audio and video tapes along with the interpretation were shared with colleagues to contribute to *dependability* and *credibility* of the research. “Self-reflexivity” (Green & Stinson, 1999), which is one tentative method of “policing yourself,” was also employed by the researcher through questioning herself during the study to avoid biases.

3.4.4 Transferability

Since the contextual data aimed to examine the context in depth, the goal was not to make generalizations to other contexts or larger populations. However, in terms of the transferability features of this study, it should be stated that similar patterns might be found in another Reggio Emilia-inspired preschool.

Qualitative studies have no generalizability but a limited transferability to other contexts (Flick, 1998; Lincoln & Guba, 1985). The semi-structured interview questions can easily be replicated in another setting. The unique features of the classroom might not be transferable. For example, projects were not transferable because of emergent curriculum features of the Reggio philosophy. However, the current research with a heterogeneous population has the transferability feature to other Reggio Emilia-inspired preschools in terms of its philosophy.

3.4.5 Data Analysis

The data analysis occurred throughout the study as it also shaped how the study proceeded. Glesne (1999) states, “data analysis done simultaneously with data collection enables you to focus and shape the study as it proceeds” (p. 130). During data collection, decisions were made about what days of the week and what part of the day to conduct

observations, where to set up the equipment in the classroom each day or hour, and what to attend to and what to record (Hatch, 2002).

As one of the first steps of the data analysis, all data were transformed into computer documents in various ways. All interviews and observations, which were audio and video-taped, were transcribed verbatim and saved into the computer program in the format of Microsoft word text. The documents were also stored in the format of Microsoft word text. The whole data set, including the pictures, was saved into the researcher's personal computer and removable disks. Coding and diagramming was facilitated by the software programs called *NVIVO* and *INSPIRATION*.

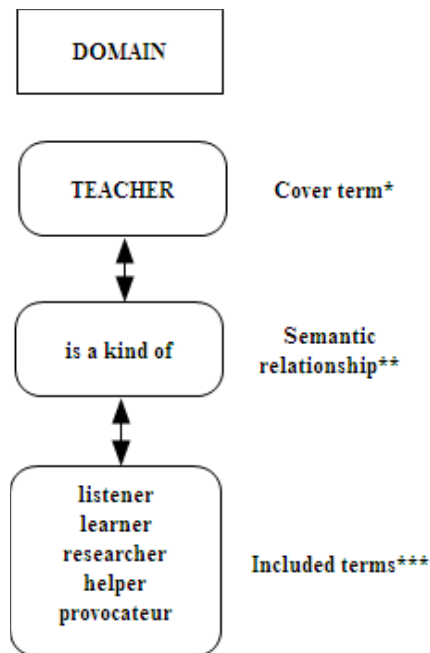
The interview audio tapes were transcribed by a third person to maintain *dependability* and to contribute to the *reliability* of the study. Because of the better accessibility and better sound quality of audiotapes, their use helped create more complete data. The researcher went through all the transcripts of audiotapes, checking them with the video-recording version of interviews and adding the missing parts, which were inaudible in the audio-recording version of the interviews. The researcher herself transcribed recordings of all observations, checking the video, audio, and mini-video recording versions of the observations simultaneously. At the same time, she also checked the pictures and wrote a short abstract for each one as complimentary to the data analysis.

Data Analysis Lenses

The current ethnographic study benefited from various data analysis lenses in order to analyze the data set, describe and interpret preschoolers' science experiences in a Reggio Emilia-inspired preschool classroom. In the role of participant observer/researcher, the data were gathered and analyzed related to this purpose from an

interpretive perspective using multiple lenses. These lenses included classroom culture (i.e., Spradley (1980)'s D.R.S. Method, which is a well-known, pioneer ethnographic method, and Corsaro (1997)'s peer culture theory), the Reggio Emilia approach, and ELCS.

Several lenses guided the data analysis, but Spradley's D.R.S. Method (1980) helped to set the cultural tone, which is the heart of ethnography. Spradley defined ethnographic analysis as "a search for the parts of a culture, the relationships among the parts, and their relationships to the whole" (p.116). Utilizing the D.R.S. Method, the researcher conducted a Domain Analysis (see Figure 3.5). A domain analysis looks for semantic relationships between cover terms (both folk and analytic terms) and included terms under those cover terms, related to a single kind of activity (i.e., science) in a social situation (i.e., Reggio Emilia-inspired preschool classroom). In later steps of the analysis, the researcher considered Taxonomic Analysis, "which involves a search for the way cultural domains are organized" (Spradley, 1980, p. 87).



* The cover term is the name for a cultural domain (Spradley, 1980, p. 89).

** The third element in all cultural domains is a single semantic relationship, the linking together of two categories (Spradley, 1980, p. 89).

*** The included terms are the names for all the smaller categories inside the domain (Spradley, 1980, p. 89).

Figure 3.5. Domain analysis.

Three Questions and Three Layers of Analysis

The following information provides an explanation of how Chapter 4 is organized. Chapter 4 is organized into three layers. The first layer, related to question 1: “How is science socially constructed and integrated into this classroom's daily life?,” used the notion of classroom culture and Spradley's developmental framework as the interpretive lens. In this layer, it is shown that this classroom's culture was replete with science teaching and learning. His Grand Tour and semantic relations system showed *the places for doing science* (e.g., blocks, art, storytime), *the ways of doing science* (e.g., drawing about it, talking about it, exploring hands on), *the reasons for doing science*

(e.g., play and peer culture, activity and school culture). Spradley provided a systematic way to reveal the embeddedness of science throughout the culture of the classroom and the basis for the original assumption that this was a classroom with rich science going on. Corsaro (1997) also helped with the question of how science socially constructed and integrated into this classroom's daily life through the peer culture theory, which refers to the culture created by children in interaction peers compared to the school culture created by school staff, to understand the reasons for doing science. This way it can be seen that the material and the social worlds of the classroom created science in this classroom.

The second layer, related to question 2: “How does the science constructed in this classroom reflect the Reggio pedagogy?,” moved to using Reggio Emilia principles (including the image of the child, education based on relationships, the role of the teacher including pedagogisti and atelierista, progettazione, inquiry-based education, documentation, the role of the environment & materials) as an interpretive lens and went back to the data to ask the Reggio question. Here, sweeping across the data set again but interrogating it for Reggio principles, helped to show many principles and where they are reflected. The “Weather” and the “Growing Things” projects were chosen to discuss Reggio principles in-depth, and to examine the deep questioning and group learning that went on. In addition to the projects, “small moments” of learning were also examined and documented because “in considering a significant experience such as that which is lived in a preschool, nothing should be neglected, not even the most apparently insignificant or marginal details” (*Advisories*, Strozzi & Vecchi, 2002, p. 44). The researcher focused on details, so that the questions and interests of children could be captured and documented.

The third layer, related to question 3- “How does the science constructed in this classroom address the science standards?,” also relates to the aforementioned data set and projects. This third layer of analysis aimed to show how these documented experiences are embedded with opportunities to address the science standards. The current study utilized the natural sciences standards for preschoolers, which were stated in ELCS of Ohio (ODE, 2004). ELCS included “Earth and Space Sciences for Early Childhood”, “Life Science for Early Childhood”, “Physical Sciences for Early Childhood”, “Science and Technology for Early Childhood”, “Scientific Inquiry for Early Childhood”, and “Scientific Ways of Knowing for Early Childhood” (see Appendix C: Early Learning Content Standards). Document analysis was also conducted with the documents. In Chapter 4, the findings from this investigation and exploration are presented.

CHAPTER 4

FINDINGS

4.1 First Layer of Analysis: Grand Tour and Semantic Relations System

Describing the life in the classroom, including its setting, materials and physical organization, generally helps to create a concrete, vivid, and precise understanding of the context. Spradley (1980) suggests that ethnographers start their research by using the method of a Grand Tour, which is one kind of descriptive snapshot of the context. It aims to describe the spatial organization and the major features of the environment in which the ethnographer is interested, as well as the events going on in this context with minimum detail (Spradley, 1980). In the current research, Spradley's Grand Tour method helped to describe the context and the physical environment in general by analyzing some observations, interview transcripts, and documentation.

4.1.1 Spradley's Grand Tour: Introducing the Context & the Physical Environment

Natural sciences education showed itself explicitly through natural sciences events/activities, science materials/tools, past science projects and the small pets and plants currently in the classroom, and many science books all around the preschool. Even on the first day of a visit, it was easy to be convinced by the intensity of science going on in the classroom, the joy of the preschoolers in participating, and the teachers' thoughtful

attitude and effort toward integrating inquiry-based science education into the curriculum. Living in the classroom with the preschoolers revealed the existence of implicit science, which was embedded in other projects/play, such as working on the Space concept at the block area through Star Wars play.

The ecology of the preschool classroom consisted of the preschoolers, teaching staff (Kathy, Mary, Alicia, and student teachers), physical environment, the schedule of activities and routines, and the Reggio Emilia-inspired educational philosophy. The color of the preschool room was cream, with furniture and materials in primary colors. There was a deliberate attempt to create a challenging, provocative and complex environment for these young children. Many stations were designed for preschoolers to work at and big posters of previous projects were displayed on the walls of the classroom. The actual works of the preschoolers were displayed everywhere –on the shelves, up on the ceiling, and on the floor; and a variety of tools/materials and resources (e.g., books) were spread all around the room. One thing that quickly got one's attention was that real things (e.g., insect collection) were displayed in the classroom or used for activities/events.

This preschool classroom had four parts (Figure 4.1): A big room with an open studio, a small quiet room with a little loft, a kitchen where they could actually bake and keep children's lunches and snacks, and a bathroom, from the top of which beautiful science projects were hanging. Children could eat snack whenever they wanted, and it was available at the snack table (e.g., crackers, orange juice). They used to spend most of their time in the big room in which there was a studio. Children were allowed to go to the kitchen only under supervision, but they could go to the bathroom and the quiet room any time.

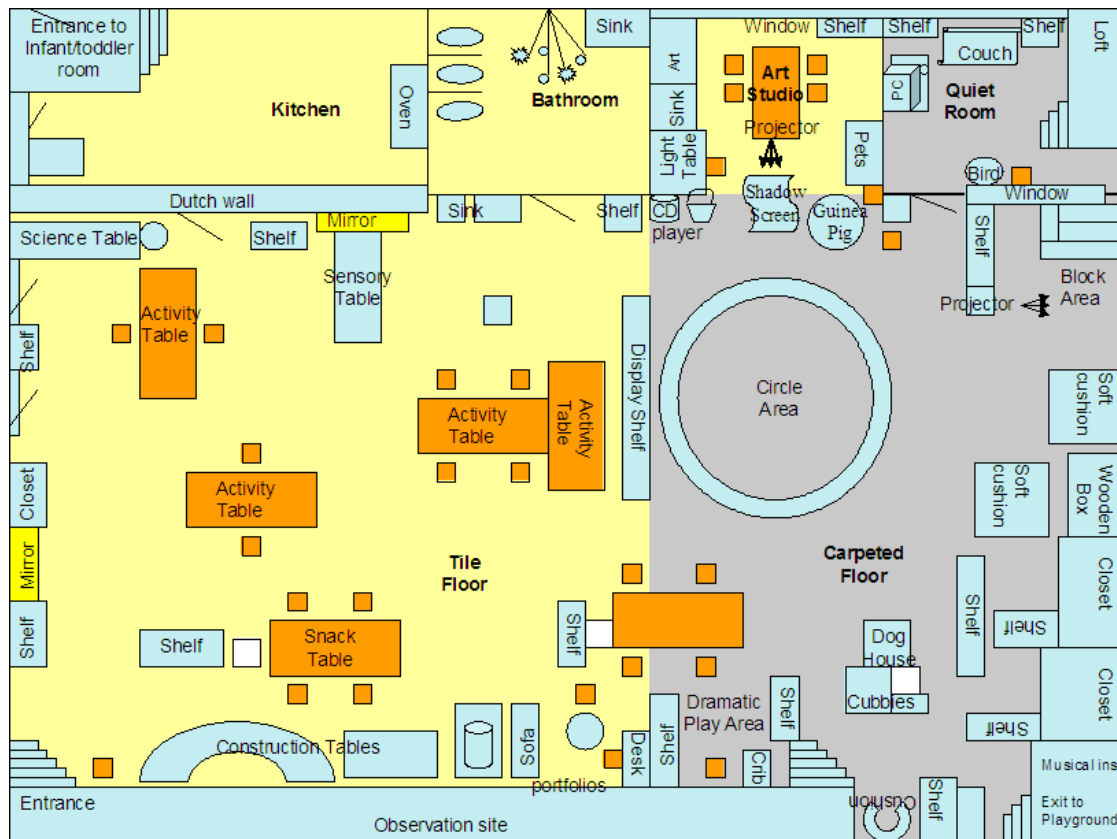


Figure 4.1. The layout of the preschool classroom.

The physical arrangement of the classroom included a tile floor area and a carpeted area. The tile floor area included many activity tables and areas for sensory and construction projects where preschoolers could engage with messy work. By the entrance there was a play area equipped with make-up materials, cloths and a mirror. On the other side of the entrance, there were construction tables where the preschoolers could build something depending on their interests and needs by using the displayed materials and tools. Across the entrance, by the kitchen wall, there was a science table on which some real plants and bodies of various insects were displayed. Near the science table, there was

an activity table where the Weather project was worked on at that time. Across this table, there was a blue plastic table for sensory activities, such as exploring water, flour, and sand. The mirror by the table gave another dimension for children when they were working at this sensory table.

The preschoolers were exploring insect habitats with pretend bugs and mulch at the plastic sensory table, and related books (e.g., “Bugs!” and “Insect World”) were displayed on the shelf by the sensory table. Arthur was at the table at this time. He was moving the pretend bugs and hitting them with a stone. Then, he put two stones on top of them and put another bug on the very top. And he also spread some mulch over them. It looked like he was hiding the bugs under the mulch and stones. Two other preschoolers were exploring Styrofoam and silver balls at the middle table. Those balls were different sizes and used for understanding the concept of size and weight. In general, the rich environment of this preschool facilitated the inclusion of the natural sciences and so facilitated children’s understanding of the natural sciences.

On one of the middle tables, four children were punching holes out of colored papers. They rotated with other children when they were done with that activity. The teacher said that this activity was to improve their understanding of color and small motor development. She said that they would save the hole punches and use them for another project like a collage work. The tables around the room were small, low tables with small chairs. They were used for activities and lunch. There were also sinks and a water fountain available for preschoolers to clean up and drink water.

Within this tile floor area, there was also a studio (see Figure 4.2). The studio within the classroom provided the preschoolers a space where they could do some art-

integrated work, such as painting, drawing, and projecting images onto the large shadow screen or wall. In the studio, there was a small fish tank, an aqua frog tank, a color spectrum, and color sprinkle papers; flowers were on the shelves, mirrors around the studio, butterfly photos and children's works/drawings of butterflies on the wall, and shiny things and art work on the windows. The view of the studio was appealing to eye and mind. There was also an activity table in the middle and a workstation on the wall by this table. There was always a project going on at this activity table or at the workstation by the wall; new projects immediately replacing old ones. At that time the Fireworks project was on the table at that time. Another frequently used activity table was the light table with a bulb in it. There were colorful plastic puzzles called "crystal towers" there.



Figure 4.2. A view from the art studio.

The tile floor also included the kitchen. There was a Dutch door (a half door), and the walls surrounding the kitchen area at the same level. The structure of the kitchen and the studio promoted communication among the children and the teachers.

Behind the tile floor area was the carpeted area. Between the tile floor area and carpeted area, there was a shelf where photos of children's pets and some clay-made works were displayed. The carpeted area served for both cozy, quiet activities and motor activities. In the middle of the carpet there was a carpet in-lay which formed a circle for circle-time group meetings and group activities. Two boys were sitting in this circle area at that time and reading the book called *The Egg* about hatching. Across the display shelf, there was a board displaying a long-time project work called *Doggie Play* along with some pictures. There was also a doggie house made out of a large appliance box. Children were free to revisit their ideas on past projects any time. At this time, three girls were playing doggie. One girl was pretending to be a baby doggie and other girls were taking care of her, walking her around the room, feeding her, and putting her to bed. They were showing affection, and the baby doggie was so happy to be taken care of. When the baby doggie was sleeping, the mommy doggie was waiting by the bed and the daddy doggie was sitting on his chair.

Just by the studio area, on the carpeted floor, there was also a big plastic tub in which a Guinea pig called *Poptart* lived. There was also a cassette player, some CDs, and some related books in the basket. The carpeted floor area opened to the quiet room. Near the quiet room, there were a variety of books, many blocks of different shapes and sizes, and a big wooden box and soft cushions on the floor where preschoolers could do motor activities, such as climbing and jumping. The block area was being used for the project

“Star Wars” and the big wooden box was a pretend spaceship at that time. There was a Space photo on the wall projected by the overhead projector and the preschoolers were playing spaceship in front of it. Just by the motor area, at the right side of the carpeted area, there were individual cubbies for preschoolers. Preschoolers had their names and photographs on their cubbies and complete access to them at any time.

In the quiet room, there was a computer for kids, a soft, comfortable couch, a fish tank, real plants, many books related to the natural sciences, a globe, beautiful, colorful projects displayed on the shelves, and a small loft where the preschoolers could climb up, to be with other kids or stay alone. There was also a bird in a small cage along with a book named *Budgie* about how to take care of it. The quiet room was isolated from the rest of the classroom, so that the children who woke up after nap time could go to that room and to take a rest or work without disturbing other children who were still sleeping in the big room. The glass between the quiet room and the rest of the classroom still allowed the children and teachers to communicate with and see each other.

Each part of the room could be seen and heard from the observation site above the classroom. Video recorders and microphones were suspended from the ceiling in several places around the preschool, but the teachers used the digital camera most of the time for recording children’s actions and works. Observers could come any time and sit at the observation site and take notes. However, as a participant observer, I was always in the room with children, sometimes playing with them, sometimes staying unobtrusively to the side and making an ethnographic record.

The preschool also had a playground, which was rich in terms of providing children natural sciences experiences. At first glance, the natural sciences showed itself explicitly

with the existence of activities and the things found at the playground, such as a water fall, a little rain gauge at top of the climber, and some plants (e.g., pepper and tomato) which were planted by children, as well as the wild habitat (e.g., the insects found on the playground).

Routines

The weekly schedule, *Curriculum Guide*, included the sections “Community Happenings,” “Literacy,” “Symbolic Languages,” “Physical Knowledge,” and “Dramatic Play.” Under each category, there was a short explanation of the plan for the following week and some news from the preschool. It was being distributed to preschool staff and parents at the beginning of each week via e-mail, but subjected to change any time. For example, they planned to do Storm Sounds with Painting on Thursday, but decided to continue on Fruit and Color painting because of children’s continuing interest in it. Another example, they planned to do the Carnations & Celery with Colored Water experiment to show how plants absorb water, but they then decided to work more on the Bubble Experiment through adding more variables (e.g., color and soap). The weekly Curriculum Guides were tentative and based on the emergent curriculum principles of the school, which are later discussed more in detail with the Reggio Principles.

The preschoolers started coming to school around 7.30 in the morning and could stay until 5.30 pm on week days. During school time, they engaged in different activities/events as a group or individually. The teachers considered the Morning Circle Time as an important beginning to each day enriching the classroom community. The preschoolers and teachers sat down in a circle, shared ideas and made plans for the day at this group discussion time. The staff stated in the orientation packet, “This includes

important discussions about the children's on-going work and new ideas that add to our curriculum." The teachers followed the daily routines and activities schedule, but were able to make changes spontaneously. It was stated in the parents' handbook that the daily schedule fosters a sense of safety and well-being in the children by allowing them to know what to expect and when to expect it. The children's daily schedule was flexible enough to provide adaptability when changes were necessary, but structured enough to provide predictability for the preschoolers. The schedule for a typical day with short description was as follows:

7:30 – 11:30 a.m. Indoor Work/Play Choice Time

Classroom opens at 7:30 a.m. Children make work/play choices in the classroom. The classroom community joins in a "circle time" meeting around 9:30 a.m. to discuss the day's events/choices. Open snack is also available.

Small Group Work

Small group work focuses on joint experiences and projects continued over time. Groups are formed according to interests and project possibilities. Small group meetings occur routinely, with their work consistently supported by one of the teachers.

11:30 a.m. – Noon Outdoor Work/Play

The children usually go outdoors by about 11:30 a.m. each day, except when weather is severe. Frequent campus walks and other outdoor exploration also occurs.

Noon – 1:00 p.m. Lunch – Story – Rest

The children have a relaxing lunch, followed by "story sharing" in small groups. After sharing books the children use the bathroom, and then rest on their cots. Most of the children sleep for at least an hour.

1:00 – 2:30 p.m. Rest Time

Relaxing music is played and teachers circulate among the children, rubbing backs and keeping children comfortable. Children who fall asleep may sleep until they naturally wake up. Children who don't actually sleep will be given books or be invited to the quiet room after about 45 minutes of relaxing on cots.

2:30 – 3:00 p.m. Transition

As children naturally awake, they are invited to the quiet room. Typically most of the children awake between 2:45 – 3:15 p.m.

3:00 – 4:45 p.m. Indoor Work/Play Choice Time

As in the morning, this choice time provides a large block of time for children to pursue their ideas. A short circle time is also included during this part of the day, and afternoon open snack is also available.

4:45 – 5:15 p.m. Outdoor Work/Play

Children complete outdoor projects and interests that began during the morning outdoor time. Planned experiences appropriate for outdoors may also be offered at this time. Many children are often picked up during this time.

5:15 – 5:30 p.m. Table Time

Remaining children work at tables in the classroom (puzzles, games, etc.) until they are picked up. Teachers complete end-of-day tasks in the classroom. Lab School closes at 5:30 p.m.

Figure 4.3. Approximately daily schedule (from orientation packet).

All of the activities were a choice for the preschoolers and they were offered simultaneously. For example, there was a size-weight activity with balls at the middle table, pretend bugs/insects at the plastic sensory table and fireworks activity in the studio. At circle time, they used to talk about what they would like to do ahead of time. After that, children could float between activities and revisit them according to interest and as they had new ideas, such as doggie play. Here is a short conversation from circle time:

Adam : I am going to play Care Bear in dramatic play area.

Amy : Me and Megan and Anne, we are playing dramatic play. Everyone can join.

Alicia : Adam, you were just saying you are playing Care Bears. They can play family, and they are kitties so see how this can work. If Care Bears or kitties are turned into like growling and chasing, we can save it for outside. Do you want to add something Megan?

Megan : No, I am not playing that game any more.

Isabelle wanted to join that group. Alicia said “It might get crowded over there” and so asked her to think about another choice. Children continued to talk about with whom they want to work.

The small group works were usually limited to 4 people at the table at a time so preschoolers took turns if more wanted to join. The other important culture issue is that the preschoolers usually chose the work that their friends had already chosen. There were some children who used to join different groups at different times, but most children wanted to stay with his/her regulars. This peer culture showed itself especially during work/play time and lunch time. For example, they chose the same activity to work on or run to the same lunch table to get a seat by each other.

The whole context was amazing with the intensity of projects going on in the classroom, the physical organization, and the teachers’ attitudes toward children in terms of the natural sciences. This was a very rich, intellectually challenging place for children

to follow their inquiries/questions, explore hands-on, and have many enjoyable experiences.

After giving a thick description of the science context through a Grand Tour, it is essential to examine and analyze the appearances of the natural sciences education in this Reggio Emilia-inspired preschool classroom through the lens of culture. Spradley's Semantic Relations analysis through cultural domain analyses gave in-depth analytical/interpretive information about the science embedded in the culture of this preschool and provided the basis for my original assumption that this is a classroom rich with science.

4.1.2 Spradley's Semantic Relations System

In this part of the analysis, examination of the first question, "how is science socially constructed and integrated into this classroom's daily life?," is completed through examination of the classroom culture and semantic relations in various domains. The following domains are three of major cultural domains found in the data set:

- 1- The Places for Doing Science
- 2- The Ways of Doing Science
- 3- The Reasons for Doing Science

Those domains were created through Taxonomic Analysis, which is based on Domain Analysis. Spradley (1980) describes Taxonomic Analysis as searching for relationships among smaller units of meaning and organizing them under the larger cultural domains which they belong to. Moreover, the notions of peer culture and school culture help one understand the reasons for doing science. In the following, those three Taxonomic Analyses are presented along with classroom culture.

The Places for Doing Science

Preschoolers co-constructed science in multiple places including almost every space of the classroom, from the quiet room, to the kitchen, the bathroom, and the main classroom, including the art studio (see Figure 4.4 and Appendix I for *Taxonomy of the Places Children Did the Natural Sciences*). Teachers arranged the places in the preschool classroom carefully and thoughtfully to provoke children's inquiry and to support their understanding of science. They provided a variety of materials and tools in those places so that the preschoolers could manipulate and learn about science. One of the teachers, Mary, indicated that they set aside several areas of the classroom where natural science materials/tools were available and children could have science experiences. She stated:

We always have an area of the classroom that is set up in that way that has a table where materials are offered in a variety of ways, with a variety of utensils or opportunities for manipulation of the materials. We also have an area of the classroom that is set up where we bring natural materials from the outside world into the classroom.

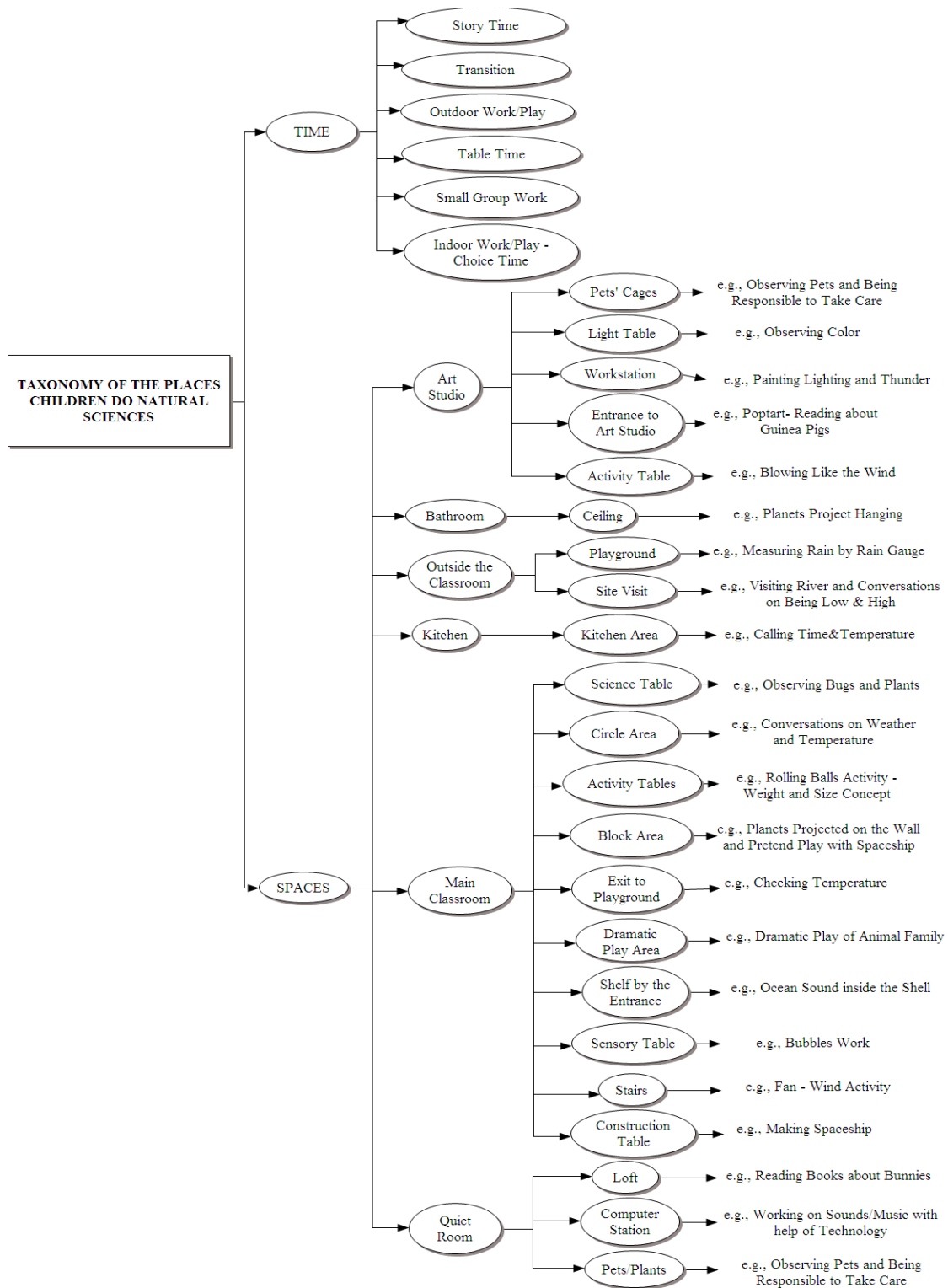


Figure 4.4. Taxonomy of the places children did the natural sciences and examples.

The playground and other places outside the classroom provided space and opportunities for children to pursue their inquiries in science and engage preschoolers with science. In the following classroom layout (Figure 4.5), little stars represent the places where science occurred most frequently including the science projects/books on display. The figure provides a visual representation of the spaces where science occurred and it indicates that science was occurring all over the classroom.

Moreover, the next figure (Figure 4.6) presents 11 science projects, and exactly when and where they were conducted. That the projects were not necessarily completed in a single day will be discussed later. It is also important to state that they expressed some of the themes during this one month period of participant observations.

Preschoolers were involved in some other themes, such as shadows, bunnies, baby ducks, toads, dominos, ocean-sound inside shells, sticky foams, and lizards.

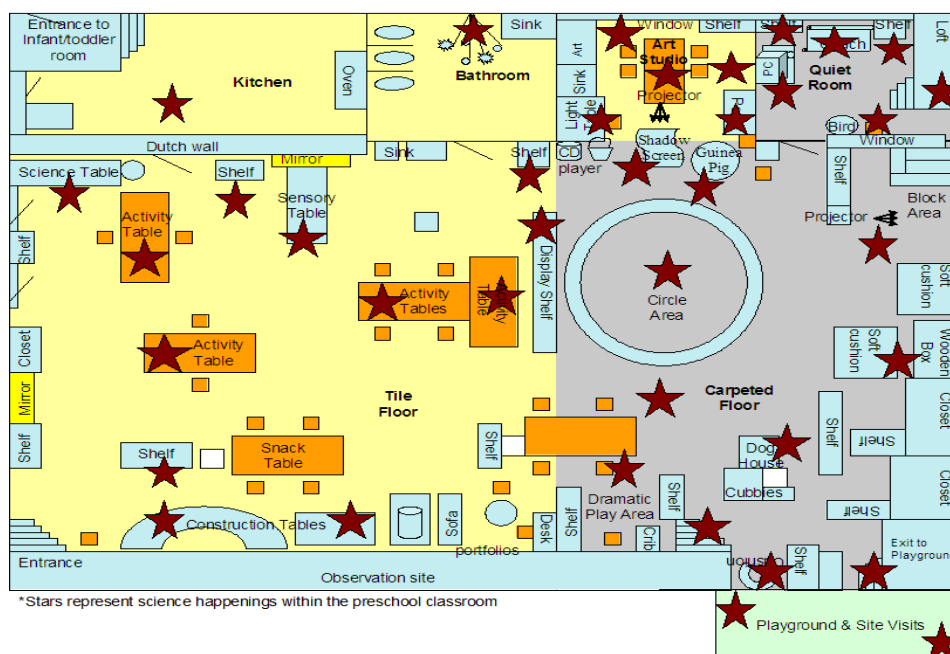


Figure 4.5. Science was co-constructed at multiple places.

THEMES*	PLACE	TIME
WEATHER	>Main Classroom (Activity Tables, Light Box, Sensory Table, Stairs, Exit to Playground, Circle Area) >Art Studio (Light Table, Activity Table, Workstation) >Kitchen >Outside the Classroom (Playground and Site Visiting)	>Indoor Work/Play Choice Time (Circle Time) >Small Group Work >Lunch/Story time >Outdoor Work/Play >Table Time
ROLLING BALLS	>Main Classroom (Activity Tables, Circle Area)	>Indoor Work/Play Choice Time (Circle Time) >Small Group Work >Outdoor Work/Play
GROWING THINGS	>Main Classroom (Activity Tables, Science Table, Dramatic Play Area) >Art Studio (Light Table, Activity Table) >Quiet Room >Kitchen >Outside the Classroom (Playground)	>Indoor Work/Play Choice Time (Circle Time) >Small Group Work >Lunch/Story Time >Outdoor Work/Play
SPACE	>Main Classroom (Activity Tables, Block Area, Construction Table, Circle Area) >Bathroom >Outside the Classroom (Playground)	>Indoor Work/Play Choice Time (Circle Time) >Small Group Work >Outdoor Work/Play
COLOR	>Main Classroom (Activity Tables) >Art Studio (Light Table, Activity Table, Entrance to Art Studio, Workstation)	>Indoor Work/Play Choice Time (Circle Time) >Small Group Work
POPTART	>Main Classroom (Circle Area) >Art Studio (Entrance to Art Studio)	>Indoor Work/Play Choice Time (Circle Time) >Lunch/Story Time
MAGNETS	>Main Classroom (Activity Tables, Shelf by the Entrance, Sensory Table, Circle Area)	>Indoor Work/Play Choice Time (Circle Time) >Small Group Work
BUGS/ INSECTS HABITAT	>Main Classroom (Science Table, Sensory Table, Circle Area) Art Studio (Activity Table) >Outside the Classroom (Playground)	>Indoor Work/Play Choice Time (Circle Time) >Small Group Work >Lunch/Story time >Outdoor Work/Play
ANIMAL FAMILY	>Main Classroom (Dramatic Play Area, Block Area, Circle Area) >Outside the Classroom (Playground and Site Visiting)	>Indoor Work/Play Choice Time (Circle Time) >Small Group Work >Lunch/Story Time >Outdoor Work/Play
SHAKERS	>Art Studio (Activity Table, Entrance to Art Studio)	>Indoor Work/Play Choice Time (Circle Time) >Small Group Work
COOKING	>Main Classroom (Activity tables, Sensory Table) >Kitchen	>Indoor Work/Play Choice Time (Circle Time) >Small Group Work

* Some of the themes during one month period of participant observations.

Figure 4.6. A single project might happen at multiple-places of the classroom at multiple-times of the daily schedule and last days or weeks.

Projects were not restricted to the spot where the experiences originated (see Figure 4.6). In other words, each experience did not necessarily end up where it began, but rather science experiences often moved to other parts of the classroom. A project might continue during the day at different time spots (see Figure 4.6) and persist for days or weeks, and it might even extend outside the classroom. The projects remained for so long because even though it might have appeared at first glance that a project ended long time ago, children could still go and revisit the ideas at any time. When the teachers foresaw learning possibilities for the preschoolers, they supported the learning at different places and at different times during the day and over days and weeks. In summary, there was no space or time limitation for student projects (see example projects Figure 4.6).

As seen in Figure 4.6, in terms of the daily schedule, science appeared at almost any stage of the schedule, namely Indoor Work/Play Choice Time (Circle time), Small Group Work, Lunch/Story time, Outdoor Work/Play, Transition- Quiet room and Table Time. The following figure (Figure 4.7) represents a more focused observation of how science occurred multiple times throughout one morning and one afternoon session. The episodes indicated in the figure were typical in terms of the number of science happenings within the classroom on any given day and the places where science occurred. Accordingly, science was not limited to a specific time spot during the day. In this single preschool classroom, it was common to have many social situations which engaged preschoolers with natural sciences events during a single day.

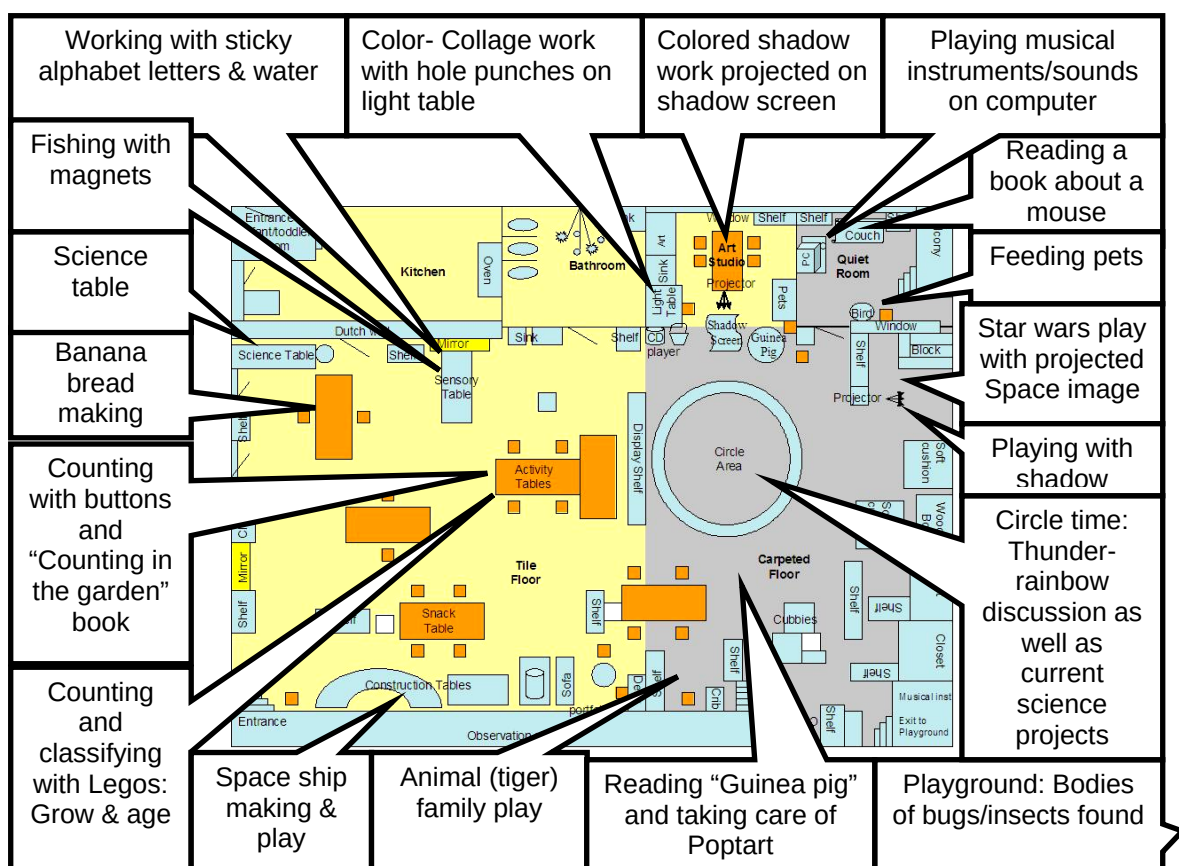


Figure 4.7. Science-rich classroom: A shot from only 1 morning & 1 afternoon.

The micro-level space lens shows that experiences with science took place by the window, on the floor, at the table, on the wall, at the shadow screen, up the climber, on the ground, on the light box, on the projector, in the sensory tub, on the phone and so on. Clearly, in the Reggio Emilia-inspired preschool classroom, science was not limited to table work or a clearly defined science area, unlike what is usually observed in some other preschools. Here, science was integrated into multiple places of the classroom at both macro (e.g., the dramatic play area, the art studio) and micro-levels (e.g., on the wall, at the window).

In addition to science happenings in multiple places and at multiple times throughout the day, science was also interconnected with other disciplines, such as math, literacy, and art (see Figure 4.8). These other disciplines happened throughout the classroom just like science. The places within the classroom were multifunctional and promoted an integrated curriculum, and this integrated curriculum promoted the multifunctionality of the classroom spaces.

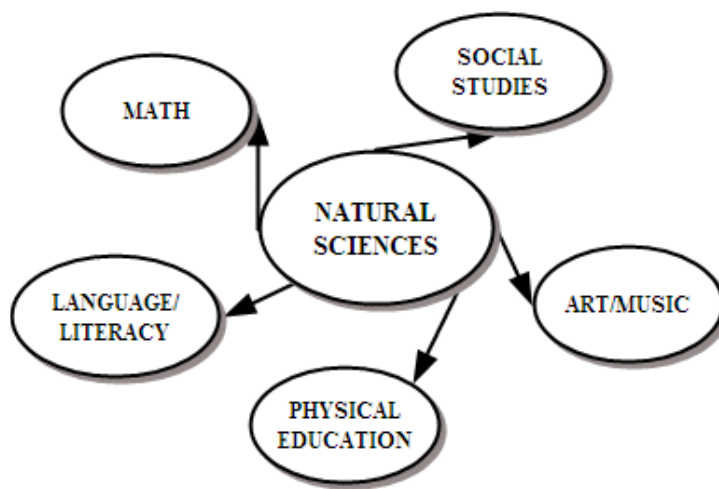


Figure 4.8. Natural sciences education is integrated into the curriculum.

An example for integrated curriculum is given below to show how science and art worked together in the Art Studio. Through the project *Weather*, the preschoolers became very interested in the wind concept. At the Friday teachers meeting, teachers decided to create some provocative and challenging experiences with the wind. One time they set up the activity table in the Art Studio with straws, paint, and white paper and started signing whoever wanted to join. Only four children were allowed at the table at a time and others

waited for their turns while working on other ideas (they use the word “ideas” in general for projects, games, and play). A student teacher provided help according to the needs of each child, for example, giving direct instruction on how to squeeze paint out and blow onto it like the wind. The following dialogue is a short excerpt from a conversation during this work:

Student Teacher (ST): Does it go really far?
Jen : Yeah, because we blow on it.
Megan : Jen, can you pass green?
Amy is waiting for her turn to use green
ST : What is happening?
Jen : It is like water.
ST : It is like water? What do you think what happens when you put the paper outside when it is windy?
Megan & Jen: Hmm it blows it.
ST : Do you think that wind blow it like this too?
No response, children are working hard blowing paint.

The excerpts from the participant observations shows that while the preschoolers were working on blowing like the wind, the teacher was questioning children’s ideas, being provocative, and trying to create cognitive dissonance. Moreover, children were gaining some social skills like sharing, asking to share, and communicating their ideas.

ST : What are you noticing it is happening to yours, Ciara?
Ciara : They are going to bars.
ST : They are going where?
Ciara : Sticking together.
Amy says she is done.
ST : Did you find it hard or easy?
Amy : Hard.
ST : What did you find hard?
Amy is pointing the paint.
ST : Spreading it out? OK.
ST wrote her name on her work.
ST : What are you noticing when you are using a lot of paint? Does it go very far when you blow it, or you have to blow harder?
Megan : Have to blow harder.
Ciara : A little harder and I can put a tiny paint there, and look how big it is now.

ST : So is it easy to blow when you have small amount of paint?
 Ciara : Yeah!
 ST : So do you think that is how the wind works outside? When there are small objects like a piece of paper, do you think the wind make it easier to blow it like a tree?
 Megan : Maybe it tripped down or something.
 ST : (Pointing to the paint jar) there is some at the bottom. Do you need some more?
 ST is putting more paint into the jar.
 Jen is squishing some paint onto the paper and screaming "I am doing it"
 Ciara : Can I have some purple, Jen?
 Jen : Look! Look!
 ST : What's happening?
 Jen : Blowing away.
 ST : (smiling) What do you think what happen if you turn the paper around and blow onto it in a different direction?
 Ciara : I want to try that. (turning around the paper)
 Jen : I want to try that.
 ST : Do you think that your splash marks will go on in the same direction?
 All trying
 Megan : Different direction.

Through asking questions, the teacher was helping children to raise their voices, communicate with others, reflect on what they were observing, and theorize about what was happening. Children were manipulating the materials and trying more challenging ideas when they were engaged more. As seen above, they tried blowing different directions, blowing harder or softer, using more or less paint. After changing the variables, they observed the consequences and communicated those consequences with others. They were confident about doing it and able to make comparisons between different situations (e.g., wind on the paper versus wind outside). Children were free to flow among activities. When they were done with the wind they could leave to work on other ideas. Individual works were recognized in the school. The teacher put the owner's name on paintings.

Clearly they started learning about the important science concept wind, used some science process skills and expressed their ideas through painting and talking. The culture of “how to do science” will be more elaborated in the following section, but the point here is that art and science were truly integrated. Since this was an integrated curriculum, rich science experiences were explicitly as well as implicitly embedded in activities and integrated with other disciplines.

The wind activity was an art work. Children did some mixing colors and painting. The product was definitely an art work (see Figure 4.9). When we examined the process of painting and the conversations among the children and teachers, implicit science embedded in this art work showed itself explicitly. The activity was actually about *wind*, which is one of the important concepts in science. It was a very unique, innovative way to explore the wind. Accordingly, science was not separated from other elements of the curricula by space and time, as discussed before. Science was truly integrated into the classroom in innovative ways.



Figure 4.9. Painting in the art studio by blowing paint through straws like the wind.

The happening of science at multiple places and times, combined with other parts of the curriculum, supported children's development, and indicated how truly science was integrated into the classroom. For example, science supported children's development in multiple ways, namely, their creative, social-emotional, cognitive, language/literacy and physical/motor development, when paired with various types of activities, at different places within the classroom. For example, creativity was prominent in the art studio, gross motor development was emphasized more in the block-motor area, and social-emotional development was more supported in the dramatic play area, and science was a part of each these. Accordingly, having science at multiple places and times, and integrating it with other disciplines, helped support children's development in multiple ways.

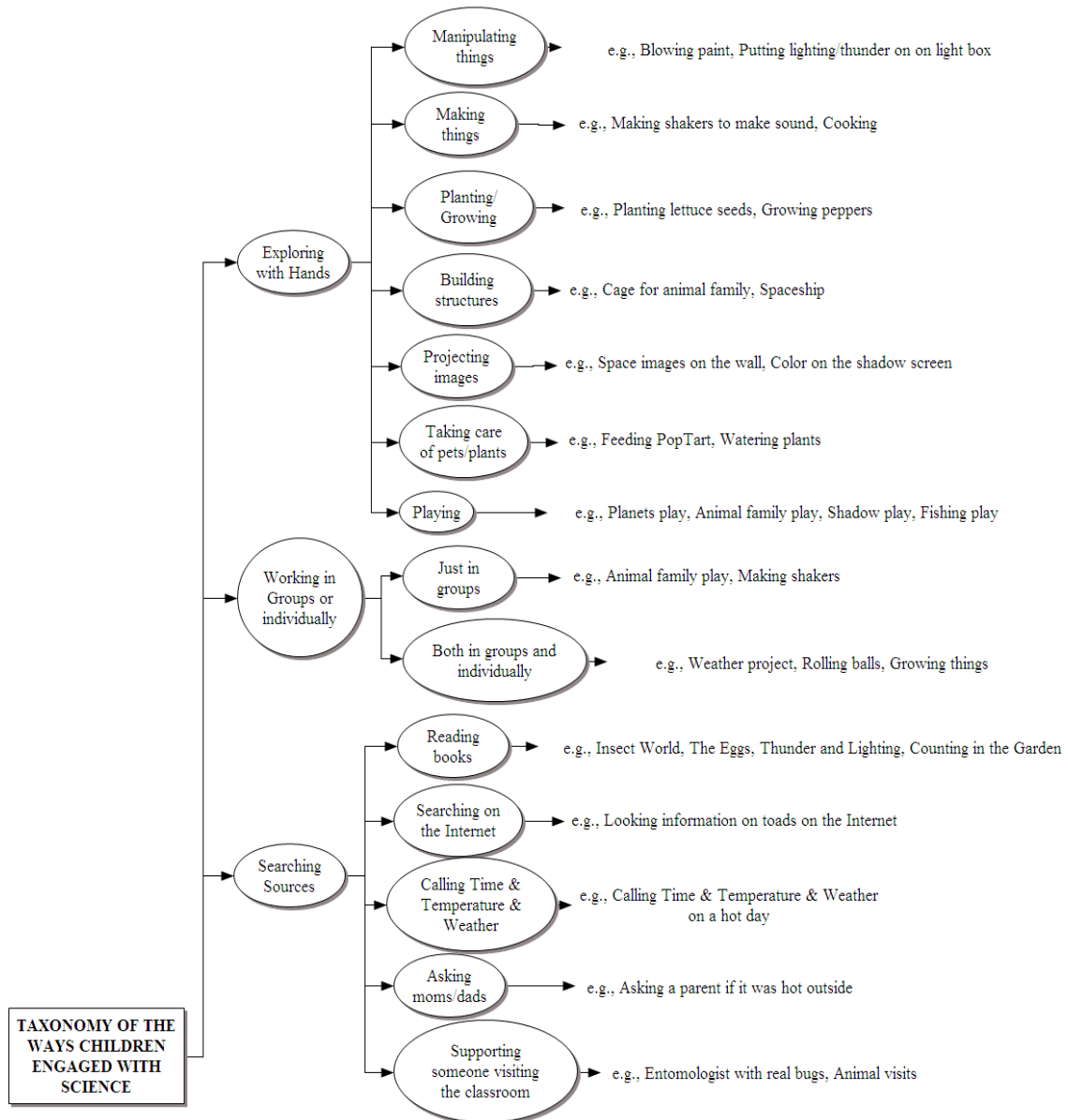
In addition to current projects going on in the classroom, it is essential to indicate that there were also old science projects and related documentation posters displayed at different places within the classroom, such as in the art studio, in the quiet room, on the shelf, on the floor, by the wall, on the mirror, on the table, in the air, on the window, and even in the hallway outside the classroom. Most of them were at children's eye level and easy to reach if children wanted to revisit them/their ideas. Book shelves with science-related books were also available in some corners of the big classroom, as well as in the quiet room. Children had complete access to books at all times to read either individually or socially, in groups. Since preschoolers did not read conventionally yet, they either interpreted the pictures, created a story based on those pictures or asked a teacher to read a book to them.

The Ways of Engaging with Science

The preschoolers in the Reggio Emilia-inspired preschool engaged with science in multiple ways. Those ways are categorized under five units, which constitute the domain of the way children engaged with science. What is included under each unit can be found in the *Taxonomy of the Ways Children Engaged with Science* (see Figure 4.10 and Appendix J). Moreover, Figure 4.11 displays some of the themes and what specific ways children were involved in while conducting those themes.

The five units under the domain of the ways children engaged with science are:

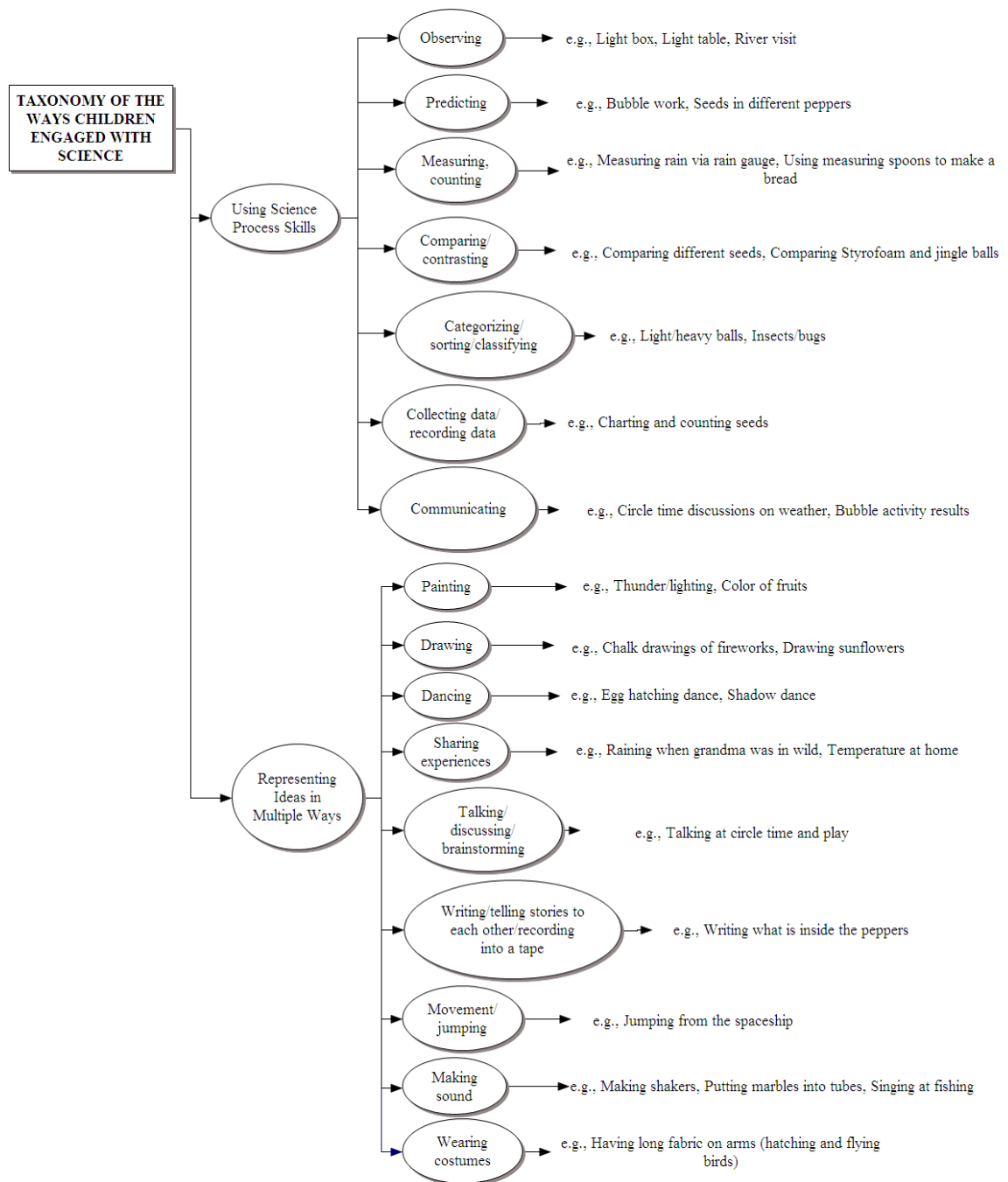
- 1- Exploring with hands
- 2- Working in groups or individually
- 3- Searching sources
- 4- Using science process skills
- 5- Representing ideas in multiple ways.



Continued

Figure 4.10. Taxonomy of the ways children engaged with science and examples.

Figure 4.10. continued.



THEMES*	HOW SCIENCE WAS CONDUCTED
WEATHER	>Exploring with Hands (<i>Manipulating objects, Making things, Projecting images, Playing</i>) >Working in Groups and Individually >Searching Sources (<i>Reading books, Searching on Internet, Calling Time & Temperature & Weather, Asking moms/dads</i>) >Using Science Process Skills (<i>Observing, Measuring/ counting, Comparing contrasting, Predicting, Collecting/Recording data, Communicating, Problem solving</i>) >Representing Ideas in Multiple Ways (<i>Painting, Drawing, Sharing experiences, Talking/Discussing/Brainstorming, Writing/ telling stories to each other/ recording into a tape</i>).
ROLLING BALLS	>Exploring with Hands (<i>Manipulating objects, Building structures, Playing</i>) >Working in Groups and Individually >Using Science Process Skills (<i>Observing, Measuring/counting, Comparing/contrasting, Categorizing/sorting/classifying, Communicating, Problem solving</i>) >Representing Ideas in Multiple Ways (<i>Talking/Discussing/Brainstorming, Making sound</i>)
GROWING THINGS	>Exploring with Hands (<i>Manipulating objects, Making things, Planting/growing things, Taking care of plants</i>) >Working in Groups and Individually >Searching Sources (<i>Reading books</i>) >Using Science Process Skills (<i>Observing, Measuring/counting, Comparing/contrasting, Categorizing/ sorting/classifying, Predicting, Collecting data and Recording data, Communicating, Problem solving</i>) >Representing Ideas in Multiple Ways (<i>Drawing, Sharing experiences, Talking/Discussing/Brainstorming, Writing/telling stories to each other</i>)
SPACE	>Exploring with Hands (<i>Manipulating objects, Making things, Building structures, Projecting images, Playing</i>) >Working in Groups and Individually >Searching Sources (<i>Reading books, Supporting someone visiting the classroom</i>) >Using Science Process Skills (<i>Observing, Predicting, Communicating, Problem solving</i>) >Representing Ideas in Multiple Ways (<i>Painting, Talking/Discussing/Brainstorming, Telling stories to each other, Jumping- movement</i>)
COLOR	>Exploring with Hands (<i>Manipulating objects, Making things, Projecting images, Playing</i>) >Working in Groups and Individually >Searching Sources (<i>Reading books</i>) >Using Science Process Skills (<i>Observing, Comparing/contrasting, Categorizing/ sorting/classifying, Predicting, Communicating, Problem solving</i>) >Representing Ideas in Multiple Ways (<i>Painting, Drawing, Dancing, Sharing experiences, Talking/Discussing/Brainstorming, Movement like weaving</i>)

* Some of the themes during one month period of participant observations.

Continued

Figure 4.11. Each theme engaged preschoolers with different ways of doing science.

Figure 4.11. continued.

POPTART	>Exploring with Hands (<i>Taking care of pets/plants, Playing</i>) >Working in Groups and Individually >Searching Sources (<i>Reading books, Searching on Internet</i>) >Using Science Process Skills (<i>Observing, Comparing/contrasting, Categorizing/ sorting/classifying, Collecting data and Recording data, Communicating, Problem solving</i>) >Representing Ideas in Multiple Ways (<i>Drawing, Painting, Talking/Discussing/Brainstorming</i>)
MAGNETS	>Exploring with Hands (<i>Manipulating objects, Building structures, Playing</i>) >Working in Groups and Individually >Using Science Process Skills (<i>Observing, Communicating, Problem solving</i>) >Representing Ideas in Multiple Ways (<i>Talking/Discussing/Brainstorming, Movement</i>)
BUGS/ INSECTS HABITAT	>Exploring with Hands (<i>Manipulating objects, Making things, Building structures, Taking care of pets/plants, Playing</i>) >Working in Groups and Individually >Searching Sources (<i>Reading books, Supporting someone visiting the classroom</i>) >Using Science Process Skills (<i>Observing, Measuring/counting, Comparing/contrasting, Categorizing/ sorting/classifying, Communicating, Problem solving</i>) >Representing Ideas in Multiple Ways (<i>Drawing, Sharing experiences, Talking/Discussing/Brainstorming, Telling stories to each other, Jumping- movement</i>)
ANIMAL FAMILY	>Exploring with Hands (<i>Manipulating objects, Building structures, Playing</i>) >Working in Groups >Searching Sources (<i>Reading books</i>) >Using Science Process Skills (<i>Observing, Categorizing/ sorting/classifying, Communicating, Problem solving</i>) >Representing Ideas in Multiple Ways (<i>Dancing, Talking/Discussing/Brainstorming, Writing/telling stories to each other, Movement, Wearing costumes</i>)
SHAKERS	>Exploring with Hands (<i>Manipulating objects, Making things, Playing, Making sound</i>) >Working in Groups >Using Science Process Skills (<i>Observing, Comparing/contrasting, Categorizing/ sorting/classifying, Communicating</i>) >Representing Ideas in Multiple Ways (<i>Talking/Discussing/Brainstorming, Making sound</i>)
COOKING	>Exploring with Hands (<i>Manipulating objects, Making things, Playing</i>) >Working in Groups and Individually >Searching Sources (<i>Reading books</i>) >Using Science Process Skills (<i>Observing, Measuring/counting, Comparing/contrasting, Categorizing/ sorting/classifying, Predicting, Communicating, Problem solving</i>). >Representing Ideas in Multiple Ways (<i>Sharing experiences, Talking/Discussing/Brainstorming, Telling stories to each other</i>)

* Some of the themes during one month period of participant observations.

The preschoolers constructed science socially, both explicitly and implicitly inside and outside the classroom. They participated in science hands-on experiences (1), worked in groups most of the time (2), conducted their own search for related natural sciences (3), applied science process skills (4), and created multiple ways of representing their ideas and theories (5). In general, it can be stated that the way these children engaged with science was more of a reflection of real life. Science was naturally occurring as part of the everyday experiences of the children. Teachers saw science in the preschool as an extension of real life and created a rich context to support it. An excerpt from an interview with Kathy, the lead teacher, supports the notion that science was a part of the children's daily experiences with their world:

I would see natural sciences as included in the same way that it is included in life. Classroom is a reflection of life. So we would first look to the children, and to their questions about their world. And then of course some of those questions are going to include natural sciences, they are going to include things that they discover in nature.

To get into this idea that science was a reflection of life, sometimes teachers observed, listened to the preschoolers, learned from them, and then took a more active role to create a challenging and provocative environment. The teachers then decided on what was appropriate for the children and provided opportunities for them to explore things that they were curious about. The teachers continued listening and reflecting upon what was actually going on in the classroom. Within this cycle, both preschoolers and teachers affected each other, and this promoted meaningful learning experiences.

Another excerpt from an interview with Kathy indicates that, consistent with the theoretical paradigm of the school, the teachers provided opportunities for the children to work on their own questions and work actively to construct their own knowledge.

We look to the children because we are a social constructivist program – where the children can construct their own knowledge based on their own questions, where we do not want to provide answers, but have them construct their own answers. And better still come evolve their own questions, new questions. So when I think of natural sciences I think of it in the same way that I would think of any other aspect of our curriculum and any other domain of learning that we would want to see what is important to the community of children. There are 20 children, so of course there is going to be lots of ideas and one important part of our role is to think about which of those ideas has the most potential for growth and development, which of them has the strongest shared interests so that we can choose just a few. We can't possibly entertain every idea that comes in the doorway, but we can make sure that what we do experience together is meaningful, that it matters to the children. So we look for those authentic experiences.

The way children engaged with science was more of a reflection of real life, because the reason for the experiences had their roots in the children's lives and experiences. The themes had meaningful places in the children's lives. While creating the school culture (e.g., making Curriculum Guides), teachers took the peer culture (e.g., children's interest in Star Wars) into consideration. The teachers built on the peer culture, which led to more challenging learning opportunities within the school culture.

For example, thunder and lighting were related to the weather theme, which was initiated after much thunder and lighting occurred during that particular time. Also, one of the preschoolers was afraid of storms because his brother told him frightening stories about thunder and lighting. Thus, a strong connection to the classroom community's everyday experiences and concerns was already there, and the teachers built upon the connection.

The teacher, Mary, gave the example of the insect investigation to show how science was part of their classroom life:

When it becomes spring here - we begin to find lots of bugs, generally outside on the playground but we're also in an old building and sometimes inside the building you find them. So we see always that there's a natural interest by the

children in bugs. Sometimes we'll capture them from outside and we'll bring them in. Sometimes - this spring somebody brought in... a bug collection and had it in that area of the classroom for many days with magnifying glasses and materials where the children could see them up close and then also reproduce their own ideas so there would be paper and pencils or pens where they could also draw what they were seeing in that area.

The following excerpt from an interview with Kathy provides another example of how a project could be embedded in real life. The children found duck eggs on the playground. This event excited children and became a starting point for them to explore more about ducks, eggs, and hatching.

We found duck eggs underneath - over here, on the playground without a spring way "oh there was a nest." It was Monday. So over the weekend a mother duck - not a good choice - she had made her eggs on the playground, not realizing that there's school the next day there will be a lot of children. So that's just amazing and children saw them and we made signs "Do not bother these eggs". Well, who knows what happened. We'll never know what happened but the next day the eggs were gone. Well it happens. That was a bad place for a nest. So it could be that the mother just left because realizing that there are lots of children. And maybe a dog got in and got them or whatever. So the project included theorizing about what - where did they go? What happened? And they had all sorts of theories - like aliens came and took them or a very tall man that could step over the fence came in and got them. They narrowed it down and then that led to a lot of expressions about eggs. About - and then we hatched eggs. We got some eggs from the poultry, science department, hatched them. So it is those kinds of real things that lead to that deep, deep learning.

This spontaneous event of finding duck eggs at the playground and preschoolers' excitement gave teachers ideas to create more education opportunities through providing a provocative and interactive environment. As the teacher stated, they even made observations of hatching eggs. Preschoolers actually worked on the project of hatching eggs for two months, which involved using their science process skills.

It is important to state the basic idea, which was looking for excitement in children. As one way of determining trend of interest, Mary, the teacher, stated, "We

observe the children's interests and we listen to what they talk about. We follow their play and then based on that we offer them experiences and materials that will support those interests." Teachers tried different ways to catch children's interest and excitement, and worked on that while nourishing preschoolers' learning experiences. They drew further the lines that were already there. In other words, teachers did not let the exciting event (i.e., finding eggs on the playground) end in itself but rather it became a starting point for more challenging experiences and education possibilities. That is also how and why the revisiting of ideas was very strong in this preschool classroom.

As observed from the experiences in the preschool, science was embedded in children's lives, not fragmented. The reasons for doing science, which was related to the starting points of themes, will be more discussed in-depth in the next section under *Taxonomy of the Reasons for Doing Science*. The way of doing science and how science was embedded in children's life will be elaborated herein, and will include some examples and some scenes from the experiences of children. The first unit for the way of doing science is ***Exploring with Hands***.

It is essential to state that the environment –not the curriculum–was provocation to the preschoolers' interest. The teachers created a science-rich context that triggered and supported preschoolers' inquires, and engaged them actively with science. Children had hands-on experiences in various ways, namely manipulating objects, making things, planting/growing, building structures, projecting images, taking care of pets/plants, and playing.

The children were offered opportunities for manipulation of materials. For example, few days in a row, the teachers provided shadow work with the overhead

projector in the art studio. The children interacted with shadows in various ways. As children's interest continued, the teachers added more items and also colored ones to create shadows. In the Curriculum Guide, it was stated "frequently the children have been equally interested in creating shadows using the light from the projector. We'll be offering some other light sources (and even some colored lights!) to support this interest in shadow work." They used the overhead projector and put different items on it, like marbles and colored rulers. They projected the images on a big shadow screen. Preschoolers created images together on the screen through rearranging the items on the overhead projector. Here is a note stated in the transcripts of observations and interest inventories:

Marian, Anne, and some other kids are in the art studio experimenting with the overhead projector and screen. There are different translucent colored shapes and materials, like a ruler, marbles. And they take an object from the basket containing translucent colored shapes being offered for this work and then use it to project colored shadows on the screen of a big white curtain. Anne and Marian are carrying their tigers on their shoulders, start putting some colored things on the projector. Kathy, the teacher, says, "If you get all of them, then other people will have any". Anne and Marian are leaving some, so that other children can play too. Megan and Jen are also putting things on the projector. Amy has found two marbles stacked together. She says "oh!" looking amazed. She is trying to figure out how to unstick them. They are making a design with colored shapes on the projector. The idea is today having children experiencing some colored shadow work, as indicated by teachers.

Adia and Megan were very interested in the different-shaped and translucent colored objects offered in a basket by the overhead projector. The girls started their work by just adding a few objects to the projector and observing the screen to see their results. Then they put all of the objects on the projector and observed how their screen was almost completely black. Then they slowly took the objects off the projector, while watching the screen, and proceeded to put all the objects back on again. This lasted about 10 minutes.

While the preschoolers were creating different images on the big screen by manipulating materials and projecting images, they were also involved in play. They

made a design with shapes and then Megan stood behind the shadow screen. She held her hands up, pretended taking a shower and started singing along with the music. She pretended the shadow screen was a shower curtain. Other preschoolers in the art studio were watching her shadow and laughing at her play. Andrea joined Megan's pretend play and stood at the other side of the curtain. Megan realized that there was somebody on the other side of the curtain and started pretend-screaming and running away. They took turns pretending to shower and realizing that they were being watched by somebody else and screaming. It was common to observe different kinds of play embedded in their science activities, or science embedded in play.

Teachers supported preschoolers' play all the time. Mary stated, "Our emphasis in our program is on play." By providing play-based experiences, teachers aimed at engaging preschoolers in science events/activities or other disciplinary fields (e.g., math and literacy) in natural ways. Preschoolers were involved in various play themes, such as the animal-family play, bugs-fight play, shadow play, space play, fishing play, and the pretend cooking. Even while conducting experiment with a fan, rolling balls, or bubbles, play was distinctly part of the event.

The shadow play continued over days, also in the block area. Teachers set up the overhead projector in the block area to support the space play with planets. One day, preschoolers used that projector to project the images of their hands. They stood about a foot from the screen and observed the movements of their shadow. When they put hands further away from the projector, the shadow got bigger. One of the student teachers and preschoolers did an experiment with shadows of hands and played at catching shadows of each other's hands on the wall. The theme embedded in the play of hands getting bigger

and eating the small ones was the distance between the projector and things, and the size of the shadows. A student teacher asked some questions like “What happens when you put your hand here? Is your hand big? What if you compare it with the screen?” and made some comments like “When you get further away, the shadow gets bigger and bigger. Oh man! Giant!”

Teachers encouraged preschoolers to talk about their ideas, what they experienced, or what they would like to do next. For example, after shadow play, they talked about it during the circle time.

Student Teacher (ST): We were just here by the overhead, we were noticing something. I put my hand up against the screen, it was very little, my shadow was very little.

Mark : Yes, she was.

ST : What happened when I was far away, Mark?

Mark : Bigger.

ST : My hand got bigger, my shadow got bigger. We were kind of noticing that...

All preschoolers are saying “mine too, mine too, mine too”.

ST : It seems like when my hand was close up to the screen, my shadow was really little. When it was further and further, my shadow was bigger and bigger and bigger. So that’s something maybe you might want to check out after circle time...

Kathy : If you want to do some experiment with shadows, you can try your hand, but also you can try some other things.

Amy : Your body.

ST : You can try some other jewelry you are wearing. That could be interesting to see how it gets bigger and smaller.

Anne : I brought it in.

ST : It is sure it is Anne’s jewelry that you brought in.

Shadow theme was an example for hands-on experiences. Another example can be the magnet activity of fishing. Preschoolers tried to catch fish at the sensory table using a stick with a string and magnet on the end, catching fish made of paper. Those paper fishes had paper clip “mouths” which can be “caught” by the magnet on the string

so that the children could catch the fish. John was involved at the sensory table catching fish. When he would catch a fish he would look at it, and then take it off the magnet connected to the string. He continued doing this for about ten minutes. Arthur and Mark and then Andrea joined. John continued a few more minutes, became involved in a dialogue, and then he left. During this time the children were actively trying to catch the fish.

Mark : We can all fish.

Arthur : I got one!

Mark : I caught one guys. I caught one!

John : I got a bigger one than him.

Arthur : Now I got two! You missed me, mine hahaaaa...come and get my fish...ahhh my fish!

Mark : Wow! I caught a big fish.

Arthur : I have two. Come get me.

John : Done.

Arthur : We both knocked ours down.

Mark : The fish is a super hero. All the fish are super heroes.

Arthur : Ohh ahahahh!

Andrea joins the sensory table with Mark and Arthur.

Mark : I caught a little one, Andrea.

Andrea: Stop guys. It's all tangled.

Mark : Black fish – it's Darth Vader. Whoever catches the black fish wins.

Arthur : Hang on.

Mark : Whoever gets the black fish wins. Cool, I caught the black fish.

Whoever catches a big fish like me wins!

Andrea: I'm winding it up. I got a red one.

Mark : I caught a big fish! (from Interest inventory)

The children interacting in this play at the sensory table were very involved with catching the fish. While they were trying to catch the fish, much interaction and conversation occurred. They were all communicating and trying to catch fish. At one time strings from two of the rods got tangled up. Andrea used her communication skills as well as problem solving skills. She asked her partner to flip the string. She also asked

the teacher's help to resolve the problem and get them untangled. The children were interested in making a game out of catching the fish and came up with new ideas with related to catching the fish. There was communication between all the children, but by the end of the dialogue each child was starting to play at the table by themselves trying to catch the fish more carefully.

The preschoolers were able to explain how magnets work. Mark was holding a little car and a piece of magnet. He was sticking and unsticking them continually. The researcher asked him why they stick to each other. A short dialogue between the researcher and Mark as follows:

Mark : It sticks, because it is magnetic.
Researcher: What about this? (Pointing a plastic toy)
Mark : No, it does not.
Researcher: Why?
Mark : Because it is not metal.

While teachers created a provocative, challenging environment for preschoolers to explore, they did not put strict rules on how to use those materials and tools. There was no correct way to work with materials. Preschoolers were free to manipulate materials and use them in various ways rather than a way which was strictly prescribed before hand. Creativity in the way of using materials was always encouraged by teachers. Materials were set up by teachers to be used for particular reasons in particular ways, but it was always open to free exploration. Kathy stressed the importance of "what messages are sent by how things are presented." Here is what she said:

We would look at many ways to support learning. It could be an experience and materials thoughtfully presented that we have a specific sort of notion about how the children would use - for representational work or for the experimental work. For instance, if we put out (we do this on our light table) containers of different hues, colors, - of a substance - water, oil and anything - and with the eye

droppers and test-tubes. We have some racks to hold the test-tubes. Then our notion is that the children will take small amounts of that water and see how those colors mix. And if we put it on a light table, we could see how those colors are illuminated from below. Make them stronger or just different perspective. So there's a notion there. Because we presented small amounts and eye droppers then we have a notion of how they can carefully use little bits. If we put out buckets of colored water or whatever and big scoops then we would have a notion that they would dump and mix and mix and mix.

The preschoolers' hands-on experiences were not limited to materials and tools. They also worked with alive things, namely plants and animals. They learned about the features of some plants and animals in multiple scientific ways, such as reading books, planting tomatoes, drawing insects. They also shared responsibility for taking care of the pets and plants at the school.

They had several plants inside and outside the classroom and interesting pets, which they considered as "important members of their classroom community." Practicum student teachers and other adults in the room were welcome to also help with the care and feeding of the pets, but were under no obligation to do so. They were also careful about any allergies or other concerns anybody might have regarding being around the pets. The current pet population included: Two box turtles named Speedy and Chance, a variety of tropical fish, some aquatic frogs, a parakeet named Kermit, a nameless toad, and a very friendly guinea pig named Poptart (stated in Children's Bios). The responsibilities list was hang on the wall and changed daily (see Table 4.1).

RESPONSIBILITIES	
Picture of the child	will take care of the Guinea pig.
Picture of the child	will take care of the turtles.
Picture of the child	will take care of the fish.
Picture of the child	will take care of the frogs.
Picture of the child	will take care of the birds.
Picture of the child	will water the plants.
Picture of the child	will check the sign-in chart.
Picture of the child	will ring the bells.
Picture of the child	is our clean-up leader.
Picture of the child	is the line leader.

Table 4.1. Responsibilities chart for the preschoolers.

Working in Groups or Individually is identified as a way of engaging with science. As social constructivist point of view was pursued by the teachers, who often gave preschoolers opportunities to work in groups. On the other hand, there was always an option to work individually if this were a child's choice. Teachers were responsive to both shared and individual needs and interests of the preschoolers.

Small group works were usually limited to four people at a time, especially when it was table work with four seats available. However, it was usual to see more or less than four people working on the same thing, especially the ones not on table. For example, the Space play occurred at the block area, which had a broad space to accommodate many people to work and play together.

Grouping preschoolers happened in various ways. Sometimes preschoolers came and asked the teacher to put their names on the waiting list for the activity. When a seat was available, the teacher called the next person on the waiting list. For example, when preschoolers were making banana bread by reading the recipe from the book, measuring

the ingredients, pouring, mixing, and stirring them, the teachers allowed only two people at a time. They shared the work: While one person was measuring and pouring the ingredient into the mixture, the other person was stirring it. When Anne and Mark were working on this, Jen approached and wanted to join. Kathy, the teacher, said, “Go and make another choice. I will put you on the list.”

Sometimes preschoolers announced at the circle time what they were planning to do and invited other preschoolers to join the activity. The three examples below represent different days during circle times and all three examples are about inviting others to play “animal family.” At the circle time, Jen invited other preschoolers to play animal family.

Jen : Me and Anne, and Marian, we are playing family. We have tigers.
Whoever wants to play, he has to have one of those tigers.

At another circle time meeting, Marian told about what Anne, Amy, and she would do. She said that they would play with lions. She also invited other people by stating “whoever wants to join.” Amy declined to play and said that she was not going to play lions but dramatic play. The student teacher said, “So if you want to play dramatic play, talk to Amy. Joe will be fishing. Anne will play lions. Andrea will be fishing. Megan will play lions, too.”

On another day, first Adam said that he wanted to play Care Bears. And then Amy said that Megan, Anne, and she decided to play Care Bears. Isabel also wanted to join Care Bears play group. Alicia, the teacher, said that it might get crowded over there and asked Isabel to think about another choice.

Deciding who was going to be in the group was as important as how many people would be in the group at a time. The example of Jen inviting other people displayed the

importance of cultural artifacts in peer culture to entering a group. She talked about her plan with her friends, whom she usually played with, and invited other preschoolers to join them. So did Marian and Amy. They often declared their regular friends as play partners, but they still asked other children to join them. Moreover, the regulars still had an option to decline and choose another play. Teachers had both a passive and an active role (e.g., staying unobtrusive, or intervening when it was needed) while children were deciding on forming small groups. Teachers also had a role of concluding and summarizing what children had already decided.

Another important point was that the “tiger” “lion” and “Care Bears” plays were extension of the same theme, “Animal Family” play. Even though the cultural artifact was changed from tigers to lions and Care Bears, the theme stayed same and the cultural artifact always saved its importance in group play as part of the peer culture. In addition to school culture, understanding the notion of peer culture in this school was an important factor in understanding how the children formed groups and engaged with science.

Searching Sources is the other way children engaged with science. The preschoolers did searching sources in various ways, namely, reading books, searching on Internet, calling Time & Temperature & Weather, asking moms/dads, and interviewing someone visiting the classroom. The ways of searching sources is not limited to those, but those are the ones observed during participant observations of science events.

Consistent with the theoretical paradigm of the preschool, the teachers opted to encourage preschoolers to conduct their own search for information. The teacher, Alicia, stated that they wanted preschoolers to “think of themselves as capable, competent researcher-scientists, not that I can memorize these facts about bunnies or babies or water

or whatever.” Filling preschoolers with facts was seen as a passive act, which could jeopardize the children’s development of inquiry skills. Teachers wanted children to become strong thinkers. Accordingly, the teachers valued preschoolers’ skills of asking questions and looking for answers by checking sources. Alicia stated:

When they're asking questions about why is the sky blue or why do butterflies fly away when I go up to them - we can give them resources to figure that out. Find out ways of offering them library books, internet - other kinds of things because I also don't want them to think that adults hold all the answers. Because they don't. And even if I knew a certain amount of one subject, it's going to change. What we even know about bunnies is going to change 50 years from now. And so for me to fill them with facts about bunnies doesn't really help them. What helps them is for them to know how to ask questions about bunnies and how to find those answers about them.

Preschoolers showed confidence in themselves. They believed themselves to be capable researchers who do their own search and construct their own knowledge. Alicia stated, “we had one child in a particular circle time who was saying ‘you want to know something about bugs? Just ask me because I know all about bugs. I read bug books.’ ... So I do think they learned to use the resources available to them - to suggest resources and know, trust that we'd provide them.” It was not unusual to hear preschoolers declaring their confidence verbally.

Here are some notes from interviews and observations about the ways of looking for information and using sources:

We might support with someone visiting the classrooms. We recently had an entomologist come in with real bugs. He offered to catch real bees unlike for children to touch them and he promised he would make once with no stingers and we had to say that’s probably not a good choice. Because then children who couldn’t choose which ones have the stingers outside might think “oh! I can just catch them”. But his idea was right to have real, real bugs. So we might have someone come in and bring things to the classroom. (Kathy)

Somebody caught the lizard and once she caught the lizard it became a pet in the laboratory school. But that started a whole investigation - they were seeing what this creature was. What you needed to do to take care of it. What kind of living conditions. What it ate. They had a zoologist person come and consult with them on how to best take care of it and identify it for them. (Mary)

Reference books or story books. Right now ... we have a family of baby bunnies living underneath one of our structures on our playground. Fifteen bunnies. Tiny bunnies. So over the weekend they went to the library, got books about rabbits, about bunnies, about where they live, what they need to eat. And the children right now are looking in those books to get ideas about what kind of food. We thought it would be a generous thing – they are all on our playground - to offer them some food. (Kathy)

Other ways that we take - explore natural sciences in our school would be through literature of course, through projected images. The children have been very interested the last several weeks in rainbows. Well we can't depend on going outside without a rainbow. But there are fabulous resources, especially on the internet of images. So what we can do then - and some of the children, many of the children actually this spring time have actually seen some rainbows, which is a lucky thing. So we can go get images off the internet and we've done color transparency prints and then project it against a wall or against the ceiling or above the easel so that there's a very real photograph that they can use as a provocation or as a reference for their work. (Kathy)

The examples above included having an entomologist and a zoologist visit their classroom, checking Internet web sites, and checking literature. Those are just a few sources that preschoolers used. Books were used by preschoolers most frequently (see Figure 4.12). Many books were available to preschoolers' use at school, but preschoolers also had opportunities to get books from libraries when they needed.



Figure 4.12. The Preschoolers engaged with using books as a source.

Different than many other preschools where reading was considered to be a quiet activity and situated in an area called “quiet area,” in the Reggio Emilia-inspired preschool, co-reading was encouraged. Interactive reading happened in different parts of the classroom, while children were interacting not just with other people in the classroom but with other things like the pets. For example, while a teacher and two preschoolers were reading the book called “Pet Care Guides for Kids: Guinea Pigs” at the circle area, they were taking care of Poptart, the guinea pig, at the same time.

Poptart is trying to climb Megan’s belly. They continue reading the book; Alicia says, “It says, they are so happy when they are fed.” Kids are laughing, because Poptart is biting the guinea pig book now. They decide to give him a piece of paper instead. Alicia, the teacher, says, “Oh! He keeps going after the guinea pig book, so Andrea and Amy thought.” Amy says, “He wants a piece of a paper!” He is biting the paper now. Amy is screaming and laughing “oh, he is biting me!” Alicia says, “You remember the bunnies book? There was wild bunnies.” They are taking turns of taking care of Poptart. Amy says that she needs five more minutes. Poptart is trying to escape from her lap. They continue reading the book, looking at the reddish guinea pig picture in the book. They are comparing different kinds of guinea pigs and discussing what they do, what color they are,

etc. Alicia continues reading the book. Amy says “he ate whole paper very quickly.” They spread the towel on their lap and then put Poptart on it again. They are all screaming when Poptart tries to escape. Alicia is reading the part about baby guinea pigs, the things they eat, and how to tell if it is boy or girl. Alicia is pointing to the boy and girl guinea pigs.... Poptart starts pooping. They clean it with a piece of cloth. Alicia is pointing to the picture in the book and saying, “That one really looks like him [Poptart].” Poptart is pooping again. They say that he might want to take a nap so they decide to put him back in his place.

As seen above, they did co-reading. While the teacher was reading the book, they all commented and discussed about what the book said. More than co-reading, they also took care of Poptart. The preschoolers looked very happy and excited. They made connections between their experiences with Poptart and bunnies they found at the playground and what they learned from the book. The evidence shows that the preschoolers were able to conduct their own search for information.

Using Science Process Skills is one of most important units for the ways preschoolers engaged with science. The preschoolers could learn a lot and enjoy doing projects within a social context. This helped with science process skills and provided many great language opportunities. The preschoolers were involved in the following science process skills during participant observations: Observing, Predicting, Measuring/Counting, Collecting Data/Recording Data, Comparing/Contrasting, Categorizing/Sorting/Classifying, and Communicating.

SCIENCE PROCESS SKILLS

1. Observing
 2. Predicting
 3. Measuring/Counting
 4. Comparing/Contrasting
 5. Categorizing/Sorting/Classifying
 6. Collecting Data/Recording Data
 7. Communicating
-

Table 4.2. Science process skills that were used by the preschoolers.

While pursuing their interests and looking for answers for their inquired topics, preschoolers were very involved in using the science processes stated in Table 4.2. All of those skills were not necessarily used in a single project but in different projects. Rather than using science process skills in a typical science laboratory context these skills were used more naturally in daily life as opportunities presented themselves. Accordingly, natural (quasi-experimental) experiments, where observation is the base, grew out of those experiences. Children became interested in a topic or question and in response teachers set up an environment intended to encourage further inquiry. As children explored and investigated, their understanding of science grew.

Preschoolers were involved in various science process skills. First of all, the preschoolers did *Observing*, such as with the wind. Different wind studies occurred in the

art studio and at the stairs in the classroom. Preschoolers experimented with the wind by blowing paint through straws like the wind, as discussed before. They changed some variables, such as putting more paint, blowing from different directions, and blowing fast or slow, and then they observed the differences and communicated their experiences with others.

During the wind experiment, preschoolers did observing using their senses. They were observing what was blown and what not while they were trying different things over and over. Here is the other wind experiment with a little fan set up on the stairs. It was started after the growing interest of children in how air conditioners work. An excerpt from an interview with Alicia, the teacher, indicates that children's interest in blowing grew into more sophisticated events with teachers' guidance.

Something that happens quite spontaneously is air conditioning vents - children figuring out - they set a piece of paper on it and it blows up and then we do wind experiments and different kinds of things that can fly through the air as opposed to heavy things. So then it becomes weights and measures. So observing their interactions with the materials So I think we really look for those teachable moments in our every day interactions with the children and expand on projects from there.

As stated by the teacher, the teachers in the classroom were always looking for teachable moments and setting up the environment according to children's interactions with the environment. As teachers aimed to create an environment, that provokes children's inquires, setting up materials for experimental experiences was usual.

The teachers set up a little fan up by the stairs and put a little gate up for the security of the preschoolers. Preschoolers were able to work with the fan as well as stay safely far away from the fan. Teachers also provided different articles that preschoolers could use for the wind experiment. They gave a basket filled with light and heavy things

like feathers, ribbons, scarf, foams, and rocks. Preschoolers conducted the wind experiment with the fan by using those light and heavy things. They threw them to the fan and communicated with each other about what was happening as seen from the observation transcripts. This continued both in the morning and afternoon.

Jen : Hey, look, what happened!

Student Teacher: What is it?

Jen : it blew away.

....

Researcher: Can you tell me what you're doing right now?

Jen : I am doing blowing things. We are just like, you just have hold this, it blows away.

...

ST : Why are they blowing?

Megan : Because of the wind.

Many preschoolers tried the wind experiment by throwing things to the fan. The excerpts from the observation transcripts support the notion that the preschoolers were able to work on science concepts and explain what was happening. They dropped things and then picked up again and again. They used different things like little foams, rocks, and feathers, and observed the difference between light and heavy things. They observed what was blown by the wind, what was not. The teachers brought up this natural experiment with the wind at the circle time discussion and tried to get children who already worked on this before the circle time and to reflect about their experience for children who did not have any experience yet.

Alicia : What we can use outside will be some wind to cool us down, but we do have wind in our classroom. Did you try that idea, Amy?

Amy : Yeah!

Alicia : What did you do?

Amy : There is a basket (inaudible).

ST : There is some fun stuff in the basket, if you want to put in front of the fan or the wind.

Alicia : What did you use Amy?
 Amy : Two scarves, ribbons, one blue and one green ribbon, one was skinny and some feathers, and some skinny ribbons and some big green ribbons.
 Alicia : If there are other things in our school that you want to try, see if they blow with the wind, then you could talk about with Anna [ST] about that. You can find more things for the basket.
 Megan : Last time you had to turn off that fan, because I was going to...
 Alicia : Yeah! You go “ooooo,” it blow you away. We have to be all covered up. We have to put an extra blanket.
 Jen : Then you go “oooooo” (pretends to be blown away by the wind).
 Alicia : Yeah. That’s why we turned it off during the rest time.
 Amy : I was at the other side of the fan.

The preschoolers used their communication skills during the activities as well as the circle time. Although sometimes it was hard to hear what they said, they were able to communicate what they did with the fan and reflect on it. Kathy mentioned the incidence that happened the day before with the air conditioner at the block area. She said that since a small blanket got sucked up to the air conditioner, the air conditioner started making noises. Then they moved the Star Wars structure away from the air conditioner, because the air conditioner was sucking things up. At the circle time, discussion continued as it follows:

Alicia : If you want to see something blowing, you can use the fan.
 Mark : Does the air conditioner suck up big toys?
 Alicia : Oh, no. The blocks are OK, it cannot pull them up but light things. You may wanna think about it, when you are working with Ashley, what things are light and what things are heavy because it can only pull up light things.
 Ciara : There is also rocks over there too.
 Alicia : How did they blow?
 Ciara : I did not check, but I saw there was rocks.
 Alicia : Hmm. Let’s see if they can blow on the fan.
 Mark : No, no.
 Alicia : Why?
 Mark : Only the paper.
 Alicia : Only the paper?

They made comments on if light and heavy things are blown or not. Mark inquired about whether big things are blown. He knew that rocks could not be blown by the fan, but the paper could. Mark also made a comment that “It cannot suck up this pillow, because it has more weight...” Although this statement might be incorrect scientifically, this was a big idea showing developing understanding of a preschooler about a science concept (i.e., weight) and a cause/effect relationship (i.e., the relationship between weight of an object and being sucked up/blow).

Preschoolers also conducted observations by using observation tools to find out about science-related things. For example, preschoolers observed the weather daily outside at the playground and made comments, such as if it was a hot day and what temperature it could be. They also observed various weather events inside the classroom through using the light box and the light table. For example, one day Kathy invited preschoolers to observe different weather conditions on the light table during circle time:

Kathy : There is also that light box, with a light bulb inside of it. There are also images, like clouds and lightning that you can put at it and look at. Mark and I worked even this morning. You can put a picture of a sunny day and then put lighting over it; you can make a cloudy day. And then take the clouds off, it is a sunny day. It is by the kitchen.

Mark : Or you can put the sun on it.

Preschoolers observed different weather transparent pictures on the light box and light table. For instance, they put sunny pictures on cloudy pictures and lighting pictures on cloudy pictures to observe the differences among various weather events (see Figure 4.13). They were very successful in conducting observations and reflecting on it.



Figure 4.13. Observing various weather episodes.

Making a Prediction is another science process skill that the preschoolers engaged in frequently. The preschoolers were able to form an idea of an expected result and a belief of what would occur based upon their present knowledge. For instance, they made some predictions about weather. At a circle time discussion, as one of the routines, the teacher, Kathy, called children by singing the circle time song. The children also joined her and start singing “Come on everybody, find a seat. It is circle time”. They were all finding a space for themselves. Richard asked the student teacher “can I sit on your lap?” The student teacher said “Megan just asked.” They all sit down in a circle. Here is a conversation among preschoolers that occurred at the circle time while it was pouring outside. Because of the rain they could not go outside, so they discussed what to do and made predictions about the weather. They decided to vote for what they would do and came up with the idea of searching for information on rainbows.

Alicia : I don't think we will be able to go to outside, but the good news is that tomorrow when we get to the school; we are going to have to check that rain gauge.

Children: Yeah!

Alicia : There is a lot of rain falling, it is a wet evening. What will happen to the rain gauge?

Mark : It is full.

Alicia : You think it is overflowed?

Children: Yeah!

Marian: And there will be rainbow.

Ciara : It is not gonna make a rainbow. It is just pouring.

Alicia : Just pouring is not gonna make a rainbow?

Arthur : Yes, it is gonna make a rainbow.

Marian: Yeah! You are right.

Alicia : Marian is hoping there will be a rainbow outside. Do you think that there might be a rainbow?

Children: Nooo!

Alicia : Why not?

Andrea: Because it is just a little bit but you need a huge much.

Alicia : A huge much of what?

Andrea: Of rain, and you need a thunder.

Alicia : So you need a huge amount of rain and thunder to make a rainbow?

Children: No.

Children: Yes.

Alicia : Marian why are you saying no?

Marian: A rainbow just come with rain (inaudible)

Alicia : It can come without thunder and lighting also?

Jen : Noo!

Marian: A month ago, it did not rain and a rainbow came to my house; it did not rain or thunder. Or it did not lighting but a rainbow has just come.

Alicia : Let's check where are those books about rainbows in our school.

Arthur : In the quiet room.

Alicia : How about this? After circle I will make sure that those books are out here. Maybe by this basket. Because we have to do some research and see. That boo has information about rain and rainbows, so we can do research.

The preschoolers made some predictions about how much rain there might be in the rain gauge. They agreed that the rain gauge would be full or even overflowed. They determined the next step would be to check the rain gauge the next day. The discussion ended with the theories about rainbows. Ciara's theory that only much rain can make the rainbow led into the discussion. Andrea and some preschoolers agreed, and even said

thunder was also required. On the other hand, Arthur, Marian and some other children did not agree with their theory but thought that just little rain could make a rainbow. Marian even talked about her observations at home and tried to support her theory with evidence. They decided to conduct research on rainbows by checking in some rainbow books.

The preschoolers were not only competent in creating their own theories but also supporting them with their evidence and discussing the differing ideas of their peers. The conflict in ideas was appreciated by the teachers and seen as an opportunity for the children to inquire more and to learn more.

The preschoolers were also involved in *Measuring and Counting* as a way of doing science. They were able to compare an unknown quantity with a known unit of measurement. The preschoolers quantified their observations using proper measuring devices and techniques. For example, within the weather project, the teachers set up a rain gauge on the playground to measure how many inches of rain they had after the rain. They also set up a thermometer on the window to measure the temperature daily and called Time & Temperature & Weather to get daily information on the weather. The teachers stated, “Some of the ideas that children are interested in charting are the daily temperature, how many inches of rain and the differences (if any) between the thermometer in our window and what the meteorologist says on the Time and Temperature & Weather phone number.” The excerpt from the observation transcripts shows that preschoolers used their science process skill of counting and measuring very successfully. Here is an example of a conversation occurring during measuring the rain with the rain gauge at the playground. Mark, Ciara, Amy, Anne, and Andrea were at the climber and checking the range gauge.

Student teacher [ST]: I will put it out.
 ST took the rain gauge and was checking.
 Mark : I cannot see.
 ST : It is right here.
 ST : We can put it right here so you can look at.
 Kathy : What are the numbers on there?
 Adam : Is there rain?
 Kathy : Yeah!
 ST : There is a quite bit.
 Ciara : How much is it?
 Adam : How many words at the rain gauge?
 Kathy : How many numbers?
 Adam : Yeah!
 Kathy : I don't know. Let's take a look at the numbers.
 Ciara : How much is it?
 Amy : Five and a zero.
 Marian: Five and a zero.
 Adam : Five and a zero?
 Kathy : Five and a zero?
 Children: Yeah!
 Anne : Hey look! Rain gauge.
 Kathy : I wonder about the numbers.
 Ciara : It is about zero and five.
 ST : It is a little bit more than zero five.
 Kathy : Is it zero point five?
 ST : Do you think it is closer to one point zero or zero point five?
 ST : Maybe it is in the middle.
 Ciara : We don't know.
 ST : I think it is pretty close.
 ST : Yeah, you can drop it, Andrea. Hope it rains again.

Preschoolers were very involved in measuring rain with the rain gauge over a course of weeks. Other than the weather project, preschoolers did some measuring and counting within other science projects. For instance, during banana bread making, they used measuring spoons. Kathy read the recipe for banana bread and then the preschoolers followed the procedure. The preschoolers counted the numbers on the measuring spoon carefully and put the appropriate amount of each ingredient into the mixture and mixed them. They measured the ingredients by using measuring spoons. The extract from the

observation transcripts indicates that the preschoolers were not only able to count, but actually able to measure something for a purpose (i.e., to make a bread) while working collaboratively.

Kathy, Anne, and Mark are making some banana bread. They are reading the recipe from the recipe book and following that procedure. Anne is holding the cup, Kathy is putting sugar in it, and Anne is dumping it into the mixture. They are looking at the numbers on the measuring cups. They wash hands before and after. They take turns. Kathy is helping them. They put in one tea spoon of baking soda. Kathy left for a phone call. Anne and Mark continue to stir the mixture very carefully. Jen wants to join. Kathy says, “go and make another choice, I will put you on the list.” Altogether they are trying to read the book and labels on the boxes, counting numbers on spoons and cups, measuring ingredients, holding and stirring carefully, following the right order stated in the procedure, considering health issues (washing hands before after or during when needed – like dropped the spoon on floor). Marian and Amy want to take turns. Kathy is putting their names on the list. Arthur and Megan took turns. Kathy summarized what they did until now, and now Arthur and Megan broke eggs and dumped them into the mixture by themselves. Kathy says, “It says we need bananas, but not just regular bananas but we need smashed bananas.” Arthur says “Yeah!” Arthur and Megan are washing their hands after dumping eggs. They also look to see if there is any shell in it. Arthur is now smashing bananas, and Megan is stirring the mixture. They change roles. John visited and watched for a while. They smell the mixture and say “hmmm.”

This was a social event; the preschoolers changed roles, took turns, worked cooperatively and used their counting/measuring skills. The preschoolers were able to measure and count something within a context of a social event (i.e., making bread, checking the rain gauge). Measuring and counting were one of the basic science process skills that were used in the preschool frequently.

Comparing/Contrasting and Collecting Data/Recording Data were another two of the basic science process skills that the preschoolers were successfully involved in. For example, the preschoolers worked on three different color peppers: Red, green, and yellow. They were asked to compare the three color peppers and make some predictions

about what the insides of the peppers would like when they were cut in half. The teacher, Kathy, helped them to record their predictions. Here is a dialog among them before writing down the predictions about the differences in red, green, and yellow peppers.

Alicia : Some people have already written down some hypothesis or predictions about what is gonna happen over by the kitchen. Did you do that work, Ciara?

Ciara : There is one of the seeds that might be in row and then the next one might be in row and then the other one might have banana seeds.

Alicia : So we are writing down what is gonna happen when we open up those peppers. Remember when we open up the cucumber?

Children: Yeah!

Alicia : We kind open up those vegetables. I think you (Ciara) were having a home day, Amy and Megan brought a cucumber; it is about this big.

Anne : I was having a home day.

Alicia : I think Ciara had a home day when we open up the cucumber.

Anne : and Jen?

Alicia : I am not sure. But on this day we had red peppers, yellow peppers and an orange pepper to cut open. We have to see if there is any difference. We also have those peppers that are starting to grow on our playground. So maybe we see inside of these peppers, we can think about what the peppers would be like on our playground.

Richard: Baby peppers I just saw. When baby peppers grow bigger, then they look like big peppers. And then they will be big, so we can pick them.

Alicia reintroduced the children what was happening at the activity table by the kitchen and made a connection with the old event of opening cucumbers (see Figure 4.14). Beyond the color difference, the teachers expected the preschoolers predict what might be different inside the peppers. Ciara predicted differences and she also commented on a similarity between them. That is, all of them would have seeds inside. After the teacher commented on contrasting those peppers with the peppers growing on the playground, Richard compared and contrasted and predicted that the peppers on the playground would grow and end up looking like those peppers at the activity table.

The preschoolers were able to observe objects, and then compare and contrast them with each other. They were comparing and contrasting beyond observations, but

they also were able to make predictions on possible contrasts. This excerpt from the teacher record states the predictions of some of the children.

Predictions:

Ciara : There's going to be seeds insides. Different colors will have different seeds. Red will have a row of seeds. Yellow might have a row of seeds too. And the orange one will have like a million of seeds mixed up.

Mark : Some seeds will be inside. Medium, big-sized seeds. They'll be the same inside but maybe a little bit different.

Megan : Red one smell different than the yellow one. But orange and the red one smell about the same. I think there will be about millions of seeds all mixed up inside.

Andrea: I think they (seeds) will be different. I don't know what color they'll be. I think they gonna be big.



Plan

Wednesday: Predictions

Thursday: Tracing, drawing

Friday: Cut them open

Figure 4.14. Red, orange, & yellow peppers: Observe, compare, predict, & record.

Preschoolers were also successful in *Categorizing/Sorting/Classifying*, which is one of the basic science process skills. They were able to identify objects and related features, and then put them in various categories. The excerpt from the interview transcripts with the teacher, Mary, indicates that preschoolers were very involved in categorizing.

Sometimes they'll make charts or graphs.... We've been interested in gravity or weight and so we've had kids go up on the deck with two different articles- like

the pan and a feather and drop them at the same time and then we see which gets to the ground first. And then they chart that. And make a graph of that. Which things are heavier, which things are lighter, those kinds of things.

Mary indicated that the preschoolers were able to use the science process skill (categorizing) in understanding and identifying some abstract science concepts, such as gravity and weight.

The preschoolers were able to identify objects/events/living things, and then group and order them according to similarities or differences in properties. Using the science process skill of categorizing led them to learn more about objects/events/living things. Alicia, another lead teacher, gave the example of the bugs/insects project. The excerpt from the interview with Alicia indicates that first the children had a cognitive dissonance since they thought that spiders were insects. This led children become very involved in classifying some animals into either insect or bug categories.

The children observe him (toad) and watch him all the time and then just recently we've kind of had an insect interest. And that culminated with well we have these crickets that we feed the toad. Let's draw them and represent the crickets that we usually just feed to the toad but look closely at them and draw them and what parts of crickets do they have and that led through a lot of work on the differences between crickets and spiders. Because we had books that were saying spiders are not insects. The children had categorized spiders as bugs. Spiders were insects. So to find out that spiders weren't insects was a big - kind of cognitive dissonance for them. But they had legs and they could crawl. What's the difference? And so drawing those things, salient thing for them became that a spider has a head and an abdomen whereas an insect has a head, a thorax and an abdomen. And three body parts versus two. So when they're drawing it, spiders have two parts and an insect has three. Not even the legs as much as the body parts. So that's a huge leap as well. That kind of categorizing again and that something can be a part of one group at the same time it's part of another is a big developmental kind of thing for children too.

Through searching books, discussing, and representing their ideas on papers by drawing, the preschoolers were able to differentiate bugs and insects from each other. Identifying

the patterns with shapes of the bugs and insects was a fun thing to do for the preschoolers. They even created small pictures of bugs and insects to find the patterns, and created a collection of bodies of insects (see Figure 4.15).



Figure 4.15. Collection of dead bodies of insects.

Lastly, one of the most important, distinct characteristics of the preschoolers was *Communication*. The children communicated their ideas with others in various ways, such as written and spoken work, graphs, drawings, paintings. They transmitted information and ideas to others. This will be discussed further under the following domain called “multiple ways of representing ideas.” As seen from the evidence stated for the other science process skills, preschoolers’ communication skills were embedded in each of them. The preschoolers used their communication skills along with other science process skills, such as predicting, measuring, and comparing and so on. They

shared ideas with each other while engaging with science. The language of inquiry was a strength of the classroom, and these communication skills helped the preschoolers express their inquiries.

Lastly, ***Multiple Ways of Representing Ideas*** is another facet of the ways that the preschoolers engaged with science. More than transmitting ideas to other people, multiple representations of ideas was about expressing ideas for themselves as well as other people in a reflective and interactive way. The preschoolers worked cooperatively and represented their ideas in a shared way. More specifically, during participant observations it was observed that the preschoolers represented their ideas related to science in very innovative, varied ways.

The multiple ways of representing ideas, which were observed during participant observations, included, but were not limited to, painting, drawing, dancing, sharing experiences, talking, discussing, brainstorming, writing, telling stories to each other or into a tape, moving, making sound, and wearing costumes. The excerpts from the interviews with the teachers and the documentation show that the preschoolers were also involved in representing ideas with clay, wire, charcoal, and water paint. The following pictures (Figure 4.16 – 4.17 – 4.18 – 4.19 – 4.20) demonstrate that the preschoolers expressed themselves in ways that involved the natural sciences.



Figure 4.16. Painting and drawing.



Figure 4.17. Three dimensional representation of an animal habitat.



Figure 4.18. Blowing like the wind.



Figure 4.19. Fruit print of fruits.



Figure 4.20. Color shadows & shadow dance.

The ways the preschoolers expressed their ideas can be categorized into two dimensional ways (e.g., Figure 4.16) and three dimensional ways (e.g., Figure 4.17). Both two and three dimensional ways triggered and supported preschoolers' inquires, and truly engaged preschoolers' hands, heads, and hearts with science. While using those ways, the preschoolers were very involved in using their hands (see exploring hands-on), minds (see inquiry-based education), and their hearts (see peer culture & interest-based activities).

The preschoolers really enjoyed working with multiple ways of representing their ideas and found chances to use their creativity and imagination. For example, while working on the little fan, the preschoolers tried to understand how the wind works by throwing heavy and light things to the fan. With some imagination they decided to put some color ribbons onto the gate so the wind can blow them all the time. Since there were different color ribbons, feather, and scarf on the gate and stairs blowing with the wind, children said that it looked like a rainbow (see 4.19). The short excerpt from the participant observation during another wind experiment gives a short glance at their interactions and how they represented their ideas.

ST : So do you think the wind works that hard to blow things around.
Megan : Harder.
ST : Harder and harder.
Megan : Yeah!
Ciara : It blow a bit harder when it rains and when it (inaudible)
ST : What happens when the wind blows harder outside?
Jen : Wind is everywhere like tornadoes. Do you know what? That is the wind (pointing her work) and green ones are storm and the purple ones are the rain.
Steve is watching Jen.
ST : So it is hurricane going on in your paper?
Jen : Yeah!

Children are trying to blow in different ways, like blowing directly to the paint, blowing slowly or hard, blowing different colors to each other so they can mix, blowing in different directions.

The preschoolers were able to express the connections they made between their work and the wind. For example, Jen did not only express herself through painting but also was able interpret her work verbally to tell what idea she wanted to represent in her work.

Using multiple ways to represent ideas richened children's understanding and the process of engaging with science. It provoked preschoolers' inquiries and questions related to science. The teachers stated that the preschoolers used a variety of materials and tools to represent their ideas, but sometimes only an expression on their face or a movement was enough for them to express themselves. The excerpt from the interview with the teacher, Mary, indicates that the preschoolers were involved in various ways to represent their ideas related to the natural sciences.

We do use a variety of materials for the children to represent their ideas about natural science. A lot of drawings and that's usually the first place we start. They are making some kind of 2 dimensional representations and again I just have to say that we've done that for children as young as 2 years of age. And then on up through the pre-school. But they also will use paint. I can remember one time we had a lovely painting - the children are interested in tigers. Big cats in general but tigers specifically and so the teachers had put up some pictures in the art area, around the easels, some different pictures of tigers, different colors of tigers, so the children could see the varieties of tigers and there was one other tiger that was behind a bush. Like there was a branch coming here and you could see the eye. You could see a little of the orange and black, a little of the chin. It was like the tiger was in camouflage. And the child who was interested in that picture painted the tiger but only painted the parts of the tiger that showed through the branches of the bush. So it was very interesting representation, but you could see that she was really focusing on the tiger. We also used clay and we use wire quite a bit as well in our classroom for children to be able to represent their thinking. We also use other drawing materials. Like sometimes they'll use charcoal. Sometimes they'll use chalk. We had a visitor visiting art teacher from Finland who came and did a whole project over the fall - this was a couple of years ago, looking at trees because the children were interested in the trees because the leaves were coming down and they were all so colorful. So they did a lot of looking at trees and parts

of trees and she had them working with watercolors as well as charcoal, as well as markers so they had a variety of ways to represent their ideas.

Mary expressed some of the ways the preschoolers used in the past. She also stressed that the preschoolers were not expressing themselves in a predictable way even with drawing.

The teacher, Kathy, stated the various ways the preschooler expressed themselves, such as wire, clay, games. The excerpt from the interview with her stressed another facet of using multiple ways of representing ideas. That is teachers' interpretation of children's expressions. She indicated that teachers looked at and interpreted children's work to understand them.

Millions of ways. Children express themselves in millions and millions of ways. Sometimes it's a look on their face; sometimes it's a reaction. Sometimes it's a conversation with another child. Sometimes it's a story that they've told their parents and they write stories or they'll dictate to us stories and we will write them down. So their notions about natural sciences as well as everything can still (inaudible) all kinds of ways, all kinds of ways. Wire, clay, games. They make up games. Actually they make up a lot of dramatic play games. It does involve animals. A couple of years ago we had some children who were wanting to - we found a fabric that has strips like tiger and they wanted to wear them, just as fabric as a blanket. Only it was just a piece of cloth. They were talking like they are growling (hrrr!), they were being tigers. So we used our bank of overhead images, got some photographs that we made a transparency projected against the wall, so the wall has giant huge tigers leaping and you know. We thought "oh, they are so interested in these colorful cats." We thought it was all about power and about - I don't know - the pattern and the tigers or - we thought it was about tigers. We watched the play for just a few days. What do we know about tigers? It is about families. What we found was they were tigers - but the dad tiger was going to work and the mom tiger was shopping and that they had to call someone to take care of the baby. So it was - we have to be careful to not stop listening - once we think that we have an idea. So - in that instance happened, children express themselves, it would be through dramatic play. It would be through their conversations and us; we should pay very close attention. We almost missed it. We almost did. We were ready to bring in all kinds of more stuff, and then somebody said "wait, wait, it's about families!"

Kathy stated the importance of truly listening to what children are trying to express so the teachers could contribute to the children's ongoing work. In short, while the preschoolers

were expressing themselves in various ways, the teachers found chances to listen to them in various ways too. Just as expressing happened in various ways, so did listening to the preschoolers. Listening was not limited to listening to verbal or audio communication, but truly understanding children's ideas, which were manifested themselves in various ways.

The Reasons for Doing Science

Analysis of participant observations, interview transcripts and other data sets revealed the presence of several themes; the research materials will be used to seek out reasons why these particular themes—rather than others—surfaced. The reasons for doing science are discussed in relation to the notions of the school culture and the peer culture in this section. Corsaro (1997) defines children's peer culture as a set of shared behavioral routines, artifacts, concerns, and values. Children produce peer culture in interaction with their peers while teachers (including the other school staff) produce the school culture (e.g., setting up rules, planning activities), which is basically the expectations of teachers from children.

The taxonomy of reasons for doing science is composed of two domains, namely peer culture and school culture. Both peer culture and school culture included many units emerged from the data set, namely play, interest, serendipitous events, needs and experiences for peer culture, and serendipitous events, and planned events/activities considering developmentally appropriate practices for school culture. The following figure displays the Taxonomy of the Reasons for Doing Science and some concrete examples that were observed in the classroom (see Figure 4.21 and Appendix K).

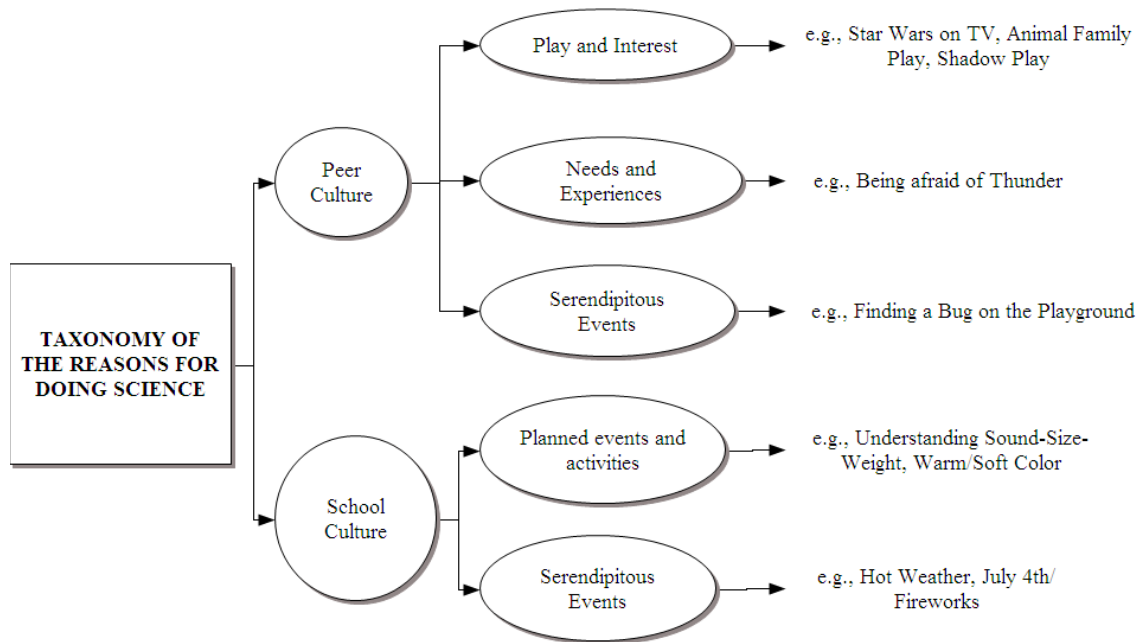


Figure 4.21. Taxonomy of the reasons for doing science and examples.

On one hand, the reason for doing science might be embedded in school culture. In other words, it was what the teachers planned beforehand or spontaneously considering various factors, such as the current conditions like the weather conditions outside, and spontaneous events happened at the playground. More importantly, they considered each preschooler's developmental progress. Mary stated, "We look at what we know about children's development. We often see reoccurring themes of interest for children, based on their experiences in the natural world and where they are developmentally."

Accordingly, they negotiated and created some objectives for the preschoolers and included them in the weekly Curriculum Guide. The excerpts from participant observations show that the teachers tried to lead the preschoolers into some directions

which they thought beneficial for them. For example, the short excerpt from the circle time discussion about making choices shows how the teacher, Kathy, invited Antonio to work on some other ideas (ideas: e.g., activities) they set up throughout the classroom, rather than what he was actually interested in doing. It is important to indicate that Kathy was talking to one child, Antonio specifically, but still not pointing out Antonio directly.

Kathy: Let's talk about some different kinds of ideas. Antonio, when you are in Europe, we talked about different kinds of work we are doing in school. It seemed to us some people are spending all of the minutes in school here. We have a lot of minutes. Some people are spending all of their minutes doing just one idea. We decided it is better for their brains, for their bodies to try some other things. So we decided after circle time try at least one other idea.

Antonio was working on music, playing CDs most of the time for days before this discussion happened. The teachers were aware of his interest in music and supported his interest in music. However, they also decided that Antonio needed to explore some other ideas (e.g., rolling balls project, pretend cooking) and invited him to work on other activities, projects, plays going on in the classroom, or create a new one of his own.

On the other hand, the reason for doing science might be embedded in peer culture. In other words, it was what the preschoolers initiated, valued, or were concerned about within their peer culture. Peer culture-related reasons for doing science included play, interest, serendipitous events, needs and experiences. For example, the weather theme related events started with a simple event of changes in the weather, the preschoolers' interest in powerful weather and fear associated with noise. In the Curriculum Guide, the teachers formulated some general educational objectives related to weather within a flexible plan and stated:

Recently, it seems like loud thunder storms are only hitting central Ohio either at rest time or as children go to bed in the evening; as a result, there has been much

discussion about weather, particularly powerful weather like tornadoes, storms and lightning. Understanding these natural phenomena may also help with some of the children's fears about the noise and wind associated with storms. We have many library books on the subject, and we also have a new rain gauge, which we set up on the playground and a thermometer for our window. Some of the ideas that children are interested in charting are the daily temperature, how many inches of rain and the differences (if any) between the thermometer in our window and what the meteorologist says on the Time and Temperature phone number.

The reason for doing weather-related activities and events had its roots in spontaneous events and children's fears/needs, which is included under peer culture. The teachers saw the potential in the weather theme and supported what was already going on in the children's lives. Within the framework of a flexible curriculum, teachers gradually built on this by providing some weather-related learning opportunities (e.g., rain gauge, thermometer, blowing through straw painting, fan experiment with the wind) so that preschoolers could learn about weather in depth.

Each theme started with a reason behind it. As the themes continued, more reasons, more leading forces occurred. Whatever the starting point/reason for beginning the science project, the common thing among those reasons was the possible learning opportunities for the preschoolers that were foreseen by the teachers. The teachers saw children's excitement and enthusiasm in something as a teachable moment, and then they turned this excitement and enthusiasm into a learning possibility.

The teachers in the Reggio Emilia-inspired preschool classroom were always looking for teachable moments and documenting experiences to interpret and understand the preschoolers. The teacher, Alicia, stated, "we really look for those teachable moments in our every day interactions with the children and expand on projects from there." When they foresaw potential in any theme, they included it in the weekly Curriculum Guide and

supported learning opportunities in various ways, especially by creating a rich environment.

Compared to many traditional preschools where a Curriculum Guide is a printed text or published teacher's guide, the weekly Curriculum Guide in the Reggio Emilia-inspired preschool was different. The Reggio Emilia-inspired Curriculum Guides were emergent, created, negotiated, and constructed weekly by the classroom community (teachers and preschoolers) and distributed to the parents, staff members, and researchers via e-mail. Based on the reasons emerging spontaneously, the teachers formulated some general educational objectives within a flexible plan. The weekly curriculum and the daily program were flexible enough to accommodate changes and spontaneous events that occurred at the school. Figure 4.22 displays the message/parent board kept in the classroom. In the Classroom Orientation Information booklet, it is stated that the messages on the message/parent board aimed to "keep you informed about our community life, our plans, announcements, daily experiences."

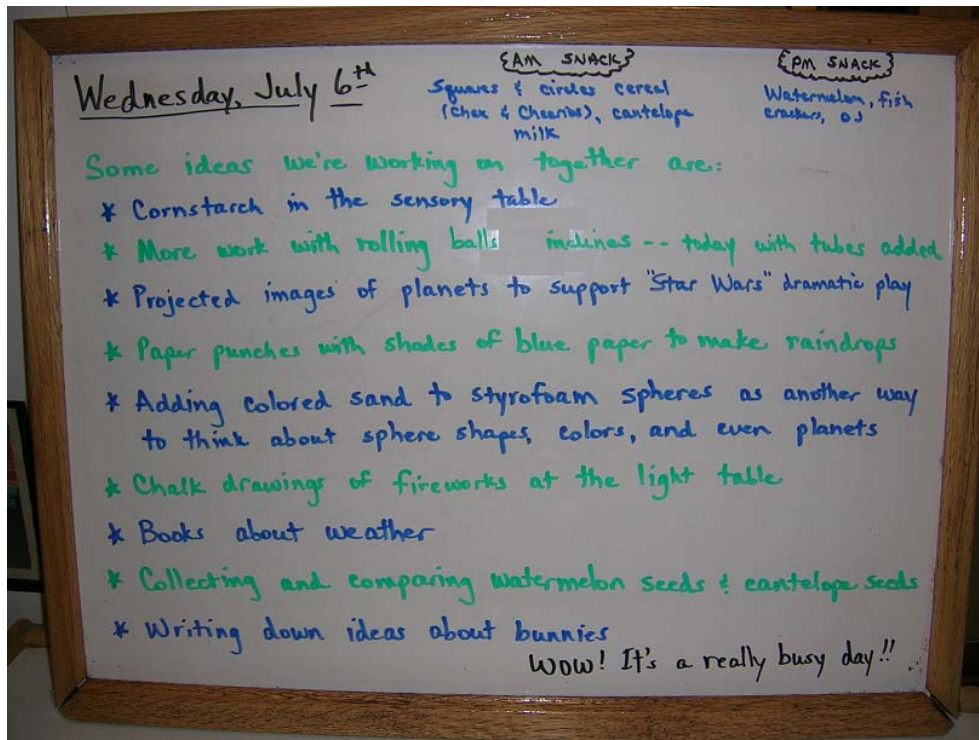


Figure 4.22. The message/parent board: An example for a daily program.

In general, it was difficult to say if a specific theme related to science came out of peer culture or school culture events because the teachers were creating a school culture with consideration the peer culture, truly integrating them with each other. While the preschoolers were becoming “students” and following the routines, rules, and values in school culture that the teachers had created, the teachers were always taking the preschoolers’ peer culture into consideration. For example, the teachers thought that it would be beneficial to expose the preschoolers to the concept of space and planets after the preschoolers became interested in Star Wars play. The teachers supported the preschoolers’ interest in Star Wars (peer culture) within their planned activities (school

culture) in various ways, such as projecting images of planets and space onto the wall of the Star Wars play area. As seen from the Figure 4.23, the peer culture and the school culture in the Reggio Emilia-classroom interacted in a spiral way.

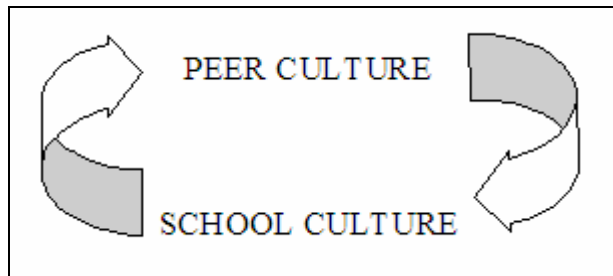


Figure 4.23. Peer culture and school culture affect each other continuously.

The teachers were always alert to observe cultural dynamics among the preschoolers. The interview excerpts indicate that they looked for teachable moments and then enriched the environment with some provocative materials and asked challenging questions. For example, they created Interest Inventories as indicated in the excerpt of the interview with Mary.

Natural sciences are included across curriculum in our school... What we call physical knowledge activities, and those can take a variety of forms and they usually are based around the children's current interest. So if they have an interest in space ideas, we might have the block area set up with a projected image on the back wall that would help them see the space as - I guess it would help support their play in providing a dramatic play space where they would feel like they were in space or feel like they were surrounded by the night or by the planets or whatever we might have projected up on the wall. (Mary)

We observe the children's interests and we listen to what they talk about. We follow their play and then based on that we offer them experiences and materials that will support those interests and we will track those interests through teacher observation and student observation. Students collect what we call "Interest Inventory" that will track the children, the children's interests over time and that's

part of their course work for the practicum experience and the teachers then will use that in their conversation about curriculum when they meet on a weekly basis. (Mary)

Interest inventories were one kind of documentation the teachers kept for each child (i.e., Individual Interest) as well as a group of children (i.e., Group Interest). Those were written documents of children's experiences and dialogues, which were used to find the treads of interests of the preschoolers and to enrich the curriculum. In short, the peer culture and school culture successfully supported each other through the negotiation between teachers and students, so that everyone contributed to the reasons for doing science.

4.1.3 Summary for Question 1

How are natural sciences socially constructed and integrated into this classroom's daily life curriculum in the preschool classroom?

The results of the current research indicated that the teachers in the Reggio Emilia-inspired preschool created a science-rich context of *social-constructivist* and *inquiry-based* education where children's natural science knowledge and skills could be nourished. They provided the preschoolers a context in which they could pursue their inquiries and interests in the natural sciences, learn about the content, use science process skills, and actively engage in scientific processes.

Preschoolers co-constructed science in multiple places, at multiple times. In summary, there was no space or time limitation for student projects. The other issue was about revisiting the old projects. Even though it might have appeared at first glance that a project ended long time ago, children could still go and revisit the ideas at any time.

Teachers arranged the places in the preschool carefully and thoughtfully to provoke children's inquiry and to support their understanding of science. They created a challenging and provocative environment by providing a variety of materials and tools in those places so that the preschoolers could manipulate them and learn about science.

Science was also interconnected with other disciplines, such as math, literacy, and art. Disciplines other than science were also practiced throughout the classroom. Many places within the classroom were multifunctional and promoted an integrated curriculum, and this integrated curriculum promoted the multifunctionality of the classroom spaces.

The preschoolers in the Reggio Emilia-inspired preschool engaged with science in multiple ways. They socially constructed science explicitly and implicitly inside and outside the classroom, participated in hands-on science experiences, worked in groups most of the time, conducted their search for related natural sciences by utilizing multiple media, applied science process skills, and represented their ideas and theories in multiple ways. In general, it can be stated that the children engaged with science as an integral part of daily life.

Science was naturally occurring as part of the everyday experiences of the children. The reasons for the experiences had their roots in the children's lives and experiences. While creating the school culture (e.g., making Curriculum Guides), teachers took peer culture (e.g., children's interest in Star Wars) into consideration. The teachers built on peer culture, which led to more challenging learning opportunities within the school culture.

In this classroom, the children's inquiry always took priority over memorizing facts and was appreciated by the teachers. Teachers wanted children to become strong

thinkers. Accordingly, the teachers greatly valued preschoolers' asking of questions and looking for answers by checking sources. Teachers believed that inquiry contributed to children's learning and understanding of the world. Inquiry shaped the actions of the teachers (e.g., how they planned the next day's curricula) within the lines of peer culture and school culture.

The semantic relations system within the taxonomic analysis (the places for doing science, the ways of doing science, and the reasons for doing science) supported the original assumption that the Reggio Emilia-inspired preschool classroom was science-rich. Moreover, a Reggio Emilia-inspired preschool classroom provided children a context where their understanding of science and their inquiry skills could be nourished and constructed socially in a classroom. The peer culture analysis also contributed to our understanding of constructing science in the classroom. Those lenses aimed to make sense of the complex integration of the natural sciences into this classroom's curriculum and socially-constructed daily life. This study did not identify all the facets of science life in the preschool. Rather, it showed science as a complex and dynamic phenomena in which both teachers and children acted together to construct meaning and understanding. The results showed that the Reggio pedagogy, grounded in inquiry, is very compatible with science education goals for preschoolers.

4.2 Second Layer of Analysis: Reggio Principles & Being "Reggio Emilia-Inspired"

In the second layer of Chapter 4, the following research question is addressed in general: *How does the science constructed in this classroom reflect the Reggio pedagogy?* In addressing this question, Reggio Emilia principles were used as an interpretive lens. The data set was examined for evidence of Reggio principles reflected

in the Reggio Emilia-inspired preschool classroom. Moreover, the examples of the “Weather” and “Growing Things” projects are utilized to discuss how the Reggio principles manifested themselves in the kinds of inquiry related to natural sciences, as well as the deep questioning and group learning that went on.

4.2.1 Being Reggio Emilia-Inspired

Before discussing how the science constructed in this Reggio Emilia-inspired classroom reflects the Reggio pedagogy, it is important to state what it means to be inspired by the Reggio Emilia approach. New (2000) states, “The genesis of current interpretations of high-quality child care and early childhood education in Reggio Emilia is [thus] well-grounded in regional and local traditions” (p. 342). This suggests that the Reggio Emilia approach has its roots in the unique culture and history of its origin (the city of Reggio Emilia, Italy), and it does not provide a packet program or curricula but an authentic perspective of early childhood education. Accordingly, the preschools in US were recognized as “being inspired” by their approach.

During the interviews, the researcher asked teachers how they were inspired by the Reggio Emilia approach. Excerpts from those interviews with teachers clarify what it means to be inspired by the Reggio Emilia approach.

There is not a pathway of being part of Reggio Emilia. It does not require adaptation wherever you are. Because the only Reggio Emilia schools are in Italy, if anybody else called call themselves Reggio Emilia school, that is not true. We are Reggio inspired. What that means, the whole point of that is that, we reinvent ourselves. So whoever is inspired by this approach, it requires that you do not adapt them but reinvent yourself. So there are many schools across the world, Korea, Scandinavia, Brazilia; all are inspired by this approach. But to say we take their approach and adapt it, it is not how we look at it. Again we think about ourselves. We look at the work of Italians, their way of thinking, and then reinvent ourselves. So to say how do we adapt, I would not even say “we do” I

would say just we think differently, we live differently because of the inspiration. (Kathy)

I think any time you know the whole thing about this approach is that it's based on the community that you're in and the children that you have... Even though their cultures, their ethnicities might be very different or the kind of routines or influences they have in their home might be very different, there are some similarities and there are some differences in that context, I think, between us and the Reggio city. But we recognize that as just an approach, as kind of a point of inspiration... So I think what it's mostly about is knowing the community of learners you have at that particular moment, and so looking at them as individuals but also within this kind of social constructivist group context, and building from there. But there's the - the possibilities is limitless of what particular choices might be what we can build upon and what will happen in our curriculum. It never feels repetitive or stale. (Alicia)

I think that the adaptations that we've made are probably around our play-based curriculum. For example, the Italians have a - I think the children as well as the adults but particularly the children have a much broader vocabulary in terms of multiple languages, certainly multiple visual arts kind of languages. Like they're much more sophisticated in their use of clay, and paint and wire, and they'll make things out of paper as well. Our emphasis isn't - we use that and we certainly have used in a much more significant way than even when I came here in 95. But we don't have the vocabulary that they have in those languages. Our emphasis in our program is on play and so I think that that's where we've adapted the Reggio approach so the children are having opportunities through play-based experiences to interact with the natural world and natural materials that they can find in the world, but I think we're working very much like the Italians in trying to bring the natural into the classroom. (Mary)

The teachers approached the questions of how to be inspired by the Reggio Emilia approach with different explanations, but in general they all indicated that the preschool classroom had its own unique culture, unique community created by its own preschoolers. They agreed that the Reggio Emilia approach was inspiration to them, not a recipe to copy and apply in their classroom, because they believed that Reggio is based on the community that you're in and the children that you have. Being Reggio Emilia-inspired, the teachers stated their interest in reflecting their own community's culture and extending the worlds of their own children. They indicated that the Reggio Emilia

approach provided them the freedom of innovations, in other words, creating their own unique Reggio Emilia approach in their unique classroom and thus “reinventing” themselves.

More specifically, the teachers indicated several things about being inspired by the Reggio Emilia approach. They indicated that their program’s emphasis was on play-based, integrated curriculum, and much like Italians they were trying to bring the natural sciences into the classroom. They stated that compared to Reggio in Italy, they were not as sophisticated in their use of clay, paint, wire, or paper. Different than Italians, they had a more heterogeneous population in class, with children from all over Columbus. Moreover, they stated that they look at children more as individuals, which is a common perspective in individualist societies. Despite social, cultural and historical differences, “Reggio is aligned historically with what the lab school is all about for a long time,” they stated.

While the teachers were reinventing themselves and being flexible to accommodate the interests and needs of their students within the science culture that they had socially constructed, they were inspired by the basic principles of the Reggio Emilia approach, which were global. In this section of Chapter 4, the theoretical sources of the Reggio Emilia approach- specifically the Hundred Languages of children, the image of the child, the role of the teacher, education based on relationships, inquiry-based education, *progettazione*, documentation, and the role of the environment and materials, are referred to answer the question of how the science constructed in this classroom reflected the Reggio pedagogy. The whole data set, including the preschool’s principles and natural sciences practices, are examined using the Reggio Emilia approach as a lens.

1. All kinds of experiences should be made available to children, not just those considered "academic." Activities which enhance physical, social, emotional, and creative development must be included.
2. Young children learn by using all their senses to explore materials.
3. Consistency in the daily schedule helps children to feel secure about their participation in the daily life of the school.
4. Children who are pressured to perform beyond their ability feel frustrated and incompetent. Children who are encouraged to participate through an unpressured, non-evaluative atmosphere will develop skills in each developmental area.
5. Children need to be with other children. Social involvement allows children to become accepting of themselves and others; provides them with opportunities to develop speaking and listening skills; and encourages appropriate social skills and social problem solving behavior.
6. Children learn to work collaboratively and cooperatively, within the community framework of our school.
7. Children need to be self-motivated and self-directed. We achieve these goals by providing children with tasks, by carefully explaining rules, and by helping children to understand and accept the responsibility and consequences for their actions without evaluating these actions as "good" or "bad".
8. Teachers provide a warm, secure, and supportive learning environment for parents and children. They must be responsible, professional, caring individuals and knowledgeable of the needs of families and children.
9. The bond between home and school is inseparable. Teachers and parents must work together to provide the best learning and growth experiences for children.

Figure 4.24. The Reggio Emilia-inspired preschool's program is set up on nine principles.

The program of Reggio Emilia-inspired preschool was set up on the basis of 9 main principles, which mostly implied the relationships of teachers with children and parents (Figure 4.24). The principles are elaborated throughout this section of Chapter 4 along with the actual classroom practices, especially using long-term projects and related activities, and small moments of learning, by sweeping through the whole data set.

4.2.2 Summary of Two Projects that Occurred in the Reggio Emilia-inspired Preschool

Weather and Growing Things projects, among so many others, are chosen to discuss the Reggio principles. Here is a short description of those projects.

The Weather project started simply with changes in the weather during summer, the preschoolers' interest in powerful weather and fear associated with noise, and a particular preschooler's brother's scary stories about powerful weather. The Weather project allowed the preschoolers to engage with different kinds of themes related to weather (e.g., rain, snow, thunderstorm, lighting, temperature, rainbow, wind, clouds) and provoked curiosity about other scientific themes (e.g., bubbles, fireworks). As a critical event, the *bubbles* activity is examined more in-depth to discover various things related to natural sciences inquiry. During the bubble activity, the preschoolers wondered if it is possible to make bubbles in shapes other than spheres by changing variables or conditions. In general, the weather project was one of the projects which happened frequently during the school year and lasted longer than some of the other projects (e.g., rolling balls).

Similarly, the Growing Things project allowed preschoolers to engage with different activities related to natural sciences (e.g., planting banana pepper, tracing and

painting flowers). *Seeds* work, which was the critical event of the Growing Things project, helped the preschoolers engage with different information related to seeds, such as what they need to grow, types of seeds, colors of seeds, counting/charting seeds, and more. The excerpt from the interview with Alicia explains how interest in seed work under the Growing Things project and the wind work under the Weather project emerged. She stated,

Something that happens quite spontaneously is air conditioning vents - children figuring out - they set a piece of paper on it and it blows up and then we do wind experiments and different kinds of things that can fly through the air as opposed to heavy things. So then it becomes weights and measures. So observing their interactions with the materials as well as kind of spontaneous things that might happen like when we have soil, dirt that we had had in our sensory table and some sunflower seeds got mixed in and we didn't know that but when we got the soil out again all of these sprouts were growing and so the children were ahh! what happened here? So then that led to a whole project on growing seeds.

They did not mean to grow seeds but seeds were growing there. This spontaneous event interested preschoolers. Preschoolers wondered about how seeds grow and the teachers took this inquiry as an opportunity to conduct an in-depth search on seeds.

Figure 4.25 displays the timeline for the two projects, Weather and Growing Things, showing how projects started and some activities that happened during the projects. Some of children's inquiries and theories developed during the projects are also presented. The cutting, critical event of Bubbles and Seed Growing and related activities, along with some inquiries and theories, are briefly identified. As seen in the timeline, after the critical event the projects continued to develop with new, authentic pathways. The projects are unpacked with the Reggio principles and the concept of "the Hundred Languages of Children."

Growing Things	Critical Event: Seeds	Growing Things
><u>Project begins:</u> Spring comes and they plant flowers around ><u>Examples of children's inquiry pathways:</u> -What do we need to grow plants? ><u>Examples of activities:</u> -Planting flower	><u>Seeds:</u> Begin after incidental seed growing ><u>Examples of children's inquiry pathways:</u> -How did these seeds grow when we didn't even mean for them to grow? ><u>Examples of children's theories:</u> -Seeds grow even though we do not mean it ><u>Examples of activities:</u> -Cutting the cantaloupe to see what is inside, and put seeds aside to be dried -Collecting seeds and making a counting chart with seeds (melon, cantaloupe, apple and cherry) -Fruit painting turn into fruit-inside painting -Planting lettuce, parsley seeds into a box -Predicting what is inside and then cutting peppers into half -Checking lettuce/parsley seeds under the light	><u>Project continues:</u> -Planting pepper, tomatoes -Planning to make salsa from tomatoes -Planning to draw peppers before eating -Drawing sunflowers and Gerber daisies on the light table -Planning to do water experiment with celery ><u>Examples of children's inquiry pathways:</u> -How plants and vegetables obtain their nourishment?
Weather	Critical Event: Bubbles	Weather
><u>Project begins:</u> Started with the stormy period and a brother's scary stories ><u>Examples of children's inquiry pathways:</u> -What makes a rainbow? ><u>Examples of children's theories:</u> -Rain erases rainbow -A huge amount of rain & thunder make rainbow -On TV, their sayings about weather are always wrong -Our grass was wet, probably it rained at night ><u>Examples of activities:</u> -Checking rain gauge and thermometer -Reading books -Calling T&T&W -Working with the wind	><u>Bubbles:</u> -Begin after blowing through straws like the wind ><u>Examples of children's inquiry pathways:</u> -How can I make a bubble? -Is it always sphere shape? -How can we make different shaped bubble other than bulb shaped one? What shape the bubble look like if you use this? -How long will it stay there if we do not pop the bubble? -How can I make a giant bubble? -Do the wind and air play a role in shaping the bubble? ><u>Examples of children's theories:</u> -More soap, different color to make different shaped bubbles -Blowing softer or harder to make a bubble -Blowing close or farther away to be able to make a bubble -If you blow out of a butterfly shape, it is sphere ><u>Examples of activities:</u> -Making bubbles using water & soap and sphere shaped things -Making bubbles using different shaped and sized things to blow through, coloring the water, and adding more soap -Using the bubble solution outside	><u>Project continues:</u> -Experiment with the wind (with fan) -Reading books -Pretend snow -Checking rain gauge and thermometer -Painting to make cloudy sky, stormy sky representations with sponges -Calling Time & Temperature & Weather -Pretending being a meteorologist -Light table with thunder and lighting book -Hot day discussion -Adding words to sunshine book -Calling weather forecast -Sponge painting and then adding lighting to thunder pictures

Figure 4.25. "Growing Things" and "Weather" projects and the timeline.

4.2.3 The Hundred Languages of Children

The term “the Hundred Languages of Children” was used in the preschool just like in Reggio Emilia schools and categorized as “Symbolic Languages” in the curriculum guides of the current preschool. Hundred Languages implies multiple ways of representing ideas and emotions through many languages. In the Reggio Emilia-inspired preschool, the preschoolers used a wide array of creative media and activities, and represented their ideas and emotions through many languages. They used two and three dimensional representation of ideas, such as painting, drawing, dancing, talking, discussing, writing, and wearing costumes (see multiple ways of representing ideas under the Taxonomy of the Ways Children Engaged with Science). The children in the Reggio Emilia-inspired preschool did not only express themselves in various ways, but also learned about things by using different ways of representation of ideas (see Figure 4.26).

During the interviews, Kathy stated, “Children express themselves in millions and millions of ways.” As seen in Figure 4.26, preschoolers expressed their ideas during the Weather and Growing Things projects in various ways, such as having a reaction on their face, playing, talking, painting, writing, and making things.

EXAMPLES FOR USING HUNDRED LANGUAGES		
	Project	Critical Event
Project: Growing Things & Critical Event: Bubbles	> Movement (e.g., planting flower, pepper, tomatoes) > Making something (e.g., making salsa) > Drawing (e.g., drawing sunflowers and Gerber daisies on the light table) > Painting (e.g., coloring carnation by putting into colored water) > Talking/discussing/brainstorming (e.g., what do plants need?) > Sharing experiences (e.g., growing cucumbers in the patio)	> Reaction (e.g., surprised face – seeds grow even though we do not mean it!) > Writing (e.g., writing predictions about what is inside peppers) > Movement (e.g., using shovel, planting seeds and watering) > Talking/discussing/brainstorming (e.g., asking what is inside a cantaloupe and the seeds in it) > Making something (e.g., making a counting chart with melon, cantaloupe, apple and cherry seeds they collected) > Painting (e.g., painting inside fruit)
Project: Weather & Critical Event: Seeds	> Reaction (e.g., being scared of stormy weather) > Discussing (e.g., discussing what makes a rainbow) > Making things (e.g., making craft work with the wind-fan) > Painting (e.g., painting cloudy sky, stormy sky with sponges) > Playing (e.g., playing pretend snow) > Writing (e.g., adding words to sunshine book)	> Talking/discussing/brainstorming (e.g., asking if it is always sphere shaped) > Making things (e.g., making bubbles with different things- triangles, squares) > Playing (e.g., racing with each other with big bubbles) > Coloring (e.g., coloring the water to make color bubbles)

Figure 4.26. The hundred languages of children.

Among various representations of ideas, play was the one mostly stressed by the teachers. In the Parent Handbook, they had a separate section for play and teachers stated, “Children reveal themselves through play.” As stated before, the teachers in the current study had much emphasis on a play-based, integrated curriculum. Play had an important section in the daily schedule of the curriculum and frequently occurred during projects. The following excerpt from the Parent Handbook indicates the view of the teachers and stresses the importance of play in children’s lives:

We believe play is one of the most powerful learning tools for self-discovery and self-realization. Play is inherently a self-expressive activity which reveals the child's personal and unconstrained response to the environment. Play integrates the young child’s personality as s/he becomes totally absorbed physically, mentally and emotionally. (Parent Handbook)

As it is stated, play was not only a tool for the preschoolers to learn about something but it was one of the hundred languages for the preschoolers to express themselves.

4.2.4 The Image of the Child

In the Reggio Emilia-inspired preschool classroom, the teachers recognized the child’s rights, own way of learning and individual development. Since the classroom was a mixed-age setting (from 3 to 5), teachers paid attention to the difference in age of preschoolers as well as other factors which made them unique. The excerpt from the online version of the parent handbook partially identifies the image of the child that Reggio Emilian teachers hold, and it stresses the uniqueness of each child:

Each child is unique. All children bring their own patterns of growth, abilities, life experiences, and values to the learning environment. We begin with a respect for each child's rights. These rights include active exploration of the world around them, security, warmth, autonomy, a positive self-concept, self-expression, peer relationships and acceptance. At the same time, we strive to help each child expand beyond his or her current state to become a more fully developed person. We seek to create the richness and diversity of experience that will take the

children along new paths, deepen their understanding and their skills, and give added complexity to the talents and personal qualities they bring to us. Our philosophy is soundly based in child development and educational theory including the work of Piaget, Vygotsky, Erickson, Dewey, and Reggio Emilia, Italy.

As indicated in the excerpt, teachers appreciated and accepted the uniqueness of each child with his background, interests, needs, abilities, and values. They did not expect every child do the same thing and provided support for each child accordingly. Moreover, teachers aimed to contribute to the child's development and learning through providing a positive, rich environment in which the child could play an active role in his development and learning. The excerpt also indicates that the teachers were inspired by many theorists, namely, Piaget, Vygotsky, Erickson, and Dewey, and the Reggio Emilia approach, which actually has its roots in those theorists' work.

Moreover, the excerpt points out helping each child "expand beyond his or her current state to become a more fully developed person." The notion of bringing the child beyond his unique situation and personal qualities reminds the notion of Zone of Proximal Development by Vygotsky. It is essential to state the related principle of the Reggio Emilia-inspired preschool: "Children who are pressured to perform beyond their ability feel frustrated and incompetent. Children who are encouraged to participate through an unpressured, non-evaluative atmosphere will develop skills in each developmental area" (Principle # 4). This suggests that there is an optimum point for an individual child to reach, thus the teachers should be careful and do not frustrate children or force them to act beyond their individual potentials.

The child was seen as a protagonist, the leading character in the Reggio Emilia-inspired preschool classroom. The specific ideas for the curriculum or the education of

the preschoolers in general did not come from a textbook or someone outside the classroom context, but it mostly came from the child, who was a protagonist. For example, the weather project started because of the scary stories a brother told a preschooler, and from weather conditions (thunderstorms and rain were very strong on those days in Ohio). Similarly, the seed activities were born out of the children's interest in how a seed can grow even though we do not plan it. Alicia, the teacher, stated, "we really look for those teachable moments in our every day interactions with the children and expand on projects from there." Each child's needs, inquiries, questions, and interests were thus playing an important role in how teachers structured the education. Based on that, the teachers shaped the curriculum (see "the Taxonomy of the Reasons for doing Science" for more comprehensive information).

However, it is essential to clarify that while teachers were talking about the image of the child they did not only focus on the individual child as protagonist. The image of the child was defined and situated within relationships. For example, while the teachers were talking about the interest of a child, they were also emphasizing how interests became a "shared interest." The notion of "shared interest" could indicate the epistemology of socially constructed knowledge and the community the preschoolers created altogether during their learning processes.

Teachers had respect for preschoolers, their ideas, and their capability of doing something. They did not even use words like "kid(s)" or "child(ren)" but used the term "people" while talking to preschoolers. The teacher, Alicia, said that they want children to "think of themselves as capable, competent researcher-scientists, not that I can memorize these facts about bunnies or babies or water or whatever." In their daily

classroom practices, teachers reflected their view of children as competent researcher-scientists, capable of intelligent inquiry, by creating a science-rich environment and encouraging the preschoolers to deal with challenging problems or situations as active participant.

The teachers believed children have a lot of potential, so they created a challenging and provocative context for the preschoolers, consistent with their goals. In the Parent Handbook, it stated that they considered four major goals for each child in the program:

- 1) To become independent and self-motivated,
- 2) To be a creative thinker and problem solver,
- 3) To be able to accept and express him/herself as an individual, and
- 4) To function successfully in a group of peers.

The teachers believed that each child has the potential to accomplish these goals. The goals were actually representing their belief of what each child is capable of. The teachers considered each child to have the potential to be an independent, self-motivated, and a confident researcher. They believed that each child is competent in science, can do science, deal with challenging situations, do self-expression through using multiple ways of representation of ideas and cooperate with others (Parents Handbook).

While the preschoolers engaged with science in multiple ways (see the Taxonomy of the Ways of doing Science for more comprehensive information), the teachers were not obsessed with teaching the preschoolers “facts.” The teachers aimed to help them become “strong thinkers.” As observed during projects, the preschoolers were great “inquirers” and “hypothesis makers,” who hypothesized and theorized to form

explanations for natural sciences events. For example, the excerpt from the bubble conversation during circle time shows that a preschooler had an idea of making bubbles in shapes other than spheres, which suddenly became a shared inquiry of the preschoolers.

Kathy : You can make bubbles because there is soapy water in there. You can make a bubble with anything that has a hole in it.

Ciara : Something with a shape. How come you blow it and it is still circle?

Kathy : That's interesting. We can get things that we had on the overhead projector yesterday. There are triangles, squares, and star shapes. Ciara is saying when you are making a bubble, using that shape, bubble is not that shape, bubble is round like a sphere.

Mark : Yes.

Kathy : Yes but how come? If it is coming from something that's shape is triangle star or square, how come the bubble is not square or triangle or star. How come the bubble is round?

Mark : I do not know.

Kathy : I do not know either.

Jen : If you try that, there is that shaped bubbles.

Kathy : You think we can get shaped bubbles?

Jen : Yeah!

Kathy : Let's move those things we were using to make flag shapes yesterday. Remember we found those things to make shadows of triangles, rectangulars and stars, things that you may have found on the flag. Let's move those over to the bubbles, blow on them and see if the bubbles are around like sphere, or the shape of the thing that you are going through. We can do that experiment. I do not know it sounds pretty interesting.

Jen : I do not have any sensory table at my home.

Kathy : Well, you do not need to, because we have one in our school. You can use ours.

Ciara : If you want, you can do the same thing at home after school.

Kathy : Yeah, it's true.

Ciara wondered "How come you blow it and it is still circle?" and Jen claimed that you can make shaped bubbles. Teachers had an honest trust in children's capacity of finding right answers on their own with teachers' guidance. Accordingly, they did not provide the right answer but guided them to search for their own answers. Teachers' honest trust in children's potential and intelligence did not also approve using typical assessment tools

to “test” them, but approved richening the science processes that preschoolers were going through and supporting them to become confident, strong thinkers who can seek answers by themselves by collaborating their peers and teachers. Accordingly, as seen in the excerpt of conversation among the children and the teachers, the teachers planned to challenge children’s thinking by way of asking intellectual questions, creating cognitive dissonance, and presenting materials and tools.

Briefly, the image of the child in the Reggio Emilia-inspired preschool could be identified as following: the child was smart, full of potential, a valuable member of the community, and unique in his/her own abilities and background. The child was a protagonist creating the curriculum with the teachers, a strong thinker, curious about the world, and asked questions. The child was a team member, able to work collaboratively with teachers and other children. The child was not only a hypothesis maker, but also a competent researcher-scientist who used science process skills and scientific ways of understanding the world, such as looking at sources, observing, and collecting evidence. The role of the child was to construct their knowledge and develop skills through exploration.

4.2.5 The Role of the Teacher

There were two lead teachers, both of whom worked full time in the preschool classroom and were also responsible for giving lectures at the college and training the practicum student teachers. There were also eight undergraduate-student teachers and a graduate-student teacher, who had a graduate assistantship [GA] position with 20 hours work load per week at the preschool. The excerpt from the Orientation Packet for parents

briefly clarifies how the lead teachers and student teachers shared the work at the preschool:

In addition to providing care and education for your child, as a laboratory school we also have a primary responsibility and obligation to teach undergraduate and graduate students. Most of our students are learning to become qualified early childhood educators. Our lead teachers teach core curriculum courses, seminars, and supervise practicum student teaching experiences. Undergraduate practicum students serve as additional support staff during their time in our classroom. They plan and implement experiences with the children, and towards the end of each quarter have “take-over days” when they take on an even stronger role in the classroom. They are constantly under the careful supervision of the permanent staff. ... Some of the undergraduate student teachers are required to choose a specific child as their “focus child.” The student may then schedule a home visit with this child and his/her family. They will also participate in some of the focused observation work (authentic assessment).

The student teachers had unique contributions to the class while they were also learning about early childhood education and child development. The lead teachers benefited from their help in the class as they trained them.

Besides the role of training and supervising the student teachers, the most important responsibility of the lead teachers was working with preschoolers. In the Parent Handbook, the roles of the teacher were stated as nurturing, observing/listening, facilitating/planning, guiding, arranging the environment and providing opportunities, supporting families, and finally being resources and advocates for preschoolers. The domain of the roles of the lead teachers driven from the whole data set including participant observations includes:

- Listener
- Learner
- Researcher

- Helper
- Provocateur

One of the roles of the teachers was *listening* to the preschoolers. Listening is not used in a literal sense of listening, but more like the one used in Reggio Emilia approach. Listening was not limited to hearing but observing, interpreting, realizing things about preschoolers, actually paying very close attention to preschoolers (e.g., their conversations, play, and work). In the Parent Handbook, teachers stressed the importance of observing and listening to the children and stated, “Teachers must be aware of how and with whom children interact, their interests and strengths, their particular learning styles, and areas that need extra attention, in order to provide the best possible environment for optimal development.” To accomplish this, the teachers did documentation using different methods of listening and collecting information about the preschoolers, such as keeping anecdotes of their conversations, taking pictures. Documentation can be considered to be a big umbrella for any kinds of listening (see documentation for more information). Karen also cautioned teachers, “We have to be careful to not stop listening once we think that we have an idea.” This suggests that teachers should remain attentive and not to jump quickly to a conclusion about issues related to preschoolers. Once teachers begin looking deeply, what they find may be different than what they saw at first.

Through listening, the teachers *learned* about preschoolers, in other words, about their thinking, understanding of the world, inquiries, interests and unique characteristics. The excerpt from the interview with Mary shows how teachers listened to the

preschoolers in the Reggio Emilia-inspired preschool classroom, and the excerpt from the interview with Alicia points out another dimension of teacher learning:

We observe the children's interests and we listen to what they talk about. We follow their play and then based on that we offer them experiences and materials that will support those interests and we will track those interests through teacher observation and student observation.

I also don't want them to think that adults hold all the answers, because they don't. And even if I knew a certain amount of one subject, it's going to change. What we even know about bunnies is going to change 50 years from now.

Through observing and listening to the preschoolers, the teachers learned about each child and came up with ideas that they could use for the general curriculum goals as well as individual objectives. Moreover, they also learned about things, such as science content, while learning about children. Furthermore, they worked on expanding their own knowledge of child development and early childhood education. For example, they had weekly meetings to exchange ideas with other teachers in the school and participated in professional development meetings/conferences throughout states (e.g., NAEYC conferences).

The teachers acted like *researchers*. While they were listening to preschoolers and trying to learn from them, they were doing research in various ways. They especially documented information about preschoolers in general, so that they could help preschoolers and provide them with a more supportive environment. Moreover, they could make preschoolers' learning process "visible" to others. The following picture exemplifies a board of documentation which displays information on brain based learning and experiences of the preschoolers (see Figure 4.27). As researchers the teachers did not only search information about child education and development but also analyzed it with

preschoolers' experiences in the classroom and displayed this to others by setting up a board.



Figure 4.27. Brain based learning and preschoolers' experiences.

The teachers were great *helpers* especially when the preschoolers needed direct assistance. In the Parent Handbook, teachers stated, “Through realistic limit setting and positive guidance, children develop problem-solving strategies and strong respect for the rights of others.” The teachers were always available to provide guidance while assuming their other roles, such as observing. For example, during the wind activity (weather project), the student teacher [ST] gave brief, direct instructions to the preschoolers by showing how to use a straw to paint the paper and make a wind on the paper. She made a short, clear explanation as follows: “Pinch the eye dropper, it will suck up some paint, and hold it to your paper and then try blowing on that paint.”

On the other hand, when the preschoolers needed more assistance, the teachers did not hesitate to increase their help gradually and encourage children to help each other. For example, after giving a brief presentation on how to blow onto the paper like the wind, the student teacher also encouraged preschoolers to help each other within the play. She did not interrupt them until she believed she had to. The excerpt from the conversation among preschoolers and the student teacher shows a brief example for that:

- ST : Anne, when you are thinking about using eye drops, think about using small drops. If you look at their paintings, small paint drops are farther blowed up.
Anne put her straw into the paint.
ST : No, Anne, stop. Your straw, it won't be a choice, your straw in the paint. Ask Christina how this idea works.
Jen : I will show you how. You put some paint on your paper, and then blow.
ST : She needs to know what to use to get paint.
Jen : That!
ST : Yeah! Eye droppers!
ST : You just squeeze some eye drop paint, just a little bit goes a long way. So just think about using little drops and use your straw and blow onto paint to make it move. There you go.

As seen in the conversation above, the student teacher continued offering assistance. In the Reggio Emilia-inspired preschool, the teachers used “scaffolding” whenever the preschoolers needed it, and encouraged them to help each other. Teachers also provided them help according to the needs of the preschoolers. For example, during the wind activity, when Steve, who was the youngest child in this class (about 3 years old), had much more difficulty than other preschoolers, the student teacher provided him more structured, extended direct assistance than the one exemplified above.

Another role of the teachers in the Reggio Emilia-inspired preschool is that of *provocateur*. During the wind activity, the teacher continued helping by asking critical, provocative, open-ended questions, such as “what happens” or ‘what do you notice when

you blow onto it?” Teachers provoked preschoolers’ inquiry in many ways, such as asking questions and setting up the environment with materials and tools. For example, they changed the items the preschoolers used to blow through to challenge their thinking. They gave items other than circle-shaped, added more soap into the water, colored the solution and so on. Each time they sought to challenge the preschoolers’ thinking and provoke them to ask more questions, inquire about things and participate in searching for answers with their peers.

Another example for teachers being provocateur can be the insect project. They conducted research on insects and made a collection of dead bodies of insects (see Figure 4.28). The preschoolers expressed their ideas by drawing most frequently. Drawing helped them revise their thinking as well as express their ideas. By drawing spiders, they saw some of the differences between spiders and insects. Alicia stated,

To find out that spiders weren't insects was a big - kind of cognitive dissonance for them. But they had legs and they could crawl. What's the difference? And so drawing those things, salient thing for them became that a spider has a head and an abdomen whereas an insect has a head, a thorax and an abdomen. And three body parts versus two. So when they're drawing it, spiders have two parts and an insect has three. Not even the legs as much as the body parts. So that's a huge leap as well.

The teachers sought to create cognitive dissonance for preschoolers in the same sense of Piaget, thus provoking inquiry and interest, as suggested by Alicia. This was accomplished through providing children opportunities to see similarities, differences, and conflicts, which create cognitive dissonance.



Figure 4.28. Insects project.

Moreover, Kathy stated the slogan they used for the preschoolers, “Every day, try something hard”. This relates to the concept in esteemed early childhood education models of “getting children stuck” so that children will look for “how to get unstuck” (a presenter’s note at AAAs forum, cited in Johnson, 1999). In general, the aim is to make children “strong thinkers” and “problem solvers.” Johnson (1999) states that all the good models discussed in the AAAS forum, including Reggio Emilia, are emphasize the importance of observing children and documenting their work. She also cites one of the presenters’ statements: “These models encourage children to get ‘stuck’, then help them to discover ways to get ‘unstuck’” (p.20).

4.2.6 Education Based on Relationships

The educational philosophy in the preschool of the current study, which was social constructivist, was based on the strong interrelationships as found in the Reggio Emilia preschools in Italy. The teachers in the current study believed:

Learning occurs through contact with adults, with peers, and with many different media, with different physical environments and through the child's own self-initiated activity. The classroom is one of the many environments offering opportunities for such contact and activity. It does not or cannot provide all the experiences and stimulation necessary for optimal development of the whole child. Quality experiences must also be provided by the family, neighborhood, community and culture. (Parent Handbook)

Teachers believed that relationships are important in children's lives. They emphasized not only the strong bonds within the preschool walls, among children and teachers, but also within the whole community, including the school. It was stated, "These endeavors are accomplished through a strong **partnership** with supportive teachers" (Parent Handbook, not bold in original). The excerpt from the interview with Kathy shows a few ways of partnership among teachers:

I'm fortunate to have a team teacher who speaks with me many times in many ways all day, every day. Another tool that we use heavily is e-mail. We e-mail each other all the time. When I have a few conversations that are transcribed, I send it out to a list of the adults in the classroom and then everyone gets to read that conversation and reflect on it and we have been into their thinking.

She also pointed out the strong relationship that lasts over years in their school community:

We know these children so well - we're here with them every day, all day, some of them for six years... They can come as early as six weeks old and they don't leave until they go to kindergarten, sometimes right after they turn 5. So it's really quite a long, long time. So we do feel like there's a very deep relationship with each child, with each family.

Each dyads of relationships, which emerged from the participant observations, namely *teacher-child, teacher-teacher, child-child, teacher-parent-child, as well as school-community*, is discussed below.

In addition to the teachers' roles/responsibilities to the children, namely being a listener, learner, researcher, helper, and a provocateur, the *teacher-child* relationship in the current preschool can be explained in terms of the child image. In the Parent Handbook, it was stated that children are strong, capable, and full of potential, have rights to use different materials to explore things, express themselves and so on. This clarifies the teacher and child relationship simply in terms of the teacher's role as being a 'partner' in children's learning processes.

Both teachers and children were equally effective in children's education. As stated earlier, depending on the needs of a child, the teacher played the role of a listener, learner, researcher, helper, or provocateur. In general, the teacher acted as a partner to the children in their learning processes. The teachers carefully observed and listened to the children, engaged with documentation of children's progress, made decisions based on the children's interests, ideas, and developmental readiness, and finally formed an appropriate curriculum (see Peer culture & School culture for more information).

Both the preschoolers and teachers were affective at shaping the curriculum in the Reggio Emilia-inspired preschool. The excerpt from the Parent Handbook states this clearly:

This philosophy affords very young children the opportunity to develop at their own pace by exploring both teacher-planned and child-directed activities. Essentially, we recognize and respect each child's individual temperament, interest, culture, and needs. (Parent Handbook)

Essentially, the teacher-child relationship in the Reggio Emilia-inspired preschool can be defined for each party as continually moving back and forth between active and passive roles in shaping the curriculum.

Teacher to teacher relationships in the current study was similar to the relationships among teachers in Reggio Emilia schools in Italy, but also different in some ways. It was similar in terms of the professional development and collective support of each other. They organized professional development meetings, such as theoretical and practicum courses, for student teachers and national-international early childhood conferences. They were also supportive of each other, sharing the work and their ideas with each other. In contrast, the college laboratory preschool trained students. Specifically, teacher to teacher relationship was different in terms of having a *lead* teacher and a *student* teacher, which refers to a kind of hierarchy in the teacher-student teacher relationship. In Reggio Emilia preschools in Italy, teachers were seen as partners and did not have any hierarchy in terms of leading or being lead. However, as the lead teachers in the Reggio Emilia-inspired preschool were considered equals of each other, it was still similar to teacher-teacher relationship in Reggio preschools in Italy.

Child to child relationships in the Reggio Emilia-inspired preschool can be defined as being cooperative and collaborative in learning processes as well as being independent and self-directed. The excerpts from the preschool principles (see 5, 6, and 7) indicated:

- Children need to be with other children. (5th principle)
- Children learn to work collaboratively and cooperatively. (6th principle)
- Children need to be self-motivated and self-directed. (7th principle)

The fifth and sixth principles emphasize the group spirits while the seventh principle emphasizes the individual spirit. As found under the domain of the Ways of Doing Science, children worked mostly in groups, cooperated with each other and constructed knowledge together. While children were working together, the teachers also aimed at

developing their independent skills (i.e., being self-motivated and self-directed). As children worked together, “shared interest” became one of the leading reasons for teachers to decide on emerging pathways of projects (see the domain of the Reasons for Doing Science). Accordingly, strong child-child relationships were one of the important issues in the school community and supported by teachers. Teachers believed that children learned from each other while they were working together.

There is an explicit recognition of the partnership among *parents, teachers, and children* since the Reggio Emilia approach grew out of a parent cooperative movement after the World War II. Although that history belongs to Italians, the strong bond among preschoolers, teachers, and parents also showed itself in the Reggio Emilia-inspired preschool classroom. The excerpts from the principles 8 and 9 and Parent Handbook indicated:

- Teachers provide a warm, secure, and supportive learning environment for parents and children. (8th principle)
- The bond between home and school is inseparable. (9th principle)

An important goal of our program is to promote family involvement and to be sensitive to family needs. That is, we 1) strive to be flexible in dealing with your child in a manner that demonstrates understanding of his/her individual family heritage and 2) we value parents’ partnership and incorporate special parental talents into the program. (Parent Handbook)

They intended parent involvement in the program and strong bonds between teachers, children and families to provide “the best learning and growth experiences for children” as stated in the principles. The parents were invited to visit the class at any time and encouraged to participate in the program. In all, parents were invited to be active participants in the activities of the school and in their children's projects and welcomed into the classroom and collaborate with teachers in curriculum decisions.

In order to accomplish the goals of maintaining good communication and strong relationships with parents, the teachers used several strategies. The excerpt from the Orientation Packet partially clarifies the nature of this relationship:

We offer a “formal” conference once per year to each family. However, please know that parents are encouraged to ask for a meeting with teachers whenever needed. The teaching staff may also request an additional conference if needed. Of course the informal communication between parents and teachers is an ongoing, every-day occurrence. Teachers welcome communication from parents. Very brief conversations are usually possible at drop-off or pick-up times. We can also be reached by phone or email. To discuss any issues, questions, ideas, etc. at length please schedule a conference with one of the lead teachers. (Orientation handbook)

To ensure effective communication, teachers arranged home visits right after the child joins the class, face to face individual meetings as needed, weekly e-mails about curriculum guide and special events, parent message board, parent mail pouches, children’s mailboxes, yearly Parent-Teacher conferences, potluck gatherings, Parent Council meeting every six weeks, and occasional parent coffees (see Figure 4.29). The researchers observed many of those during participant observations and received weekly e-mails about curriculum guide and special events.

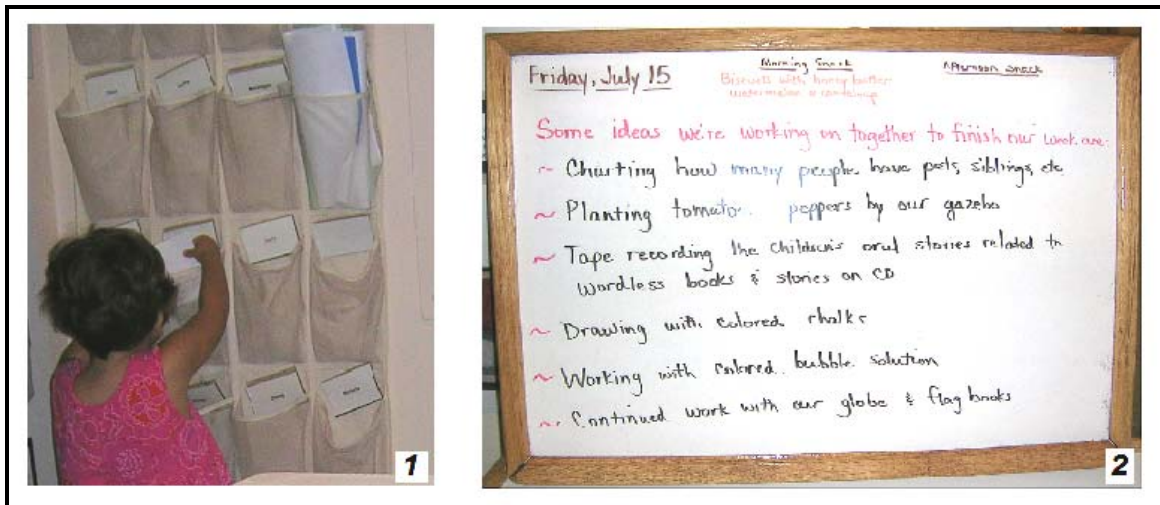


Figure 4.29. 1- Parent mail pouches & 2- Parent message board.

Since most of the parents were working full-time or had limited time for onsite conversations for other reasons, the media other than face-to-face or phone meetings helped much to foster communication among parent-teacher-child. Teachers and children gave messages about current issues (e.g., community happenings, individual issues or curricula) to parents via various kinds of media indicated above or sent messages via Internet.

Lastly, the *school-community* relationship was valued in the Reggio Emilia-inspired preschool. The teachers found ways to maintain strong bonds with the outside community. For example, the teachers gave presentations about their school at national and international conferences (e.g., NAEYC). They also shared their experiences with other people in other forums, such as Internet discussion forums (i.e., REGGIO-L@LISTSERV). They provided anybody an opportunity to visit and observe their class from the observation site. They also invited people to the class for enrichment reasons,

such as an entomologist, who gave a presentation about insects. The strong school-community relationship also showed itself in that the preschool served as a learning center for university students and researchers, being a laboratory school located at a university. They let researchers come in and conduct research on their sites, such as for this current study. They even invited the researcher of the current study and other researchers to share their studies and related observations with the families at a parent meeting. They pursued every possibility to maintain meaningful, strong relationships with the community.

In summary, since the educational philosophy is based on strong relationships, and a continuous, cooperative interaction between those involved in the school community, collaboration and cooperation took place in all dyadic relationships.

4.2.7 Inquiry-based Education

It is important to state that the Reggio Emilia-inspired preschool provided preschoolers with inquiry-based educational practices in science. Each domain under the Taxonomy of the Ways Children Engaged with Science, namely exploring with hands, working in groups or individually, searching sources, using science process skills, representing ideas in multiple ways, proves that the Reggio Emilia-inspired preschool science education was based on inquiry.

Teachers saw preschoolers as young scientists, who inquired about the world, asked questions, and then actively and collaboratively conducted science investigations. In this classroom the children's inquiry always took priority and was appreciated by the teachers. Teachers believed that inquiry contributed to children's learning and

understanding of the world. For instance, Richard approached the teacher to talk about a bunny picture and the bunny they found at the playground.

Kathy : I think that was the bunny from our playground. That was my question “is that the same bunny?”

Richard: It does not look alike.

Kathy : It does not, hmm. That’s interesting. Then let us to have a note... what does not look same.

Richard: Because that one is little.

Kathy : Really?

Richard: And it is brown.

Kathy : I thought the other one was brown.

Richard: It was black.

Kathy : Oh, it was?

Kathy : I thought they were brown.

Richard: Maybe that’s black, and but that bunny, that one is brown and it looks little to me. Maybe it was a baby and it was brown to me.

Kathy : Maybe. Let’s ask our friends at the circle.

Richard: I know a lot about bunny.

Kathy : I know you do.

The teacher brought up this topic at the circle time.

Kathy : ... Here is another idea. You remember bunnies we have found on the playground. At the end of the last week, we looked down from the window. Guess what we saw?

Sophia : What?

Kathy : Bunny. It was the same bunny we saw on the playground. But Richard thinks that it is different. We have to figure out. There are photographs on the table. Let’s look at those photographs. Is that the same bunny we saw on the playground?

Megan : Yes!

Jen : No!

Kathy : I am not sure. There are some books about bunnies over there.

They also talked about other ideas that they could do with bunnies. A child said, “Catch them?” Kathy said, “No.” She introduced what she set up (books, papers, and pens) at the table for them. She invited them to write down their ideas of bunnies on the paper. Richard said, “If you can write the ideas you like about bunnies?” Kathy replied, “Sure.”

Some projects emerged from preschoolers' shared questions. The environment with the materials and tools set up by the teachers as well as the natural environment was provoking children's inquiries and leading them to ask questions. Some of the shared questions of the preschoolers were as follows:

- If I blow in a triangle, does the bubble turn-out to be a triangle shape?
- Do I need more soap to make a star-shaped bubble?
- Is spider an insect?
- How does the rainbow happen?
- Does a huge much rain make the rainbow?
- Do we need thunder to have the rainbow?
- Can the air conditioning vent suck up big toys?

When the preschoolers still had some inquiries, they had an opportunity to go back and revisit the old projects/ideas. The excerpt from the interview with Alicia indicates that the preschoolers had questions from the beginning of the projects through the end of the projects. Alicia gave the example of the Bunnies project.

I think it's up to us as the facilitators as— that role of the teacher— is to capture that and when they're saying “Well, I think this” or “I think this” to write this down and then to use the language of science. Like – “So you are predicting that this is going to happen” or “Your hypothesis is that this is going to happen.” That was happening with the bunny project a lot that they said “Why are they living here?” “Do they eat the mulch because they're living under the climber?” We have a - a piece of playground equipment that has a platform and a nice shelter and so this mother bunny is under there with her babies and the children found it. So then they said “Do they eat mulch” and we said “We don't know. How could we find out what they eat?” They said, “We should put out a bunch of food and see which one they eat most of.” So we put out carrots and lettuce - the children generated a list. And we had books about bunnies and it was really - the bunny books that the bunnies drink mother's milk. Baby bunnies drink - so they wanted to put out a tray of milk. Carrots, lettuce, mulch. And when we came back the next day the carrots were gone. The lettuce was nibbled. The milk was gone but I think it had spilled.

And the mulch was still there. They said “Oh, they eat what Poptart eats.” And then that led to a discussion, Poptart is a rodent. Bunnies are rodents. There were pictures in the bunny books of the bunny teeth and they thought that was like Poptart the guinea pig's teeth. So it kind of - putting animals into groups of families. Rodents and mammals and things like that. It was also a natural kind of part-of-ness. So I think at this age it's really up to us to give them a language of science, to give them the tools of asking questions and figuring out - what's a variable that I can manipulate, softness. What can I do to find out what they eat? What can I do to see why they're living there? So I think that that natural curiosity is there. We just have to give them an outlet for solving those problems.

The projects were supported by teachers and peers, and they evolved as preschoolers constructed their own knowledge cooperatively with their peers. The projects continued as long as the children's interest held. The teachers planned the classroom experiences to promote children's understanding of natural sciences. This study revealed that the Reggio Emilia-inspired preschool offered a science-rich context that triggered and supported young preschoolers' inquiries about the world and effectively engaged preschoolers with science.

Inquiry shaped the actions of the teachers (e.g., how they planned the next day's curricula) within the lines of peer culture and school culture. Since using language was very important in this class, teachers used science terms (e.g., experiment, theory, hypothesis, predictions, temperature, and thermometer) in their daily language. The examples given under the domains showed how inquiry-based education in the classroom was strong and supported by the teachers. In the following part of the data analysis, how children's inquiry shaped the curriculum will be discussed along with how progettazione is reflected in this Reggio Emilia-inspired preschool classroom.

4.2.8 Progettazione

Progettazione, which is an Italian term, refers to the long-term projects on which children and teachers work collaboratively to build. Within the framework of an emergent curriculum, children develop inquiry-based projects over time. This excerpt from an interview with Alicia explains how their projects within the emergent curriculum framework were shaped over time:

Because we have an emergent curriculum, and we have the children year round and have them for a long period time through our observations, teacher observations of the children, we can see kind of these threads of interest. We see interests that they start to come across. And they are in their classroom environment outside and during the media at home and when we see something in particular that we see offers a lot of potential we'll grab onto that and expand on it in our curriculum. So if it's always working from their ideas, from their interests but it will - we kind of choose the things that we feel have the most potential either for project work or for going a long period of time, or thoughtful use of materials or kind of experiences we want these children to have so we will build upon that interest in a way we see developmentally appropriate.

Alicia clearly stated how they developed the projects and the curriculum. Teachers documented preschoolers' work, play and conversations through pictures, notes, tape recordings and sometimes videos. They reviewed these carefully together with student teachers, looked for the most potential ideas, made decisions and then guided the curriculum accordingly (see Figure 4.30). The pathway of the weekly decision making process is not as straightforward as seen in Figure 4.30, but this simplified demonstration might be helpful to give some idea. It should be stated that emergent modifications might occur daily following the similar pathway of the weekly decision-making process.

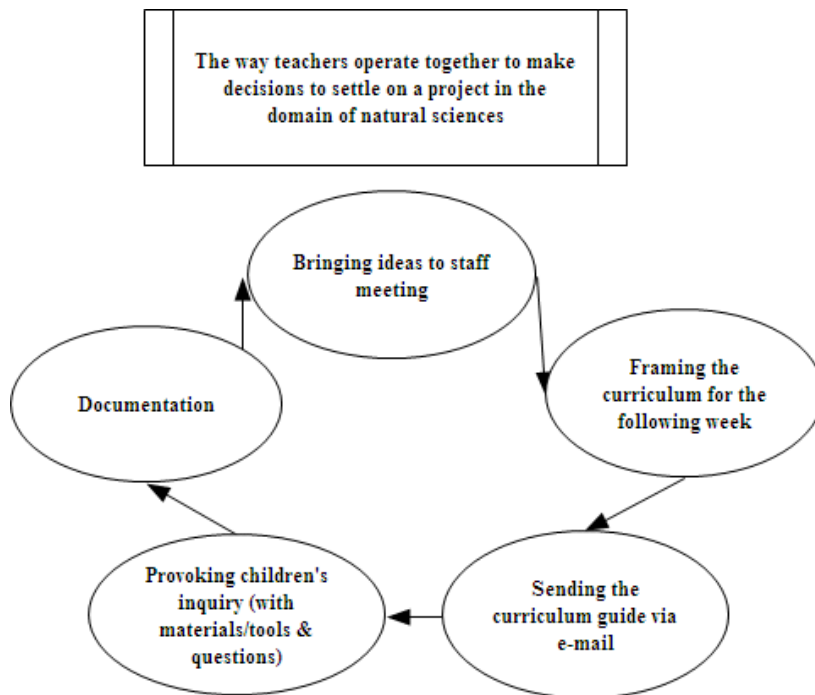


Figure 4.30. Making decisions to settle on a project in the domain of natural sciences.

It is essential to state that while the curriculum was emergent in the Reggio Emilia-inspired preschool and open to changes and new pathways any time, the daily schedule was consistent and more structured with some flexibility. This was stated in the preschool principles: “Consistency in the daily schedule helps children to feel secure about their participation in the daily life of the school.” Within a consistent daily schedule (e.g., free-play time, circle time, lunch time, nap time), the preschoolers were free to make decisions on what to work on. Moreover, the emergent curriculum was consistent in itself. Emergent did not mean randomly working on different things each time, instead works had a meaningful connection with each other.

It is essential to stress again what Alicia said, *the teachers grab onto what promised more potential for the preschoolers (not just anything) and expand on it in the*

curriculum. Weather and Growing Things projects are good examples of long-term projects, which promised more educational possibilities and were based on preschoolers' interest, ideas, and developmental readiness to acquire new skills. To understand the inquiry process the preschoolers engaged with, it is essential to examine in more depth some conversations that went on during a project.

As stated before, the Weather project started with a simple event of changes in the weather during summer, the preschoolers' interest in powerful weather and fear associated with noise, and specifically a brother's scary stories about powerful weather. Throughout the Weather project, before the critical event Bubbles (see Figure 4.31), the preschoolers became interested in a variety of themes related to weather, such as thunder, rain, rainbow, wind, and temperature. The preschoolers inquired about those issues, asked questions (e.g., what makes a rainbow?), worked on these ideas, and created some theories (e.g., Rain erases the rainbow; you need a huge amount of rain and thunder to make a rainbow). Similar to the way the Weather project was born, the sub-themes and new ideas under the project started with the children's inquiry and the foreseen potential.

Critical Event
><u>Bubbles</u>: Begin after blowing through straws like the wind. ><u>Examples of children's questions/inquiry pathways</u>: How can I make a bubble? Is it always sphere shape? How can we make different shaped bubble other than bulb shaped one? What shape the bubble look like if you use this? How long will it stay there if we do not pop the bubble? How can I make a giant bubble? Do the wind and air play a role in shaping the bubble? ><u>Examples of children's theories</u>: More soap, different color to make different shaped bubbles. Blowing softer or harder to make a bubble. Blowing close or farther away to be able to make a bubble. If you blow out of a butterfly shape, it is sphere. ><u>Examples of activities</u>: Making bubbles using soapy water and sphere shaped things. Making bubbles using different shaped and sized things to blow through, coloring the water, and adding more soap. Using the bubble solution outside in the sensory table.

Figure 4.31. Critical event: Bubbles.

Children's inquiry and interest gave teachers ideas about the curriculum which was emerging and teachers shaped the curriculum by choosing the most promising ideas for science projects, enriching the environment for relevant exploration. It was like ideas were leading to other ideas and determining the emerging pathway of a project. The teachers even made daily changes to the weekly curriculum. For example, while preschoolers were working on the "wind" by blowing through the straw like the wind during the weather project, blowing reminded preschoolers blowing through things to make bubbles. The preschoolers, thus, became interested in bubbles (see Figure 4.31). Upon preschoolers' interest in bubbles and the potential teachers saw in it, next day the

sensory table was set up by the teachers with geometric shapes (square and circle) and water mixed with soap. The preschoolers started working on bubbles while simultaneously working with wind by utilizing a little fan and some heavy/light materials. In order to show how children's inquiry shaped the curriculum, the children's conversation while working with bubbles will be discussed briefly.



Figure 4.32. Bubbles experiment.

The following day, the preschoolers became interested in making bubbles, the teachers set up the sensory table (see Figure 4.32: Step 1). The pictures in the figure represents four steps: Step 1- Using square- and circle-shaped things; Step 2- Adding star-, plus-, arrow-, triangle-shaped cookie cutters; Step 3- Coloring the bubble solution pink, yellow, green; Step 4- Adding more soap. Preschoolers stopped by the table to make some bubbles in the morning. Here is an excerpt from the audio and video transcripts of the children talking while making bubbles. The inquiry and research done in this dialogue shows how children often worked with each other to answer to questions and confirm statements originated by their curiosity.

Amy, Joe and Ciara are working at the sensory table making bubbles. There are circle and square type of items to make bubbles. Water is not colored.

ST : Hey, how does that work?

Ciara : You can put your hand through it before even it pops. (She is playing with bubbles in her hand)

Joe is working with tiny bubbles on his hand without using any item. Amy is just watching.

Ciara : (making a big bubble) Look how it is big!

ST : That's a gigantic bubble. (ST is taking picture of her gigantic bubble)

ST : What happens when you blow on it harder and softer?

Ciara : Let me try harder.

Joe blow through an item and tiny bubbles stick to his face. He is laughing. ST cleaned his face. Ciara is making a bubble onto her hand, she holding the bubble carefully until it pops. Amy left. Megan joined the table and started watching Ciara's bubble carefully.

Joe is trying to blow but could not make any bubbles yet except the tiny bubbles above the water. He is keeping his mouth too far from the hole. Ciara is making bubbles quickly and slowly.

ST : Megan, hold this side and blow into it.

Megan tried but it did not work.

Ciara, who is the expert now, came close to Megan and holds her item and said "Hold it from right here."

ST : You need to hold it close to your month or farther away.

Ciara : You have to do like that, a little.

ST : A little close but a little far?

Megan left, washed her hands, and came back. Joe is watching Ciara carefully and trying hard. He left to wash his hands. Ciara says that her mom showed her how

to do that. ST said, “Oh! That’s a huge bubble.” Megan is watching her carefully. They are looking at their cloths talking about how they match. Ciara is making bubbles and also showing her necklace to ST. Amy came back and started making bubbles.

ST : Hey, there you go, you have one!

Ciara : You can’t blow into the same hole, because it won’t make bubble.

ST : Huh!

Amy left and washed hands.

Ciara : Look! That’s kind of slippery!

ST : Bubbles are tricky like that.

Amy : I see Gerry! (Gerry came into the room)

ST : Oh, my gosh! He is here.

Megan tried blowing into an item but it did not make any bubbles. Ciara took it from her and tried blowing, but again it did not work.

ST : I think Kathy decided, that one, you might have to go a little bit harder because the holes are so, so tiny

Ciara tried a few more times and said “Ok, that’s enough.”

The preschoolers watched each other, conducted hands-on investigation of bubbles, inquired more things about bubbles, and in time came up with new questions. Within a play context, the more “expert” ones helped the other kids and showed good examples for cooperation among children. The preschoolers learned through cooperating with other children and the teachers and using creative arts as central features of the program during the long-term projects, which were based on children's interests, curiosity and understanding. The student teacher asked some questions to provoke their inquiry and, as a partner, actively engaged in making bubbles with the preschoolers.

Later, at circle time, they discussed making bubbles. The critical question came from Ciara. She asked, “*Something with a shape. How come you blow it and it is still circle?*” This question determined the next pathway of the activity. Some preschoolers claimed that it is possible to make a bubble different than sphere shape. Some of the preschoolers and the teacher, Kathy, said, “I don’t know.” The teachers decided to move

some geometric shapes (i.e., cookie cutters) from the shadow work area to the sensory table.

The teachers did not provide an answer to Ciara's question of the bubble shape. In the Parent Handbook, it is clearly stated why teachers do not provide answers:

Teachers must [then] provide opportunities for active participation, investigation and experimentation. Teachers do not provide all of the answers, nor all of the questions, but encourage children to raise their own questions, solve their own problems, test hypotheses and analyze results.

This suggests that the natural sciences education was based on the children's inquiries and questions, and the aim is to get children to find answers by searching. The teachers did not provide answers but supported children's skill of seeking answers.

The preschoolers continued working on bubbles after the circle time. This time they also used star-, rectangle-, arrow-, and triangle-shaped cookie cutters. The preschoolers were surprised because the bubbles were still coming out round. The excerpt from the audio and video transcripts displays the conversation between children and teachers:

Kathy : Gerry, are those shapes making shaped bubbles? That was a round-shaped bubble.
Gerry is making bubbles using different shapes. ST joined him. ST is blowing into the arrow shape.
ST : Is it looking like an arrow?
Gerry : Yeah. It pops out. Look at this.
ST : Circle made circle.
Gerry : It was a big one.
ST : Does it look like an arrow or circle?
Gerry : Circle.
ST : But I used an arrow. What about the "plus"?
ST : It is circle. (Pointing Gerry's arrow) It looks like a circle too.
ST : How about the triangle?
Gerry : It is circle.
ST : These crazy bubbles are all circle.

ST left, Kathy joined. While Gerry is making bubbles, he is looking at the mirror to see it. Before, he tried to make bubble and then turn it toward himself to see in time but the bubble was gone.

Kathy : What is the shape of bubble?

Gerry : Circle. See, see. (making a bubble with an arrow)

Gerry is making bigger bubbles and blowing more than before. He is trying to blow different ways, soft, hard, long, short.

Kathy : Where does it go, when it pops?

Gerry : I do not know. What about this?

Kathy : It is big.

Kathy : Now you have more than one.

Gerry is squishing the bubbles in his hand.

Through this dialogue, the active questioning and interests of children are demonstrated.

The preschoolers' investigation with bubbles was getting more completed than just making bubbles, because they were changing some variables. For example, they tried shapes other than circle and square blow through. Moreover, they tried blowing differently to see if it makes a difference and if they could make shaped bubbles. For example, they tried blowing softer and harder, blowing close or further away.

The field notes also show that the preschoolers started asking new questions other than "how to make different shaped bubbles." Some preschoolers inquired, "How come some of them pop and some blow?" and "How long can a bubble can stay there if they do not pop the bubble?" Moreover, they became interested in how to make bigger bubbles. The teachers were careful about changing one variable at a time, so the preschoolers would not be confused, but they worked toward more complicated situations. As a result, the children brought up new, sophisticated questions.

The following day, the teachers set up the sensory table with some other changes. They colored the bubble solution with dark pink, green, and yellow. Before circle time, preschoolers worked on the bubbles experiment at the sensory table. A short excerpt from

the transcripts shows that the preschoolers worked cooperatively, enjoyed the event in a play atmosphere.

Arthur, Mark, and Gerry are making bubbles. Kathy is asking Arthur if they should have this outside at the playground; Arthur says “yeah.” Gerry is making bubbles with a circle; Arthur says “ooh you made a big bubble!” Arthur made a bubble which flies in the air, saying “Looook!” Mark is working with the star. Steve has joined. Each part has different color: yellow, dark pink and green. Children are trying different shapes: arrow, square, circle, star, and plus.

They tried to understand how to make bigger bubbles without popping them, racing with each other. Other than focusing on the shape of the bubbles, they discovered and became interested in another feature of the bubbles, which was size.

At the circle time, they discussed the bubbles experiment and reflected on what they observed and experienced at the sensory table. Having hands-on experiences and explorations and being challenged with the materials and questions helped the preschoolers to realize some issues related to bubbles. This excerpt is taken from the circle time conversation:

Kathy is introducing the bubble experiment with colored water and shaped things.
Kathy : When you are using the triangle shape or square shape, what shape does that bubble blow?
Jen : Does not blow!
Kathy : It does not blow a square?
Jen and Ciara other kids: Nooo! (Jen is making circle with her hand)
Ciara : Nooo! If it is star, it won't be star.
Kathy : You tried the whole day yesterday to make those shapes happen.
Alicia : Why do you think it is? Even if you blow out of a star shape, it won't...
Ciara : ... make a star.
Alicia : Why?
Ciara : I don't know.
Jen : I think some magic.
Alicia : Some magic? Let's start do some research.
...
John : You cannot make a shape of diamonds. When you blow it so hard (inaudible)

Alicia : Bubbles are circles. So no matter how you blow, the bubbles always look like a circle.
 Ciara : One time I used form and it worked but now I forget how I got to do that.
 Kathy : Maybe it needs you to do it again.
 Alicia : Richard do you have something to say?
 Richard: If you blow out of circle, it would make a circle.
 Alicia : That's true.
 Ciara : But if you blow out of a butterfly shape, it is circle. Circle, circle, circle.
 Arthur : It makes a bulb.
 Alicia : Yeah, like a bulb shape. A bulb kind of shape is sphere. It is round all the way around.

It is important to state that Jen, who claimed to have made shaped bubbles before, had some experience at the sensory table and said that it is not possible to make shaped bubbles. This exemplifies that a child can find his/her own answer with some search and some guidance. Since the preschoolers were agreed that there would be no shaped bubbles, the teacher focused on the next step, now asking “why?” The teacher invited preschoolers to do research to deepen their understanding of bubbles.

After circle time, some preschoolers continued working with bubbles. The teachers tried to provoke their inquiry more and kept asking why it is sphere all the time. The preschoolers, being strong thinkers, made some hypothesis to explain why it is always sphere-shaped and continued to search to see if there is a way to make other shaped bubbles.

The environment was not static but always responsive. The teachers were setting up materials and tools accordingly, changing things/variables at the sensory table to better support children's inquiry. Changing some variables also helped the preschoolers learn more things about bubbles and come up with new theories, such as “soap makes it strong.” Here is the excerpt:

Kathy : Look, there is star shape, right?
 Mark : Yeah, we have to figure out why they do not make star shape.
 Kathy : Why did not they make star bubble if it is star shape?
 Child : I kind of know why.
 Kathy : Why?
 Child : Because there is not enough bubble there.
 Kathy : Is that right? (Inaudible) Not have enough bubble?
 ...
 Child : Because it is too round, and this is square, that's why it is not.
 ... making bubbles and laughing
 Kathy : What do you think, Mark?
 Mark : I think, I think we need more bubble.
 Kathy : Like more soap?
 Mark : Yeah, more soap.
 Kathy : You wanna try more soap? Ok.
 Children are screaming, laughing. Kathy is adding more soap into the solution.
 Kathy : There is more soap. Let's see if it makes any difference. There is more soap.
 Megan : This is mine.
 Kathy : OK, here you go. Do you see any difference?
 Megan : It does not.
 Kathy : It does not?
 Megan : It does not look on mine.
 Child : Wait a minute. Maybe it just makes round shape.
 Kathy : Maybe it does.
 Child : Maybe it just makes round shape.
 Kathy : There is a lot of round shape here. Oh look! These are square.
 ...
 Child : Big.
 Child : Hey you cannot pop it.
 Child : Noo.
 Kathy : Pop the bubbles just you make. If you try to pop each other's bubbles, ...
 Megan : Hey I made a big one!
 Kathy : Wow, right in your hand. How cool is that?
 Child : It won't pop.
 Kathy : It won't? Pretty strong, huh?
 After adding more soap, children realized that their bubbles do not pop quickly.
 Kathy : You can blow on your own bubbles.
 Children are blowing, screaming when the bubble is on their head, or somewhere weird.
 Kathy : Adam, that's a big one.
 Megan : Adam!
 Child : Hey, Adam, go on your own space. Stop it, Adam.
 Adam : I am not trying to catch you.
 Children are playing with bubbles and laughing.

Child : Hey Kathy, I don't have any space.
Anne is singing.

The preschoolers hypothesized that if they had more soap in the water, they might make different shaped bubbles. The teacher added more soap. The preschoolers checked it after more soap was added. They realized that it is still sphere shape but it is stronger than before and it does not pop quickly. While they were playing and interacting with each other, they socially constructed their knowledge through hands-on experiences.

In the curriculum guide, the teachers planned their bubble experiment for the following week. Even though the weekly curriculum guide was planned ahead of time, the teachers had to make some changes during the week. The paragraph from the curriculum guide states what the teachers planned for the following week:

Questions were raised last week about the bubbles in the sensory table; the children worked hard at discovering why the bubbles remained in a sphere shape even when a differently shaped bubble wand was used! To continue this investigation, we will be using the bubble solution outside in the sensory table as some of the children thought that perhaps the wind and air might play a role in shaping the bubble.

They planned to do the bubble experiment outside the classroom, at the playground, because some preschoolers hypothesized that the wind and air make a difference in the shape of bubbles. However, since the weather was not appropriate for children to go outside, the teachers had to postpone what they planned to do outside, as the teachers stated in the following week's curriculum guide:

Our bubble work is also continuing. With recent high outdoor temperatures, we limited our playground time last week and so didn't get to do our bubble work planned for outside. We'll be revisiting the children's questions about the shape of bubbles, various sizes, and even colors that can be seen in soap bubbles.

Accordingly, they postponed this activity outside to the following week. As stated in the taxonomy of reasons for doing science, plans related to natural sciences depended on many criteria. One of them was the conditions (e.g., weather conditions).

While the bubble experiments were going on, the weather project continued with a variety of sub-themes and activities. The preschoolers continued calling Time & Temperature & Weather to get information about the current weather. They checked the thermometer on the window daily and the rain gauge when necessary. They had their rain and thunder discussions, engaged with activities related lighting and thunder (e.g., light table, sponge painting, adding lighting to painting), conducted a wind experiment, and added words to the “Sun Shine” book. They also became interested in being meteorologist. In the curriculum guide, the teachers stated:

One interesting experience being offered is using maps and a video camera to explore the role of meteorologists. Several of the children are familiar with meteorologists on television and radio, and are interested in finding out more about the work that they do. This also ties in well with our recent work finding various interesting locations on the globe.

The teachers anticipated that the thread of interest of the preschoolers was doing some pretend play with some roles the weather people do. Moreover, they stated the tie with other curricula (i.e., social sciences). The interest of children in weather was growing in different ways which connected to other topics going on in the classroom, even within the other curricula. This suggests once more strong integration in the curricula.



Figure 4.33. Pretend snow.

Moreover, inspired by pretend cooking with starch at the sensory table, the preschoolers became interested in pretend snow, and the next day the sensory table was set up by the teachers with cornflakes and snow animals (Figure 4.33). It is important to stress here that there is not a straight forward pathway for a single project. As seen in the weather project, wind activity as part of the weather project became an inspiration for a theme: Bubbles; or the cooking project became an inspiration to a theme within the weather project: Snow. In short, the projects were not independent from each other, but connected to each other by theme and timeframe. Different projects within the whole curricula (e.g., natural sciences, art, social studies, and math) were growing and making a *web* together.

In order to make it clear, it is essential to state that the themes and activities within the projects are stated here in an order as if they were separated by a critical event. However, themes under the projects overlapped with critical events. Different themes and

activities within a project were conducted simultaneously in the classroom. Sometimes a project became a provocation and gave birth to another one, or turned into a completely different idea. From an outsider's point of view, it might seem like there was a huge traffic jam in the classroom in terms of the projects. However, the preschoolers knew the rules and inquiry was like traffic lights controlling the traffic. The themes were not fragmented but built upon one another over time, so that everything was smooth, meaningful, and predictable in itself. The preschoolers re-visited their original work and ideas and continued working on the main project simultaneously with the critical event. After critical events, the preschoolers continued refining their original ideas further through new experiences, activities and forms of expression.

In terms of how to decide to end the project or if the project is finished, the teachers suggested a variety of reasons and ways during the interviews (see Figure 4.34). First, they indicated that at the very beginning of the project they may decide to end a project simply because it is not working (e.g., sometimes your experiments do not work). Second, they stated that if the children are not coming to that activity any more, the teachers decide to end it. However, they indicated that before ending a project, they do the following: 1) They help children to revisit their ideas one more time; 2) they check where the thread of interest going through ongoing documentation; 3) they go to community meeting and ask children if they want to continue working on that project. Depending on these, they decide to continue, or to end the project, or choose a different pathway.

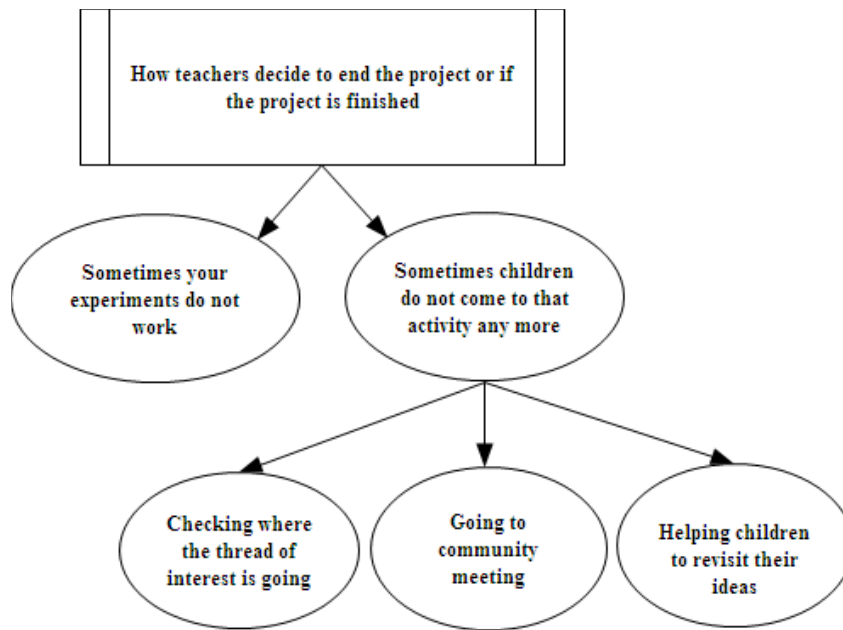


Figure 4.34. How teachers decide to end the project or if the project is finished.

4.2.9 Documentation

Teachers engaged in the documentation of preschoolers' growth and learning (see Figure 4.35). Other than preschoolers' product, or standardized tests or evaluation results, the teachers in the Reggio Emilia-inspired preschool valued and supported children's learning processes, their growth, and their achievements in terms of the quality. In the Parent Handbook, it is stated,

We are focused on process over product. We provide opportunities for children to try out new ideas, to shift backward and forward and to gain satisfaction from the repetition of activities. Through the process of orientation we provide and keep open avenues for: creative expression, the development of mastery/individuality/initiative, the development of a positive self-image as a learner and a doer, and the development of self-understanding and empathy for others through integration of feelings, thoughts, and actions.

The teachers focused on the process the preschoolers went through instead of the product the preschoolers created. When the teachers were focusing on process, they were

responsive to children's individual development, and made decisions on how to support their development based on what the teachers learned through documentation.

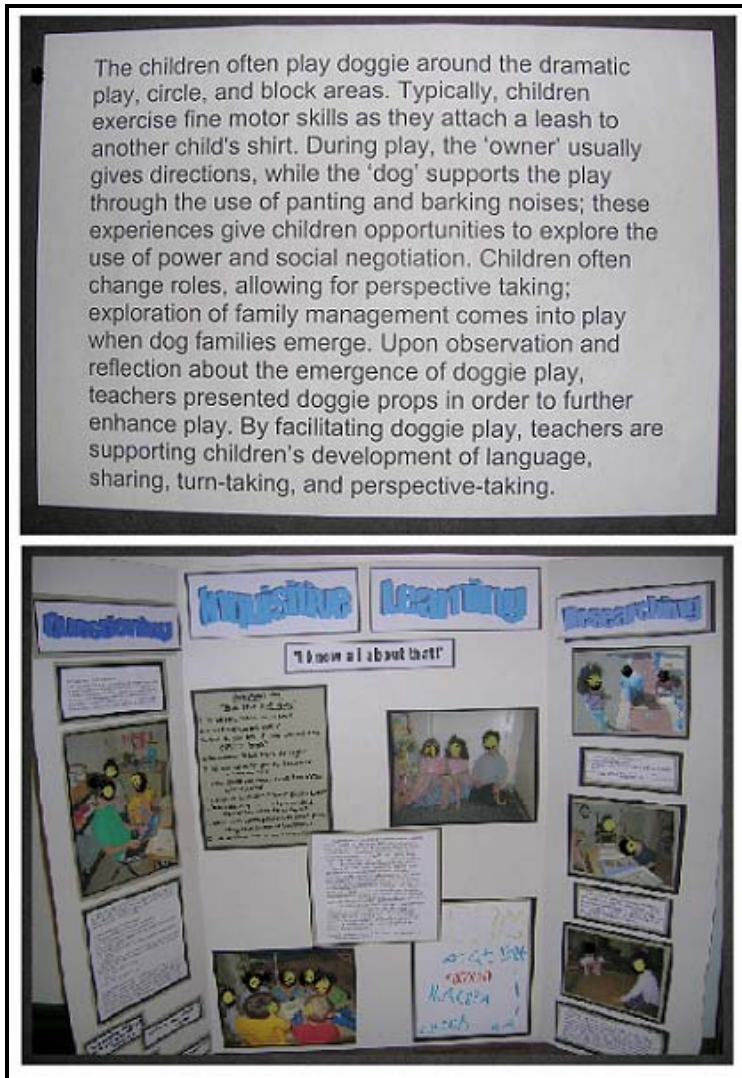


Figure 4.35. Documentation of children's experiences makes learning visible to others.

Teachers made their decisions on curriculum and children's individual development based on their documentation of what they observed in the class. Most of the ideas were born this way as seen many times in the Weather and Growing Things

projects. The excerpt from the earlier interview with Alicia was a good example for this: After the preschoolers' excitement (i.e., Ahh! What happened here?) about the growing seeds unintentionally, the idea of seeds was born and continued for weeks. Documenting the observations about this interest and then including it in the curriculum gave birth to the growing seeds project.

As Alicia stated, "we really look for those teachable moments in our every day interactions with the children and expand on projects from there," following this event, the teachers decided to work on the idea of growing seeds and included this in the curriculum. In the Curriculum Guide, it was stated:

During last week's seminar meeting, the Practicum Student Teachers ("Some-Day Teachers") decided together on three main interests for the curriculum planning that they are now working on. These interests (weather, growing things, and dance/music) were selected based on observing the children's play and conversations, and also on the learning potentials around these ideas. (Curriculum Guide for July 11- July 15, 2005)

It is essential to state that documentation did not end there but continued and shaped the project continually. Once they finalized the following week's curriculum, they continued documentation to gain more insight into the ongoing project and determine possible future pathways of the project.

During the face-to-face semi-structured interviews, the teachers stressed that their documentation is a combination of different things. Kathy, the teacher, stated that it is mostly a combination of children's work, conversations, observations, photographs, the teacher interpretation, the teacher's reflection and sometimes children's reflection. Moreover, the teachers stated that they perform documentation in their classroom in a variety of ways (see Figure 4.36): Taking digital photographs; using a video-camera;

using tape records; keeping anecdotal notes and transcribing conversations of children fast at the process; and keeping work samples. They stated that of those techniques, they favored using a digital camera to take pictures, because they are more fluent with it than with a video-camera, and it is less time consuming and easier to manipulate. In terms of transcribing children's conversations, Alicia indicated that the student teachers create Group and Individual Interest Inventories, "where they'll just take a moment of the classroom and write down these children are engaged in this idea kind of a who, what, where, when."

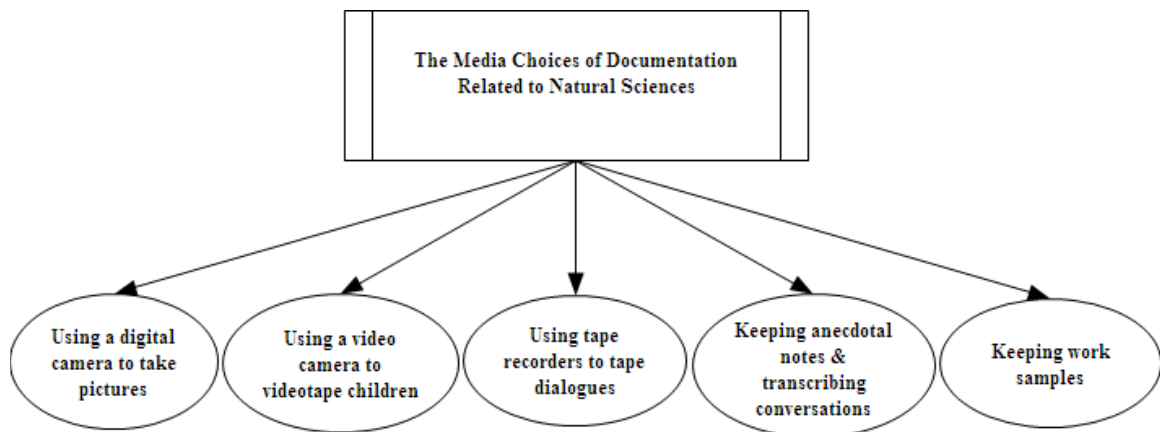


Figure 4.36. The media teachers used for documentation.

In answer to questions about the process and media choices for documentation related to natural sciences, the teachers stated that they work cooperatively with the student teachers do documentation continuously, having both formal and informal staff meetings with each other. The student teachers needed to do eight hours a week in the classroom. During this time, as part of their assignment, they had to do observations

(documentation). The lead teachers and student teachers met with students on Fridays to discuss issues (i.e., what is the thread of interest and where is it going?) about preschoolers. They shared their own observations and brainstormed to find what Kathy called “deeper ideas” in the documentation, ideas not obvious at first glance. This short excerpt from the interview with Kathy gives some information about the function of Friday meetings:

With our practicum students and our graduate students we make up a web - or kind of a list of ideas. And then actually on Fridays, Kathy* and I write down the curriculum guide for the coming week, “guide” being the operative word. Because although we might think “boy, they're really interested in inclines and balls,” maybe it turns into really they're interested in how fast they go. Something might come through further observation. So we're flexible enough to be able to change in the middle of the week. (*name is changed)

The teachers used documentation for making decisions about the curriculum and to support the preschoolers' development of skills.

For documentation, the teachers focused especially on children's play. The short excerpt from the Parent Handbook showed how play facilitated and contributed to documentation in terms of providing rich information to teachers:

Children reveal themselves through play. Consequently, play serves as a communication device through which adults can observe, assess, and plan for each child's development. How they play, with whom they play, and where they play all provide insights into children's developmental levels, growth patterns and unique personality characteristics. Adults use this information to plan and restructure play experiences which will further enhance and facilitate growth and development for each child.

As stated in the excerpt, the teachers looked at their play to gain insight into preschoolers and then used this information to better support their education and growth/development.

They also benefited from displaying documentation of the preschoolers working on projects for others to see. Mary stated, “our documentation makes the learning visible

to everyone and I think that's why we have different ways of showing it." In the classroom and on the hallway, there were many posters that displayed the documentation of children's learning processes. The teachers indicated that they displayed documentation on the panels inside the classroom and in the hall, and presented them at parent meetings as well as sent them home to parents. They also presented their documentation at formal conferences and workshops to the public audience (e.g., NAEYC). Mary cautioned that while they were focusing on displaying their documentation to parents, visitors, and public in general, their documentation unfortunately became more product-oriented sometimes.

4.2.10 The Role of the Environment and Materials

The environment was responsive, not static (see Figures 4.37 & 4.38). For example, the sensory table was being set up by the teachers every day with different themes. As explained in the reasons for doing science, there was always a reason for setting up the sensory with some specific items and the reasons was embedded in either peer culture or school culture or both. The following figures exemplify the changes in the art table and the sensory table.

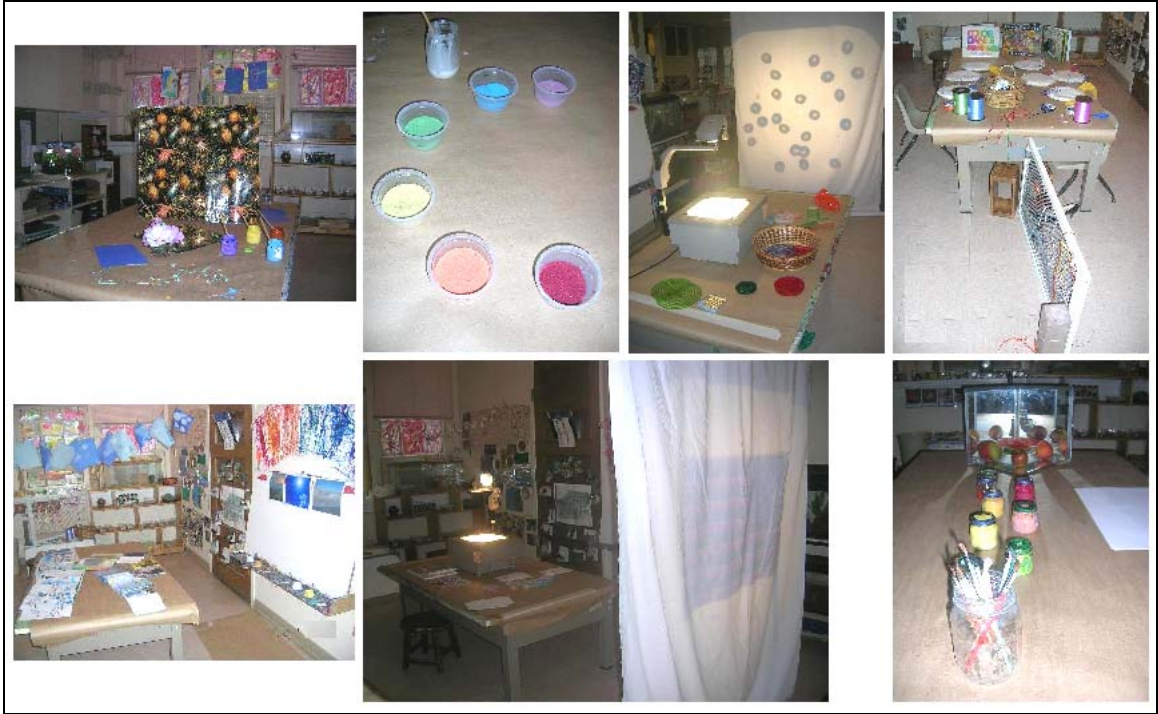


Figure 4.37. Responsive environment: Art table projects occurred over time.



Figure 4.38. Responsive environment: Sensory table projects occurred over time.

Through documentation and good listening to the preschoolers, the teachers made decisions on what would be the next in terms of the new pathway of the projects and the curriculum in general. They prepared the environment and provided the materials and tools accordingly. It can be said that the teachers co-created the essential qualities of the space with the children. In the Parent Handbook, it is stated:

We view one of the tasks of the early childhood educator as being able to assess, monitor, and understand the developmental level of each child and to provide the stimulus and appropriate environment for optimal and continual growth to occur. The Lab school must recognize both the strengths and unmet potentials of each child and provide activities that build upon these competencies and support continued development. We believe the child's active, self-initiated play and exploratory-discovery activities, as well as adult systematic planning and verbal guidance and modeling, are necessary to develop competencies and coping strategies.

It is believed that environment has an important role in the development and growth of children. The teachers prepared the environment to support this and provided a space where the preschoolers could explore and interact with materials (e.g., materials and tools were set up for hands-on experiences to support the curriculum). The environment also encouraged self-initiative (e.g., they made it easy to reach things so children do not have to wait for an adult to hand something). All these qualities of the environment supported one of the principles of the preschool: “Young children learn by using all their senses to explore materials.”

The importance of those materials and tools came from the experiences and learning “possibilities” they provided the preschoolers. The lead teacher Kathy said,

We can make sure that what we do experience together is meaningful, that it matters to the children. So we look for those authentic experiences. The other really important part I think of our approach is to use always, always as much as possible, real things, real materials, real encounters. So it's a real plant, a real

animal. A real - different sources of light. I'll think (inaudible) that we'd use candlelight. I'm pretty sure we're not supposed to have any fire but candlelight is a different kind of light, a focused kind of light. It casts a much different shadow so very carefully we would choose lots of different real things. Encounters for the children.

Instead of simply stating the number of science materials or variety of them in the classroom, the teachers emphasized their approach to using materials and tools and made a careful selection of them among all other things. They meaningfully integrated the materials and tools into the ongoing projects or the curriculum in general.

The teachers were careful about making a thoughtful selection of materials for the preschoolers, taking into account the children's interest and the availability of materials.

The lead teacher, Alicia, said,

It's always working from their ideas, from their interests but it will - we kind of choose the things that we feel have the most potential either for project work or for going a long period of time, or thoughtful use of materials or kind of experiences we want these children to have so we will build upon that interest in a way we see developmentally appropriate.

The emerging interests of the children and the educational possibilities foreseen by the teachers directed the selection of materials and tools, and the arrangement of the environment. At all times, these selections and arrangements remained developmentally appropriate.

Along with a thoughtful selection of materials, the teachers paid much attention to how materials would be presented to create learning possibilities for the preschoolers. In the words of Lella Gandini, "the environment is the third teacher." Kathy said, "It's important that you think about what messages are sent by how things are presented." She said,

We would look at many ways to support learning. It could be an experience and materials thoughtfully presented that we have a specific sort of notion about how the children would use - for representational work or for the experimental work.

Teachers believed that the preschoolers are full of potential and what they need is to be surrounded with challenging materials and tools. Accordingly, the preschoolers were surrounded with things (note: not just things but challenging things) to experiment with, sources to conduct their own research (e.g., internet and books) as well as pets and plants to learn about while taking care of them (e.g., Poptart – the guinea pig, banana peppers and tomato plants).

Teachers set up the environment in a way to encourage children to conduct investigations. They aimed to provoke children's inquiry about the world so by providing "provocative materials and tools" and a chance to explore freely. In the Parent Handbook, the teachers also stressed the importance of free play and adult guidance after providing a supportive, challenging environment:

We believe our school must provide a stimulating environment where children are free and encouraged to engage in a variety of play experiences. An array of attractive, sturdy, and well-designed equipment and materials must enhance the physical environment to invite curiosity, imagination, investigation, cooperation, and discovery. Although play is the major vehicle for learning, adult guidance, support, and direction are needed to stimulate further curiosity and growth, to encourage participation in activities which will strengthen development or enhance particular skills, to help children solve problems or discover new solutions to old problems, to help children make reasonable choices and to act on these choices, and to help children evaluate their thinking and plan further action. (Parent Handbook)

Environment, adult support, and free play— all those worked harmoniously. None of them interfered with the other one. The preschoolers were exposed to challenging

situations through the carefully arranged environment, free to play and explore their surroundings with joy, and provided the security and enrichment of adult guidance.

4.2.11 Summary for Question 2

How does the science constructed in this classroom reflect the Reggio pedagogy?

After simply clarifying what “being-inspired” means, the phrase “Hundred Languages of Children” and Reggio principles (the image of the child, the role of the teacher, education based on relationships, inquiry-based education, progettazione, documentation, the role of the environment and materials) were discussed through using the whole data set and the principles of the Reggio Emilia-inspired preschool. The analysis of the data shows a strong reflection of the Reggio Emilia approach in this preschool classroom. Especially the teachers’ images were of the child being very strong and intelligent. The “Weather” and the “Growing Things” projects are chosen to discuss Reggio principles in-depth, and to examine the deep questioning and group learning that went on.

Teachers saw preschoolers as young scientists, who inquired about the world, asked questions, and then actively and collaboratively applied science processes in various ways (e.g., observing, taking care of some pets/plants). In this classroom the children’s inquiry always took priority and was appreciated by the teachers. Teachers believed that inquiry discourse contributed to children’s learning and constituted the base for making sense of the world (Lindfors, 1999). Inquiry shaped the actions of the teachers (e.g., how they planned the next day’s curricula) within the lines of peer culture and school culture. As using language was very important in this class, teachers used science terms (e.g., experiment, temperature, and thermometer) in their daily language.

4.3 Third Layer of Analysis: Early Learning Content Standards [ELCS]

In this layer of analysis, the third research question “*How does the science constructed in this Reggio Emilia-inspired preschool classroom address the science standards?*” is answered through utilizing the whole data set. Science experiences and applications in the Reggio Emilia-inspired preschool classroom are compared and contrasted with preschool science standards, specifically ELCS of Ohio (ODE, 2004; see Appendix C). Moreover, the perspectives of the teachers and their attitudes toward standards are examined utilizing the interview transcripts. It is seen that the Reggio Emilia-inspired preschool classroom in this study met and even exceeded the pre-K standards for natural sciences although the teachers did not directly aim at meeting standards.

After giving examples of how the richness of many projects satisfied science standards, the Growing Things project is analyzed in more detail. Specific, in-depth information selected out of the whole data set and considering each subgroup of science ELCS standards. The subgroups are: *Earth and Space Sciences*, *Life Science*, *Physical Sciences*, *Science and Technology*, *Scientific Inquiry*, and *Scientific Ways of Knowing for Early Childhood*. Each subgroup(s) of ELCS was successfully satisfied by the projects looked at here, and some of the science standards for preschool-aged children were even exceeded. In Figure 4.39, each project (i.e., Weather, Rolling Balls, Growing Things, Space, Color, Poptart, Magnets, Bugs/Insects Habitat, Animal Family, Shakers, and Cooking) is presented along with how it helps fulfill specific subgroup(s) of standards.

THEMES*	EARLY LEARNING CONTENT STANDARDS [ELCS]
WEATHER	>Earth & Space Sciences (e.g., worked on rain, rainbow, wind, sky, temperature, changes in weather) >Physical Sciences (e.g., worked on colors in rainbow) >Science & Technology (e.g., used light box and light table to look at transparent pictures and explore weather; used a rain gauge to measure rain and a thermometer; used things like cookie cutters to blow into and used soap to make bubbles; used straws or a fan to blow like the wind) >Scientific Inquiry (e.g., asked questions about how rainbows happen) >Scientific Ways of Knowing (e.g., did sponge painting of clouds to express ideas, did exploration with others)
ROLLING BALLS	>Physical Sciences (e.g., used tubes to roll balls fast and slow, compared light/heavy and large/small balls, constructed a ramp for rolling marbles) >Scientific Inquiry (e.g., explored light/heavy balls) >Scientific Ways of Knowing (e.g., did exploration with others)
GROWING THINGS	>Life Science (e.g., discussed needs of plants and seeds) >Earth & Space Sciences (e.g., worked on soil, sun, changes in the environment like falling leaves or growing things) >Science & Technology (e.g., used shovels to dig plants into dirt) >Physical Sciences (e.g., sorted seeds by shape/color, worked on color of fruits/seeds) >Scientific Inquiry (e.g., explored how seeds grow) >Scientific Ways of Knowing (e.g., being careful about not to break plants, did exploration with others)
SPACE	>Earth & Space Sciences (e.g., worked on space and planets) >Science & Technology (e.g., used the overhead projector to project images; used wire, aluminum, shiny foam boxes, shiny tubes, and foam to make spaceships) >Scientific Inquiry (e.g., wondered about spaceships) >Scientific Ways of Knowing (e.g., did exploration with other preschoolers)

*Some of the themes during one month period of participant observations.

Continued

Figure 4.39. Projects and standards.

Figure 4.39. continued.

COLOR	>Physical Sciences (e.g., worked on color of fruits, color spectrum) >Science & Technology (e.g., used paintbrush, sponge, and straw to paint, chalk and charcoal to draw; used computer to paint; used crystal towers, light table & puncher) >Scientific Inquiry (e.g., asked how to make orange) >Scientific Ways of Knowing (e.g., offered ideas through conversations, and paintings)
POPTART	>Life Science (e.g., discussed needs of Guinea pigs) >Scientific Inquiry (e.g., worked on the features of Guinea pigs and babies) >Scientific Ways of Knowing (e.g., became helpful and considerate toward Poptart, did exploration with others)
MAGNETS	>Physical Sciences (e.g., picked up objects with magnets) >Scientific Inquiry (e.g., worked on what it sticks, what not) >Scientific Ways of Knowing (e.g., did explorations with others)
BUGS/ INSECTS HABITAT	>Life Science (e.g., explored needs of toads; discovered differences between insects and spiders) >Scientific Inquiry (e.g., inquired about what insects are, what bugs are) >Scientific Ways of Knowing (e.g., offered ideas through conversations and drawings; were careful not to harm them; did exploration with others)
ANIMAL FAMILY	>Life Science (e.g., worked on young and grown family members of lions/doggies) >Scientific Ways of Knowing (e.g., expressed ideas through pretend play; did exploration with others)
SHAKERS	>Physical Sciences (e.g., explored changes in the quality of the sound) >Science & Technology (e.g., used scissors while making shakers; used computers to play with sound) >Scientific Inquiry (e.g., worked on how to make soundless shakers) >Scientific Ways of Knowing (e.g., did exploration with others)
COOKING	>Science & Technology (e.g., used measuring spoons to measure ingredients; used cooking utensils to make banana bread) >Scientific Ways of Knowing (e.g., did exploration with others)

As seen from the figure, every subgroup of science standards was covered successfully within various projects during such a short period of participant observations. In one month, the preschoolers met more than one science standard indicator in all of the following: Earth and Space Sciences, Life Science, Physical Sciences, Science and Technology, Scientific Inquiry, and Scientific Ways of Knowing for Early Childhood. Even when the emphasis of each project might have been one subgroup of ELCS science standards (e.g., Growing Things project: Life Science standard), other subgroups were often satisfied as well. The preschoolers met and even exceeded the ELCS standards for natural sciences through quality science experiences in the Reggio Emilia-inspired preschool classroom. The weather project can be given as an example for this.

The ELCS pre-K standards indicate that “preschoolers should be able to observe and use language or drawings to describe changes in the weather (e.g., sunny to cloudy day).” In the Reggio-inspired classroom, children pursued their interests in weather extensively and intensively (see Figure 4.40). For instance, they observed the weather daily, called Time & Temperature & Weather, checked the rain gauge and the thermometer when needed, painted different clouds and thunderstorm pictures in the art studio, read weather books, experimented with the wind, played with pretend snow at the sensory table, and expressed their ideas on weather in various ways (e.g., circle time discussions). As a result, the children not only observed and used language, but they also became interested in the weather, actively engaged with it, and gathered data and looked for patterns in data.

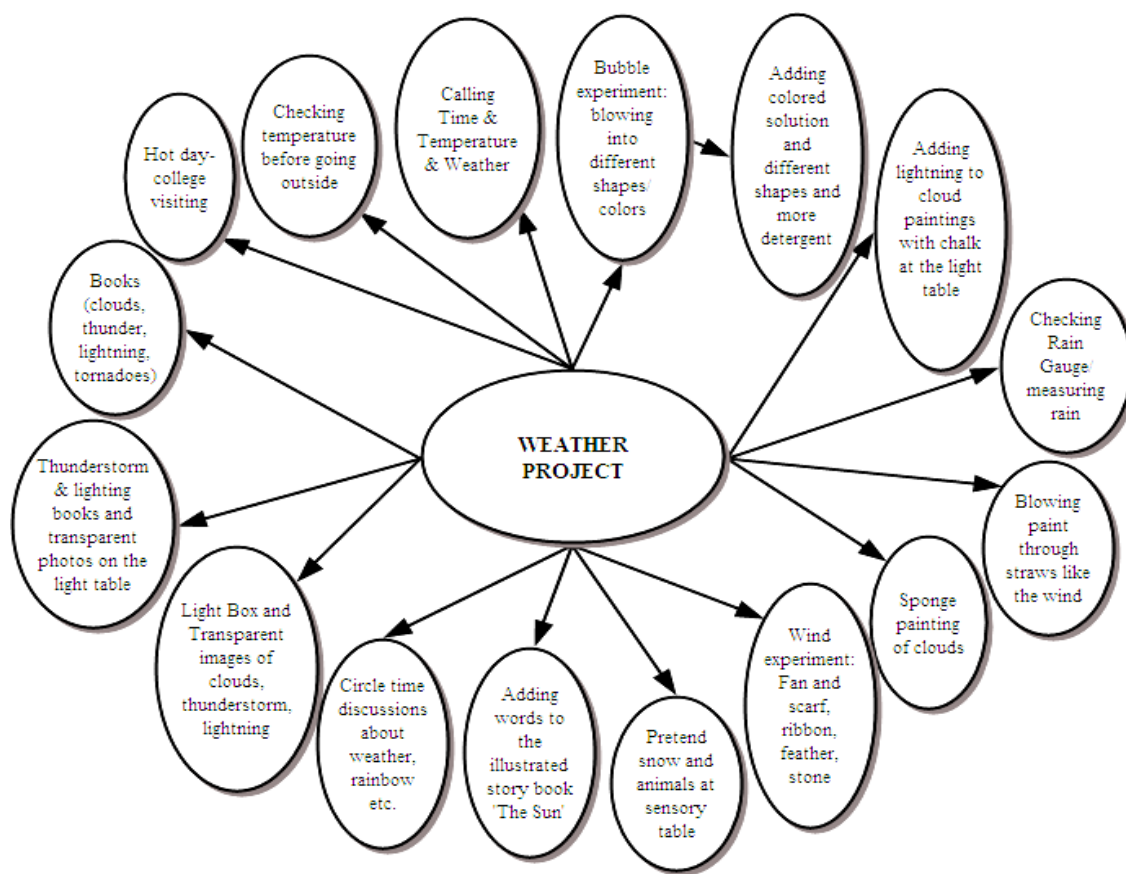


Figure 4.40. The Weather project.

The activities in which the preschoolers were engaged were consistent with the ELCS for pre-K and content learning standards for Grade 2. For example, in ELCS, one of the Earth and Space Sciences standard indicators is “describe weather by measurable quantities such as temperature and precipitation.” The preschoolers in the current study actively worked on measuring rain by the rain gauge and temperature by the thermometer many times over weeks (Figure 4.41). They were able to measure rain and temperature. They were also capable of using science language and frequently engaged in long discussions about science issues such as this:

Kathy : It is not going to snow today. But we did call OSU forecast. We looked at our thermometer in front of the window. Does anybody remember what the temperature is?

Children: 80

Some children: 90

Kathy : That's the forecast, they said that it might.

Richard: It is gonna be 90 degrees.

Kathy : It is 90 degrees, it is true.

Many of the children are speaking at the same time.

Kathy : If you want to add something, please raise your hand, because if we all sound together, the words are coming out, and they are all getting mixed up. Jen?

Jen : I say 90 degrees.

Kathy : 90 degrees?

Adam : If we can (inaudible) we can into the courtyard or vote.

Kathy : That's true.

Ciara : Or we can vote or go to courtyard.

Mark : I have a thermometer on my window. And guess what?

Kathy : What?

Mark : It says it gonna be 60 degrees.

Kathy : When you were at your home, it was 60 degrees?

Mark : It was raining.

Kathy : When you were at your home, is this thermometer in your kitchen or in your backyard or in your bathroom. Where do you look to see the thermometer?

Mark : Window.

Kathy : At a window? But where in your house?

Mark : In the kitchen.

Kathy : In the kitchen? OK. Let's figure that out if it says 60 degrees when you are in your kitchen, and our thermometer says 90 degrees...

Mark : Oh yeah! My thermometer says 90 degrees.

Kathy : It did?

Adam : Mine too.

Kathy : You wanna check with your moms, your dads, people in your house about that. How about that? We can write down, go home tonight and check and see if you have a thermometer at home you can look at. You might have one that tells about inside temperature and the outside temperature.

Megan : I have one; I have one in our kitchen.

Kathy : You do?

Megan : Table. Me and Amy measure temperature outside and then measure temperature inside and then time (inaudible)

Kathy : OK. Sometimes people have control on their world somewhere, where they control their air conditioning and furnace, well that might save the temperature in your house.

Ciara : What are you talking about?

Kathy : I am talking about mis (inaudible) usually when you have a furnace and an air conditioner in your home, there is something somewhere on your wall and it tells you what the temperature is.

Ciara : What size is this and what shape is this?

Kathy : It is usually rectangular and -

Ciara : I think I have one.

Kathy : You might have one like that.

This conversation suggests that the preschoolers in the Reggio Emilia-inspired preschool classroom understood the measurement of temperature and the tool used to measure it.

The conversation also suggests that the preschoolers could use the weather-related terms properly. They could engage in discussions about weather meaningfully and share their experiences and ideas with others.

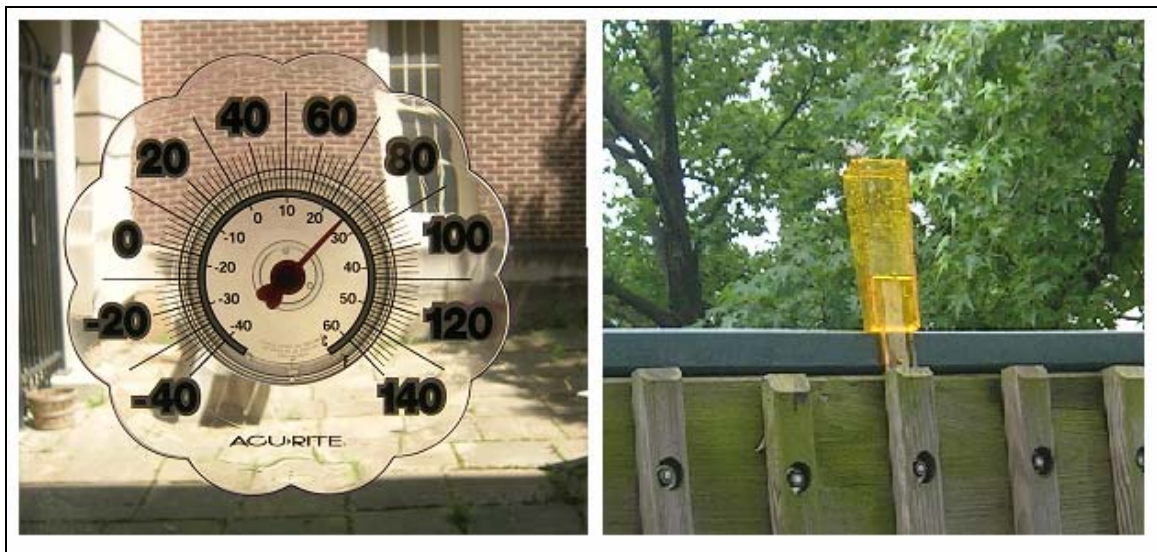


Figure 4.41. Thermometer and rain gauge.

The important thing is here, the standard (Indicator: describe weather by measurable quantities such as temperature and precipitation) was aimed specifically at *second-grade students*, but the preschoolers successfully and easily met it in the Reggio

Emilia-inspired preschool classroom. This might be an indicator of how successfully the preschoolers in Reggio program achieve the standards and even met higher grade level standards in a meaningful way.

To understand how the science constructed in the current preschool classroom addressed the science standards, it is essential to examine one project more in-depth.

4.3.1 Growing Things Project

During the Growing Things project, the preschoolers successfully met the related ELCS standards for pre-K natural sciences. In addition, activities or events related to this project are presented and related to subgroups of ELCS standards, namely, Life Science, Earth & Space Sciences, Physical Sciences, Science and Technology, Scientific Inquiry, and Scientific Ways of Knowing for Early Childhood.

In Figure 4.42, several pictures from the Growing Things project activities are presented. In short, Picture 1 represents the event of cutting a cantaloupe at lunch, examining the inside and saving seeds for a seed collection. Picture 2 represents the activity of planting peppers and tomatoes by the gazebo on the playground. Picture 3 represents reading books about seeds and plants, as well as planting and watering lettuce and parsley seeds. Picture 4 represents the seeds chart that the preschoolers created by sorting and counting seeds. Lastly, Picture 5 represents drawing sunflowers and Gerber daisies at the light table. Including those, some activities and events are analyzed and compared with related science standards. In the following, one example event/activity is presented for each subgroup of pre-K science standards, accompanied by a relevant benchmark and an indicator. The benchmark states what all students should know about, and the indicator is a checkpoint to monitor students at each level.



Figure 4.42. Growing things project.

Standard: Life Science for Early Childhood

Benchmark: Discover that there are living things, non-living things and pretend things, and describe the basic needs of living things (organisms).

Indicator: Identify common needs (e.g., food, air, water) of familiar living things.

The preschoolers were able to identify common needs of familiar living things. For example, they discussed what plants need before planting the banana peppers and tomato trees by the gazebo on the playground. With help of the teacher, they read the directions from the little paper attached to the trees. They concluded that they need dirt, sunshine, and water. They understood the needs of plants and also commented on them. Here is an example dialogue between a teacher and a child about what plants need:

Kathy is reading the direction about *how plants grow*. Kathy says that they need sunshine and water or rain to grow.

Richard: *I did not even bring my shovel.*

Kathy : Oh we got shovels; we have a lot of shovels.

Richard: I have a shovel, but I did not bring it.

Kathy : Oh! (Reading another direction) This says these are sweet peppers.

Richard: Sweet peppers?

Kathy : Yeah! Look at those. And it says that they need to have sunlight.

Andrea has joined them and started listening to the directions.

Richard: *There is no sunlight in here.*

Kathy : Yeah! There is no sunlight in here, we've got to get those outside. It says, we are supposed to water it two times a week. And it says, it needs to have a (inaudible) space, and it takes about two months before you can pick the peppers.

Kathy : Now let's take some soft dirt and shovels to our playground.

Richard: *This one is like a baby pepper tree.*

Kathy : Yeah! Look at those, tiny peppers. This one is a little bigger. This one, Andrea, is almost like a leaf. This one is a little bigger; this one is a little bigger. And this one is a different shape, isn't it?

Richard: Is that a pepper?

Kathy : Yeah! Do you know what is growing here?

Richard: What?

Kathy : Look. (Looking at the picture)

Richard: Tomatoes.

Kathy : Yeah. Looks like tomatoes are on the picture.

Kathy is pointing the tomato plant, saying “this plant does not look like having lot of leaves, so I am thinking that it needs to be outside and some soft dirt and some sunshine.

Richard: *Yes! Because this one has a little bit leaves falling out.*

The dialogue shows that Richard was not only aware of what plants need, but he was also able to comment on the consequences if their needs are not met (i.e., leaves falling out).

The preschoolers understood the needs of plants, and also actively engaged with the work of providing for those needs (see Picture 2 & 3). In short, they planted trees and seeds into dirt and watered them. They also provided sunshine by planting trees on the playground outside or by putting seeds under the light inside the classroom. While Kathy, the teacher, was bringing their attention to the needs of plants by reading care directions, she was also helping them understand the different appearances of plants, the function of water and rain, the growth of plants in time, and some use of peppers/tomatoes after they grown (e.g., making salsa).

Standard: Earth & Space Sciences for Early Childhood

Benchmark: Observe, describe and measure changes in the environment, both long term and short term.

Indicator: Explore and compare changes in the environment over time (e.g., leaves changing colors, outdoor temperature, plants growing).

The preschoolers understood that plants grow over time. The excerpt from the conversation between a child and the teacher was interesting.

Kathy : Another idea is how things grow. Remember, we have planted those flowers on the playground. Have you noticed that they are getting bigger, bigger, bigger?

Richard: They are growing taller.

Kathy : Oh they are.

Richard was aware that plants get bigger in height and comment on it upon teacher's statement of that plants getting bigger.

In general, the preschoolers became aware of how plants grow as they engaged in exploratory activities and helped care for them. The preschoolers actively and collaboratively explored plants growing over time. First they planted flowers at the playground. Then they became surprised by seeing unintentionally planted seeds growing in the sensory table and started working on seeds. They then planted lettuce and parsley seeds as well as tomato and banana pepper trees. They observed them growing and also provided what they need as part of their classroom responsibilities (e.g., watering two times a week). In short, they actively participated in growing things and had some responsibilities. In the Curriculum Guide, the teachers summarized their activities and plans as follows:

We have a new small vegetable garden growing on the playground, too! We planted tomatoes and peppers close to the flower boxes near the entrance of the gazebo; we will be researching the needs of these particular plants and caring for them over the next several weeks in the hopes that we will soon be able to use these vegetables in snack-maybe making our own salsa!

As stated in the guide, the teachers planned to conduct research on growing things in which the preschoolers could take an active role. The other important thing is that since the Reggio Emilia-inspired preschool program was project-based, the Growing Things research did not end after just planting and observing growth, but continued in a meaningful way (e.g., eating those vegetables), just as it was started in a meaningful way (i.e., spring came & children inquired about in seeds). The preschoolers learned about things step by step, within a meaningful context, in a coherent and fun way.

Standard: Physical Sciences for Early Childhood

Benchmark: Discover that many objects are made of parts that have different characteristics. Describe these characteristics and recognize ways an object may change.

Indicator: Sort familiar objects by one or more property (e.g., size, shape, function).

The preschoolers engaged with sorting a variety of things. One of those things was seeds. They understood that peppers, cantaloupe, melon, cherries and some other fruits and vegetables have seeds inside. They explored vegetables and seeds in various ways (e.g., predicting what is inside peppers, cutting fruits and painting representations of them), and made a collection of seeds. In the Curriculum Guide, the teachers stated their plan with sorting and collecting seeds as follows:

In support of our upcoming work exploring how things grow, we've begun a seed collection. So far we have seeds from a cantaloupe, a few watermelon seeds, and some from apples at lunch time. As we encounter other things with seeds inside we'll keep adding to our collection. Eventually we hope to have a collection that would support many experiences such as sorting, counting, comparing and of course planting!

As stated in the curriculum, in the following days the teacher tried to expand the preschoolers' experiences with seeds to charting and counting seeds.

Kathy also brought up the topic at the circle time discussion. The following excerpt from the transcripts shows that Kathy introduced children to the activity table set up with seeds and some materials to make a seed chart. She pointed out the growing interest of children in seeds and explained the planned activities with seeds, specifically charting seeds and counting along with the "One Bear, Two Bears" book.

Kathy : John became interested in cherry seeds when he was eating yesterday, and we washed those seeds, from inside of cherries. They are over there. We have

some seeds from the melon, the orange one, they are over there. I think we have other kinds of seeds, too. So, we were wondering if you would like to try to make a chart that is about counting but also that's about those seeds.

The teachers helped the preschoolers engage with saving seeds of different vegetables and fruits, and then sorting, counting, and comparing them. As evidence shows, all the activities/events were connected to each other and even with other disciplines (e.g., math-counting). The project approach provided the preschoolers with an opportunity to engage with science in a smooth, natural, coherent way, such as saving seeds from what they ate at snack time and then drying and charting those seeds according to number and common characteristics (see Picture 1 & 4).

Standard: Science & Technology for Early Childhood

Benchmark: Explain that to construct something requires planning, communication, problem solving and tools.

Indicator: Use familiar objects to accomplish a purpose, complete a task or solve a problem (e.g., using scissors to create paper tickets for a puppet show, creating a ramp for a toy truck).

An environment set up with some materials and tools was very important in the Reggio Emilia-inspired preschool, considered a provocation to children's inquiry. The teachers always encouraged the preschoolers use objects in familiar ways as in creative ways. Using shovels to plant trees or seeds into dirt can be given as an example for this standard. The preschoolers had a purpose in using the shovels and accomplished the mission of digging dirt and planting trees/seeds successfully. They knew the function of the shovel and made use of it easily and properly.

Moreover, when the preschoolers were looking at flowers and doing some painting, they used the light table, another example of using technology in science. They were utilizing the light while drawing. The light was provided by the teacher to add another dimension to the project and to contribute to children's creativity while drawing and painting (see Picture 5).

It is essential to state that the safety of the children always had priority and teachers carefully monitored the preschoolers' use of materials. For example, when it was needed, the teachers used the knife to cut vegetables and fruits (e.g., "cutting peppers to see the inside") but did not let the preschoolers cut. Safety measures allowed the preschoolers to interact with technology as part of their science education but in appropriate ways: they learned to identify and benefit from technology without endangering themselves.

Standard: Scientific Inquiry for Early Childhood

Benchmark: Ask a testable question.

Indicator: Ask questions about objects, organisms and events in their environment during shared stories, conversations and play (e.g., ask about how worms eat).

Provoking inquiry and encouraging children ask questions were always one of the main purposes of the teachers in the Reggio Emilia-inspired preschool classroom. As discussed throughout the study, the preschoolers inquired about things all the time (see Figure 4.43). The teachers helped the preschoolers to follow their inquiries and to actively engage in science and work collaboratively. For example, the excerpt from a

Curriculum Guide states that the preschoolers inquired about how plants obtain their nourishment:

The children are very interested in roots and how plants and vegetables obtain their nourishment. To this end, we will be conducting some experiments throughout the week where carnations and/or daisies are placed in colored water so that we can see the effects. This experiment may also be done with celery.

As stated in the excerpt, the teachers planned to do a carnation experiment with colored water upon children's interest in and inquiry about how plants obtain their food.

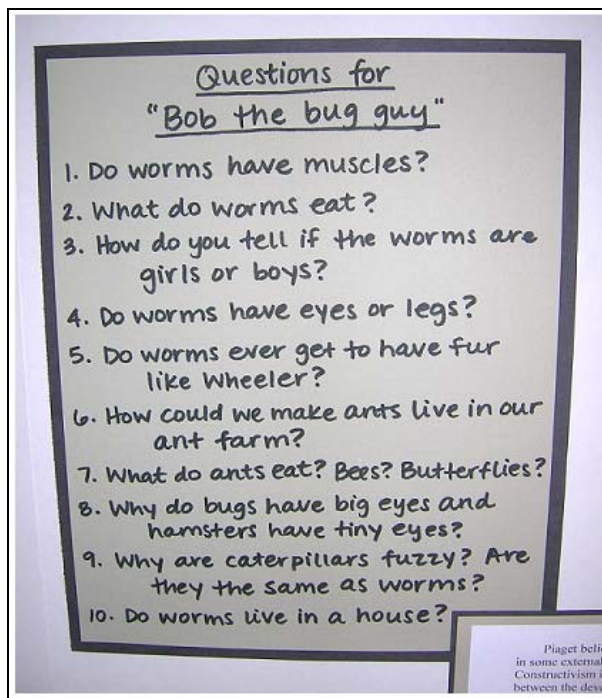


Figure 4.43. Documentation on the preschoolers' questions on insects and worms.

The work of seeds also started with preschoolers' inquiry about how seeds could grow at the sensory table even though they did not mean to plant them. Upon this question, a journey with seeds began. The preschoolers were not only involved in

planting some seeds to observe how lettuce and parsley seeds grow under light (see Figure 4.42 – Picture 3), but also some other activities, such as making predictions about how red, green, and yellow peppers will look when they cut them open. As another example, they looked at brightly-colored fresh, half fruits as a provocation for working with various paints, as stated in the Curriculum Guide:

We have been painting representations of fruits using colors we mixed to match the skins. In further support of our research surrounding growing and gardens, we will be cutting some familiar fruits open to make appropriately colored prints in the studio. In addition to apples and pears, we will also use some uncommon fruits for printing such as star fruit.

In short, upon their inquiries about seeds, the preschoolers were engaged in a variety of activities related to natural sciences; they examined the insides of various vegetables and fruits and worked with seeds in various ways.

It is essential to state that asking questions is one indicator for pre-K science inquiry standards, but conducting investigations is an indicator for *Grade 2* science inquiry standards. In ELCS, it is stated, “Explore and pursue student-generated ‘how’ questions” for Grade 2. In the Reggio Emilia-inspired preschool classroom, the preschoolers did more than just ask questions and inquire about things on the world, they actually engaged in science through explorations and hands-on investigations as long as their interest and learning opportunities lasted. After they inquired about seeds and asked questions like “how come seeds grow in the sensory table even though we did not mean it,” they conducted hands-on investigations on seeds and plants, worked in groups or individually, searched out sources (e.g., books), used science process skills (e.g., predicting, observing, counting, sorting) and represented their ideas in various ways (e.g., painting, discussing, and drawing).

Standard: Scientific Ways of Knowing for Early Childhood

Benchmark: Recognize that diverse groups of people contribute to our understanding of the natural world.

Indicator: Participate in simple, spontaneous scientific explorations with others (e.g., digging to the bottom of the sandbox, testing materials that sink or float).

In the Reggio Emilia-inspired preschool classroom, the preschoolers frequently participated in simple, spontaneous explorations with their peers and teachers, in projects like Rolling Balls, Magnets, and Bug/Insect Habitats as happened during the Growing Things project. For instance, during the Growing Things project, they shared the work of planting banana pepper and tomato trees by the gazebo and planting seeds into the boxes together. They took turns, worked cooperatively while planting and watering the trees. Their explorations were not necessarily simple but, they grew more complicated over time.

The preschoolers were very curious about things, and the teachers gave them a chance to do their own investigations. Moreover, the teachers encouraged them to be considerate toward living things. For instance, before planting banana peppers and tomato trees on the playground, the preschoolers wanted to explore the trees. The excerpt from the conversation among Anne, Megan, and the teacher, shows that the preschoolers had hands-on and minds-on explorations while being gentle toward living things.

Anne and Megan are looking at the tomato and pepper plants. They are touching peppers.

Megan: Look at these peppers!

Kathy : I know. Look at these peppers. Treat those very, very gently. That is a real life plant. If you see it outside, it is not ok to hurt them.

Megan : What's this? (Pointing at the dark green pepper)

Kathy : What do you think it is?

Megan : I do not know.

Kathy : We need to get a gardening book and look and see. We have to do some research.

The preschoolers were wondering about what they were and wanted to touch them. They were also gentle so as not to break or hurt the trees. The teacher, Kathy, reminded them that those are real plants and guided them to conduct research using some sources, such as books, to answer their inquiries about plants.

In short, the preschoolers participated in spontaneous scientific exploration with their peers and teachers very frequently and met standards' objectives successfully.

4.3.2 Reggio Emilia-inspired Teachers' Perspectives on Standards

The results derived from the data set shows that the Reggio pedagogy, grounded in inquiry, is very compatible with science education goals and standards for preschoolers. On the other hand, Mary, the teacher, stated that they are not mandated by standards. She said, "We have used the Ohio Pre K standard for - we have used them to look at our curriculum and kind of check our curriculum. We aren't mandated yet by the State of Ohio to follow the Pre-K standard."

Although they were not mandated, they utilized standards in various ways. To understand the place of standards in the Reggio Emilia-inspired preschool program and to get multiple perspectives, the researcher also interviewed teachers about how they benefit from the pre-K standards and whether those standards are compatible with the Reggio Emilia Approach. The results were intriguing. Although they did not really target meeting them, they met and even exceeded the standards for pre-K. They explained why they do not target the standards and stated some mistakes people might make if they directly target standards.

Upon the question of how the Reggio Emilia-inspired teachers benefit from the pre-K standards and whether the standards are compatible with the Reggio Emilia Approach, the teachers indicated that it is very compatible and can even lead children to exceed the standards for pre-K.

We meet or exceed - in most cases, exceed. Kathy and Alicia were working on these the other day and they realized all of a sudden that they were looking at the second and third grade standards and all of those were being met in our classrooms and our curriculum is so well integrated that the standards are being met in multiple areas at one time. So we feel very confident that our work is meeting the standards. (Mary)

Of course they are compatible. It's very compatible. Uh - and yes we're very tuned in to those standards and when you look at our work, and we make the connections between the work that we're doing and those standards. It would be the indicators, the pre-K indicators that we pay close attention to. What we're careful to not have happen is that *we don't let our curriculum be driven by those*. We reflect in a way that makes sure that those - that those standards are in our heads and then over that long period of time that we have the children that we are satisfied that *we're doing a good job of setting the stage for their later experiences*. That's different than looking at this time as all about preparation for something else. This isn't a time of life to just get ready for something else. It isn't a time to get ready for school. *It is school!* They are learning. They're learning more and faster than everyone. So we look at this kind of like as precious - as each day is precious and that we have to make sure that we do the best we can do to make their time with us meaningful and then we sort of back (inaudible), and make sure that through that process that we haven't neglected to touch on any of those standards. We do not. *We do all them and beyond. Yet very compatible but we would want to not lose sight of that authentic, deeper, life together and not let it be driven by the standards.* (Kathy)

Kathy and Mary stated that their work is very compatible with standards. Kathy explained that they keep the standards in mind, carefully making sure they are setting a stage for later experiences. One of the important points she stressed was that they do not create the curriculum based on the standards. In other words, standards do not drive the curriculum, because this would take away from the authenticity of the work, meaningful experiences, and in-depth understanding in science.

Kathy also indicated that preschool is not seen as preparing children for school, rather it is school and children are learning. In that sense, she stressed the importance of standards in their education in terms of setting more challenging goals and experiences for later stages.

Similarly, Alicia indicated that the standards do not drive the curriculum and said, “We’re not married to the standards.” She gives the Poptart experiment as an example for inquiry-based education instead of standards-based:

The Poptart experiment wasn't just something I imposed on them and made them do. It was sort of driven by the children and by their interests - they could remember it, revisit it... Reflect on it and then use it in a different way, build upon it- so it's very effective and useful for them. Not just to think of ways to get through the science standards. So we're going to do this and that will be it. We want them to be able to use the information they gained and the knowledge that they gained and be able to explain it to other children. (Alicia)

Alicia indicated that they do not meet standards by imposing ideas on children. This supports Kathy’s valuing of the authenticity of the work, meaningful experiences, and in-depth understanding in science. In short, the teachers suggested that children’s inquiry, interest, and needs – not the standards - drive the curriculum.

Alicia also stressed the importance of individual children’s needs, which standards do not consider. The excerpt from the interview with her states the importance of forming specific goals for each child:

I think [we] trust our own knowledge of child development and also our knowledge more importantly of the individual group of children. So we might discuss this individual child needs more fine motor time. This individual child needs work with identifying colors or being able to articulate ideas (inaudible). So we might have an individual goal for a child and then make sure that they engage in some choice in the classroom that builds upon that.

Standards are accepted limits of typically developing children's capability of doing something and capacity of understanding something so that the indicators do not refer to each individual child's needs. In this sense, stepping out of standards and identifying individual goals for each child is very essential.

Alicia states that the preschoolers are already achieving the standards because of the way they do science in their classroom. An excerpt from the interview with Alicia states those points:

We certainly do not look at the ODE standards and say we really need to have a (inaudible). Here's this indicator, this pre-K indicator of knowing that nights - day goes into night. So we need to have it in there on day into night. We trust that in our conversations, our daily conversations and our interactions with books, and in the classroom that they're going to gain that... they're nothing that I think is developmentally inappropriate or too hard for children. I think the danger in all standards comes when people teach to them and use that to guide their curriculum. So it's not something that we don't believe in or that we don't think are helpful or true or good. It's just that we don't let them drive the curriculum. I know I can trust that the children in our school will know these things and we'll have lots of experiences with them. We will have this kind of language to build upon again further and further in their educational processes. (Alicia)

She suggests that standards are very easy to accomplish because they are developmentally appropriate. On the other hand, she cautions teachers of the danger of driving the curriculum based on standards and losing what makes work meaningful for children.

Alicia also explained the assessment method they use in their classroom, called "Focus observation method," instead of using indicators as an assessment. The excerpt from the interview with Alicia describes the method and how the teachers benefit from it:

We are working on the document where we have - for many years our assessment tools with a focus - we called it a focus observation and it was divided into social, emotional, cognitive and physical/motor and we had kind of indicators that we

ourselves looked for. Right now to make this visible to other people we are going back through the indicators and plugging them into what we already use and really what we're finding is... So the document we use for assessment is our own just focused observation method. I can certainly give you a copy of that. And we update that almost quarterly with the children. Sometimes it can get repetitive. Again we know these children from sometimes birth to 5 1/2. Sometimes they come from the community at 3. And so we will know them for 2 1/2 years. So it might not be something we - the huge - I wouldn't say each quarter she continues have a friendship with these di di di. We plug into this assessment photos- it's all digital so photos, work samples from the children, their dialogues, those things that I just told you we use for documentation are all digital so we can plug them into this assessment tool as well and then also I can use that to say boy, I really need to get this child more chances to use bicycles or gross motor things - they're needing more in that area and I can offer that in the curriculum. So while we're aware of the standards, certainly very familiar with them and well-versed with them. They don't drive our curriculum. The children's ideas drive the curriculum. (Alicia)

Alicia stated that they use focused observation for assessment instead of indicators and explained that they create Focus Observation through documentation of children's growth and development. Based upon that, they articulated ideas and set up goals for individual children.

On the other hand, they benefited from standards in some ways, especially when they wanted to make learning visible to other people to show they are successful. The excerpt from the interview with Mary explains this:

We don't follow them [standards] per se every time when we plan curriculum. We don't pull out the standards and look at it, but periodically, especially when we're getting ready for professional, for our parent conferences we might pull out some of them or when we're teaching our classes to our undergraduate students we'll pull out the standards and say look how this project supported the standards. (Mary)

Mary indicated that standards were useful in making their children's progress visible to other people. Since they wanted to have strong communication with the community, standards helped explain and describe their education.

4.3.3 Summary for Question 3

How does the science constructed in this Reggio Emilia-inspired preschool classroom address the science standards?

In order to answer the third question, the whole data set is examined through using the ELCS of Ohio for pre-K natural sciences. After presenting a broad perspective by analyzing many projects in terms of science standards, one specific project “Growing Things” is examined more in detail. In short, the results derived from the data set shows that the Reggio pedagogy, which is grounded in inquiry, is very compatible with science education standards for preschoolers and even exceeded standards for pre-K.

Moreover, upon the question of how the Reggio Emilia-inspired teachers benefit from the pre-K standards and whether the standards are compatible with the Reggio Emilia Approach, the teachers indicated that they are very compatible. In fact, children taught with this approach often exceed the standards for pre-K. Yet, this success does not come out of a rigid standards-based curriculum, but an attentiveness to each child’s interests and the culture of the group whole. The standards are used for reference when periodically evaluating students. This sometimes helps the teachers see an area that a child made need more work in, but more often the success of the children meeting and exceeding standards provides a more concrete way of showing the effectiveness of the approach. Furthermore, they stated that preschool isn't a time to get ready for school, it is school.

CHAPTER 5

DISCUSSION

5.1 Introduction

The overall goal of this ethnographic study was to gain insight into natural science education in a Reggio Emilia preschool and begin to address the gap in the literature by showing how natural sciences education is conducted in preschool. The study presented here approaches daily life in classrooms from a cultural perspective. As ethnography is “a research paradigm that serves to uncover life in the classroom” (Ferne & Kantor, 1994, p. 159), the current study aimed to uncover much of the complexity of how the natural sciences were socially constructed and integrated into this classroom’s daily life curriculum. In addition, I used the Reggio Emilia approach framework and the science standards for preschoolers in order to see if two competing paradigms in the field could be synergistic.

Kantor and Fernie (2003) state, “the complex stream of classroom action, socially constructed by the group of participants, becomes more understandable when thought of in terms of its cultural elements-activities and events, routines and rituals, norms and expectations, roles and relationships, and so forth” (pp. 207-8). As the focus of the current preschool ethnographic study is culture, I examined the cultural processes, values,

artifacts, norms, social actors and so on to understand the complex, dynamic situation, briefly, the context of the classroom. When the context was investigated, it was seen that science was embedded in the culture of the classroom. The results of the study show that science education was not preplanned to be included in the curriculum. It was already there, naturally found in the daily life of this classroom and thus it was integrated into the curriculum. The study shows that science knowledge was created by the social actors of the classroom (i.e., students and teachers) and it was a situated activity. The current study helps educators realize the richness of science education in a Reggio Emilia-inspired preschool.

Green, Dixon, and Zaharlick (2005) state, “it is *cultural knowledge* needed to locate the current developments within Education in the larger intellectual history of ethnography across disciplines” (p.150). Accordingly, the current ethnographic study aim to provide information about how science is constructed in a Reggio Emilia-inspired preschool and prove to early childhood educators that moving to a standards and discipline-based educational paradigm is not necessary but the Reggio Emilia pedagogy, which is grounded in inquiry, is very compatible with science education goals and content standards for preschoolers. However, this study did not identify all the facets of the science life in the Reggio Emilia-inspired preschool. Rather, it showed that science inquiry is a complex and dynamic phenomenon in which both teachers and the children acted together to construct meaning and understanding. The current study revealed that the preschool classroom: 1) offered a rich context that initiated and supported preschoolers’ inquiries in science and led preschoolers to actively construct their science-knowledge in interaction with others; 2) showed a strong reflection of the Reggio Emilia

approach; and 3) met the pre-K standards for natural sciences. The classroom's culture was replete with science teaching and learning. The results showed that the Reggio pedagogy, which is grounded in inquiry, is very compatible with science education goals and content standards for preschoolers.

The research questions of this ethnographic study are examined under the three layers of analysis in Chapter 4. The whole data set, which includes interviews and participant observation transcripts, documents/artifacts, and field notes, were examined. Moreover, in order to answer the research questions, eleven projects were chosen and unpacked, namely, Weather, Rolling Ball, Growing Things, Space, Color, Poptart, Magnets, Bugs/Insects Habitat, Animal Family, Shakers, Cooking, as well as some other projects or events related to science education.

In this part of the study, the results are first discussed along with the contribution of the current study to the literature in terms of the notion of the classroom culture by Spradley and Corsaro, the Reggio Emilia approach, and preschool science education in literature and standards. After that, demonstrations for the classroom are stated by discussing implications and recommendations for early childhood educators and science teachers. Lastly, recommendations for future research are stated.

5.2 Theories into Practice: Spradley and Corsaro

In this layer of analysis, the first research question “*How are natural sciences socially constructed and integrated into this classroom's daily life curriculum in the preschool classroom?*” is answered utilizing the whole data set. Two theories that guided the study are discussed: Spradley’s D.R.S. method, which is a well-known ethnographic method, and Corsaro’s Peer Culture theory.

Spradley (1980) helped to set the cultural tone of the study. Examination of semantic relations in the classroom using Spradley's Taxonomic analysis showed that the Reggio Emilia-inspired preschool classroom was science-rich in terms of the places for doing science (Taxonomic analysis 1), the ways of doing science (Taxonomic analysis 2), and the reasons for doing science (Taxonomic analysis 3). This supported what Rinaldi (1998a) states, "our *progettazione* must involve multiple actions, voices, times, and places" in Reggio Emilia schools (p. 119, italics in original).

In this Reggio Emilia-inspired preschool classroom, taxonomic analysis of the places for doing science (e.g., blocks, art studio, circle time), the ways of doing science (e.g., drawing about it, talking about it, exploring hands-on), and the reasons for doing science (e.g., play and peer culture, activity and school culture) showed that natural science was not limited to planned activities, or a specific space or time, and it happened in multiple ways in a social context. Science was infused in classroom life, and it was a natural part of the daily lives of preschoolers. Science was lived there.

Peer culture analysis helps us see distinctive cultural features of a particular classroom (Ferne, Kantor, & Whaley, 1995). The results of the research Ferne, Kantor, and Whaley conducted show, "The peer culture elements that children construct have looked quite different from year to year, reflecting the new cohort, their personalities, and changing events in the world and media beyond the classroom" (p. 118). Accordingly, peer culture theory was another lens for the current study to understand and examine the culture of this preschool classroom in relation to the natural sciences education, specifically the taxonomy of the reasons for doing science.

Many aspects of our daily life involve elements of natural sciences, so that science was naturally occurring as part of the everyday experiences of the children. Science education might be considered to be a purely school culture event. Similar to the research done by Kantor, Elgas, and Fernie (1989), which reveals the complexity of group times and how school culture and peer culture was intertwined during group times, the results of the current study show that the preschool science events had both peer culture and school culture dimensions. The reasons for science experiences had their roots in the children's lives and everyday experiences with other children. While creating the school culture (e.g., making Curriculum Guides), the teachers took peer culture (e.g., children's interest in Star Wars) into consideration. The teachers built on peer culture, which led to more challenging learning opportunities within the school culture. In the following, the reasons for doing science and peer culture as well as the places for doing science and the ways of doing science are discussed in detail.

5.2.1 Socially Constructed and Integrated Natural Sciences Education into the Curriculum in the Reggio Emilia-Inspired Preschool

Spradley's Grand Tour showed that the natural sciences education in the Reggio Emilia-inspired preschool classroom displayed itself with the intensity of projects; conversations; teacher documentation; posters; science books; the joy the preschoolers were having; the teachers' thoughtful attitude and effort toward integrating inquiry-based science education in their emergent curriculum; the routines (e.g., group arrangements) including the daily schedule; and the provocative environment set up with science materials, tools and natural things such as classroom pets.

Examination of the semantic relations; namely the places for doing science (e.g., blocks, art studio, circle time), the ways of doing science (e.g., drawing about it, talking about it, exploring hands-on), and the reasons for doing science (e.g., play and peer culture, activity and school culture), using the Taxonomic Analysis supported the original assumption that the Reggio Emilia-inspired preschool classroom was rich in science. The peer culture analysis also contributed to our understanding of constructing science in the classroom. Those lenses aimed to uncover the complex way the natural sciences socially constructed and integrated into this classroom's daily life curriculum.

Similar to Reggio schools in Italy, continuity and transparency between spaces were always emphasized (Rinaldi, 1998b), and the space was thoughtfully enriched with materials, tools, and equipment, organized to encourage choices and discoveries, to foster social exchanges and interactions between the things and the people, and to provide spaces where children can stay alone if they want (Gandini, 1997). The preschoolers co-constructed science in multiple places and times in the Reggio Emilia-inspired preschool classroom. Projects did not have strict time tables or locations. A single project could be revisited at multiple times in the day, and continue on for days or weeks. One project also took up multiple areas both inside and outside the classroom. In the Reggio Emilia-inspired preschool classroom, science was not limited to a time in the daily schedule or a table work or a clearly defined area, as it is usually observed in some other preschools. It was integrated into multiple places of the classroom at both macro (e.g., the dramatic play area, the art studio) and micro-level (e.g., on the wall, at the window). Moreover, throughout the day the preschoolers were free to flow among activities which were spread out around the classroom.

The other issue was the revisiting the old projects. Even though it might have appeared at first glance that a project ended long time ago, children could still go and revisit the ideas at any time. The teachers arranged many places in the preschool carefully and thoughtfully to provoke children's inquiry and to support their understanding of science. In the Reggio Emilia-inspired preschool, just like Reggio schools of Italy, science was infused into the daily classroom culture.

A child views the world as integrated, not separated into disciplines, and in the Reggio Emilia-inspired preschool classroom, science was also interconnected with other disciplines, such as math, literacy, and art. These other non-science disciplines were also interconnected with one another. The places within the classroom were multifunctional and promoted an integrated curriculum, and this integrated curriculum promoted the multifunctionality of the classroom spaces. The Reggio Emilia approach provided a basis for an integrated curriculum for preschoolers and truly integration of natural sciences in the classroom in innovative ways, because the Reggio-inspired teachers believed that classroom is the reflection of real life, and real life is integrated not segmented.

In short, there was no space or time limitation for student projects. The preschoolers co-constructed science at multiple places and times both in the classroom and outside it (e.g., playground). Moreover, the projects lasted days and weeks and were even revisited weeks or months after they were done. Science was truly integrated into the curriculum and the classroom life of the preschoolers.

The preschoolers in the Reggio Emilia-inspired preschool engaged with science in multiple ways. They socially constructed science explicitly and implicitly inside and outside the classroom: They participated in hands-on experiences with science; worked in

groups most of the time; conducted their research for related natural sciences by utilizing multiple sources; applied science process skills; and created multiple ways of representing their ideas and theories. The results showed that in a Reggio Emilia-inspired preschool, learning about science is a very exciting, hands-on, social, in-depth, inquiry-based and meaningful experience.

Multiple ways of engaging in science were analyzed and interpreted under the five units, namely, exploring with hands, working in groups or individually, searching through sources, using science process skills, representing ideas in multiple ways. Many examples from various projects given under each unit showed the richness and uniqueness of the ways of doing science in the Reggio Emilia-inspired preschool.

The preschoolers socially constructed science explicitly and implicitly inside and outside the classroom. In general, it can be stated that the way these children engaged with science was more of a reflection of real life. Science was a naturally occurring part of the everyday experiences of the children. To get into this idea that science was a reflection of life, sometimes teachers observed, listened to, and learned from the preschoolers; they caught children's interests and excitement and then took a more active role in creating a challenging and stimulating environment to nourish preschoolers' learning experiences.

The teachers in the Reggio Emilia-inspired preschool created a challenging and stimulating environment, provided a variety of materials and tools in those places so that the preschoolers could manipulate and learn about science through hands-on experiences (i.e., manipulating things, making things, planting things and growing, building structures, projecting images, taking care of pets and plants, playing). The environment –

not the curriculum— was provocation to the preschoolers’ interest. The environment was set up with materials and tools that allowed children to actively engage in science. There was no correct way to work with materials and tools, and the teachers stressed the importance of “what messages are sent by how things are presented.” Thus, not only the presentation of materials and tools but how they were presented was also important in this classroom. Moreover, the preschoolers’ hands-on experiences were not limited to materials and tools, but extended to living things, such as classroom pets and plants.

As the projects proceeded, new needs occurred, and the teachers set up the environment as inspirational and provocative to children’s understanding and experiencing of science and created cognitive dissonance. The teachers in the classroom were always looking for teachable moments and setting up the environment in response to how children interacted with it.

It was common to observe different kinds of play, which were embedded in their science activities or in which science was embedded. By providing play-based experiences, teachers aimed at getting preschoolers engaged in science events/activities or other disciplinary fields (e.g., math and literacy) in natural ways. While conducting experiments with a fan, rolling balls, or bubbles, play was distinctly part of the event. Much interaction and conversation occurred during these events, especially play, which contributed to preschoolers’ social development.

The teachers were responsive to the shared and individual needs and interests of the preschoolers. As a social constructivist point of view was pursued by the teachers, preschoolers often had chances to work in groups. Corsaro (1988) states, “as children develop a sense of doing things together they gain a gradual and more abstract

recognition of the significance of this fact, a recognition of community” (p. 20). In the current study, it is seen that Reggio Emilia-inspired teachers provided children many opportunities to play and work together. For example, different than many other preschools, where reading was mostly considered to be a quiet activity and situated in an area called “quiet area,” in the Reggio Emilia-inspired preschool, co-reading was encouraged. The preschoolers learned a lot and enjoyed doing science projects within a social context. This also helped them experience science process skills and gave them many language opportunities.

School culture reflected itself in many ways, such as the grouping of preschoolers. For example, teachers let four preschoolers at a time work at the Wind activity in the art studio. In addition to school culture, understanding the notion of peer culture in this school was an important factor in understanding how the children formed groups as they engaged in science. While structuring their peer group, artifacts of the peer culture played surfaced. The theme remained the same but the cultural artifact changed. In the Animal Family play, one time it was tigers, then lions, and then Care Bears. Even though the cultural artifact was changed from tigers to lions to Care Bears, the theme stayed same and the cultural artifact always saved its importance in group play as part of the peer culture.

Consistent with the theoretical paradigm of the preschool, the teachers opted to encourage preschoolers to conduct their own search for information. Filling preschoolers with facts was seen as a passive act, which could jeopardize the children’s development of inquiry skills. Teachers wanted children to become strong thinkers. Accordingly, the teachers highly valued preschoolers’ skills of asking questions and looking for answers

through checking sources. Preschoolers showed their confidence in themselves in terms of “I can do it” many times throughout the study and used different research methods, such as reading books, searching the Internet, calling Time & Temperature & Weather, asking moms/dads, and interviewing a visitor to the classroom.

The preschoolers used in the following science process skills during participant observations: Observing, Predicting, Measuring/Counting, Collecting Data/Recording Data, Comparing/Contrasting, Categorizing/Sorting/Classifying, and Communicating. The integration of these skills into daily life made them more natural than if science process skills were used in a typical science laboratory context.

The preschoolers were able to work on science concepts and explain what was happening. They used their communication skills during the experiments as well as circle time meetings. Their explanations did not have to be accurate, but the teachers encouraged them to make comments and give explanations for events. By asking questions, the teachers helped children to voice their ideas, communicate with each other, reflect on what they were observing, and theorize what was happening.

The preschoolers were very successful in creating some theories. They were able to create their own explanations and theories about events based on their own observations and previous experiences. They were able to form an idea of an expected result and a belief of what would occur based upon their present knowledge.

The preschoolers were not only competent in creating their own theories but also supporting them with their evidence and discussing the differing ideas of their peers. The conflict in ideas was appreciated by the teachers and seen as an opportunity for the children to inquire more, to learn more, and to become stronger thinkers.

The preschoolers were also able to compare an unknown quantity with a known unit of measurement very successfully. In other words, the preschoolers quantified their observations using proper measuring devices and techniques. The preschoolers were able to count and measure something for a purpose, such as to make bread, while working collaboratively. Making bread was a social event in which the preschoolers changed roles, took turns, work cooperatively and used their counting/measuring skills.

The preschoolers were able to identify objects/events/living things, some abstract science concepts, such as gravity and weight and categorize them according to similarities or differences in properties. Using the science process skill of categorizing led them to learn more about things. The preschoolers were able to conduct observations— even sometimes with some observations tools— and make comparisons and contrasts, and make predictions of possible contrasts. They were able to interpret and explain their observations, draw inferences based on what they observed, formulate hypotheses, and make educated guesses based on evidence that could be tested through observation.

The children communicated their ideas with others in various ways. These ways can be categorized into two dimensional ways and three dimensional ways. Both two and three dimensional ways triggered and supported preschoolers' inquires, and truly engaged preschoolers' hands, heads, and hearts with science. While using those ways, the preschoolers were very involved in using their hands (see exploring hands-on), minds (see inquiry-based education), and their hearts (see peer culture & interest-based activities). It provoked new questions, preschoolers' inquiries and imagination related to science.

Using multiple, creative ways to represent ideas richened the process of engaging in science and children's understanding of it. More than transmitting ideas to other people, multiple representations of ideas was about expressing ideas for themselves as well as other people in a reflective, innovative and interactive way. The preschoolers were also able to express the connections they made between their work and science. As the language of inquiry was a strength of the classroom, verbal communication also helped the preschoolers a lot to express their inquiries.

Documentation was teachers' interpretation of children's expressions. One of the teachers in the Reggio Emilia-inspired preschool indicated that teachers looked at children's expressions, which happened in various ways, and interpreted those to understand them. In short, the preschoolers expressed themselves in various ways, so the teachers found chances to listen to them through their various outlets not just verbal communication. Since expressing happened in various ways, listening to the preschoolers took many ways into account.

In the current study, the reasons for doing science were embedded in the school culture and peer culture. School culture was what the teachers planned beforehand or spontaneously considering various factors, such as the current conditions like the weather conditions outside, and spontaneous events happened at the playground. More importantly, they considered each preschooler's developmental progress. They negotiated and created some objectives for the preschoolers and included them in the weekly Curriculum Guide. Sometimes the teachers tried to lead the preschoolers in directions they thought beneficial for them.

Another reason for doing science was embedded in the peer culture of the preschoolers. In other words, peer culture-based science events were what the preschoolers initiated, valued, or were concerned about within their peer culture.

In the Reggio Emilia-inspired preschool classroom, the teachers made the peer culture an integral part of the school culture. While the preschoolers were becoming “students” and following the routines, rules, values in school culture that the teachers created, the teachers were always taking the preschoolers’ peer culture into consideration. Kantor and Fernie (2003) state,

Every aspect of classroom life is a matter of social construction, that is, each aspect is co-constructed by teachers and children, over time, in face-to-face interactions. Sometimes, the lead role in this co-construction belongs to the teacher. So, for example, in school culture events such as the small-group time analyzed by Williams, the teacher has the more obvious and pivotal role... However, when the face-to-face interaction of small group is analyzed ethnographically, we see that the shape of the event has a great deal to do with the interests and contributions of the children.” (p. 208, sentences skipped)

Similarly, the results of the current study show that the peer culture and the school culture in the Reggio Emilia-classroom fed into each other and successfully supported each other as teachers and students negotiated the reasons for doing science.

Gandini (2004) states, “Ideas for projects originate in the continuum of the experience of children and teachers as they construct knowledge together following the inquisitive minds of children” (p. 23). She also indicates that those projects might grow out of an event, an idea or a problem which is posed by children, or an experience initiated by the teacher and continued as children’s interest continues. In the current study, it is seen that the reasons for the experiences had their roots in the children’s lives and experiences. A strong connection to the classroom community’s everyday

experiences and concerns was already there, and the teachers built upon the connection. It is seen that while the teachers were creating the school culture (e.g., making Curriculum Guides), they took peer culture (e.g., children's interest in Star Wars) into consideration. The teachers built on peer culture, which led to more challenging learning opportunities within the school culture.

Each project began with a reason behind it. As the activities and events continued, more reasons, different leading forces occurred. Whatever the starting point/reason for doing science was, in order to continue working on a specific topic, the common thing among those reasons was children's interest and possible learning opportunities foreseen by the teachers.

Based on the reasons emerging spontaneously, the teachers formulated some general educational objectives within a flexible plan, called a Curriculum Guide. The Reggio Emilia-inspired Curriculum Guides were emergent, created, negotiated, and constructed weekly by the classroom community and distributed to the parents, staff members, and researchers via e-mail.

5.3 Assimilating the Reggio Pedagogy in an American Preschool

In this layer of analysis, the second research question "*How does the science constructed in this classroom reflect the Reggio pedagogy?*" is answered utilizing the whole data set.

After clarifying what "being-inspired" means, the phrase "Hundred Languages of Children" and the Reggio principles (the image of the child, the role of the teacher, education based on relationships, inquiry-based education, progettazione, documentation, the role of the environment and materials) are discussed using the whole data set and the

principles of the Reggio Emilia-inspired preschool. The analysis of the data shows a strong reflection of the Reggio Emilia approach in this preschool classroom.

The results of the current research indicated that the teachers in the Reggio Emilia-inspired preschool created a science-rich context of *social-constructivist* and *inquiry/interest-based* education where children's knowledge of natural sciences and skills could be nourished. The Reggio Emilia-inspired teachers provided the preschoolers a context where they pursued their inquiries and interests in the natural sciences, learned about the content, used science process skills, and actively and cooperatively engaged in science processes. This was not a linear, simple, predetermined process, but very complex and happened in multiple ways like a spider web.

The science experiences in the Reggio Emilia-inspired preschool that are reported here cannot be replicated or reproduced because the Reggio Emilia approach is not something to implement. It is a philosophy that teachers can be inspired by. Teachers can appropriate and assimilate the Reggio Emilia approach into what is relevant in their own, unique context. The Reggio Emilia approach proposes the idea that no two schools will ever be alike, so that what works for the Reggio Emilia-inspired preschool in the current study will not necessarily work for another Reggio school.

The Reggio Emilia approach has its roots in the unique culture and history of its origin (the city of Reggio Emilia, Italy). It does not provide a packet program or curricula but an authentic perspective to early childhood education. Accordingly, the preschools in US are recognized as "being inspired" by the approach.

Being Reggio Emilia-inspired, the teachers in the current research stated their interest in reflecting their own community's culture and expanding the worlds of their

own children. They indicated that the Reggio Emilia approach provided them the freedom of innovations, in other words, creating their own unique Reggio Emilia approach in their unique classroom and thus “reinventing” themselves. Accordingly, this let them to be in some ways different from the Reggio Emilia schools in Italy. While they were inspired by the principles of the approach, they were also, for example, more individualist.

Kantor and Fernie (2003) state, “thinking of classrooms as dynamic and patterned cultures provides a new and useful framework for looking at and understanding what is going on in a particular classroom-the “feel” or personality of the group, why things are either going well or not going well for a teacher or particular children” (p.211). The experiences reported here belong to this specific classroom community with its teachers, students and families. Even in the same classroom with the same teachers, the investigations and the experiences related to natural sciences might be different with different children in future, so that it is essential to look at the culture of a specific classroom and make decisions accordingly. NRC (2001) indicates that there is no one best way for an effective early childhood science education, and states that the best technique is to select “the right tool for the right task at the right time” (p. 11). In the current study, the Reggio Emilia-inspired teachers showed that the important thing is making a careful decision for that community considering those preschoolers’ interests, inquiries and development. Accordingly, a tool might be right for that task at that time, but an individual child should also be ready or interested in it for effective teaching and learning to take place.

There is some research which examined the experiences in preschools inspired by the Reggio Emilia approach and discussed how the approach can be *adapted* into an American context. For example, Savoye (2001) indicates, “Critics complain that Reggio is too complex to implement” (p. 2). There is a misconception that being inspired is equivalent to implementing something. The Reggio Emilia approach is not a predetermined program to implement.

Similar misconceptions appear in Desouza’s statement (1999): “Adapting the Reggio approach in the school curriculum in the United States is not an easy task” but a challenge (p. 8). Maybe the problem is trying to “adapt” the Reggio Emilia approach. Kathy, the preschool teacher in the Reggio Emilia-inspired preschool, said, “We are Reggio inspired. What that means, the whole point of that is that, we reinvent ourselves. So whoever is inspired by this approach, it requires that you do not adapt them but reinvent yourself.” She also stated, “There is not a pathway of being part of Reggio Emilia.” The Reggio Emilia approach proposes the most appropriate, innovative early childhood education approach for any classroom because it is about assimilating the principles into your own, unique context. There is no right or wrong way to be Reggio Emilia-inspired, it simply requires appropriating the Reggio principles and living in your own world with your own realities. It is not difficult to be Reggio Emilia-inspired.

Although the experiences would be different in each community, the pedagogical principles driven from the Reggio Emilia approach would be common. For example, children’s interest would direct the path in natural sciences education. As evidence shows, the classroom practices in the Reggio Emilia-inspired preschool were consistent with the notion of the hundred languages of children and the Reggio Emilia principles

(the image of the child, education based on relationships, the role of the teacher, progettazione, inquiry-based education, documentation, the role of the environment & materials).

5.3.1 Reflections of Reggio Emilia Principles in a Preschool

In Chapter 4, the data set is examined for evidence of Reggio principles reflected in the Reggio Emilia-inspired preschool classroom and the inquiry related to natural sciences. To accomplish this, the principles of the current preschool and the “Weather” and “Growing Things” projects with their timeline are unpacked for the Reggio Emilia principles. This displays how the culture of this Reggio Emilia-inspired preschool classroom showed the Reggio Emilia approach.

The classroom practices in the Reggio Emilia-inspired preschool were consistent with the Reggio Emilia principles. This was exemplified by the teachers’ image of the child as very strong, intelligent and competent in science. In the following, after stating what the term “Hundred Languages” means, each principle is discussed briefly one by one in terms of how it was reflected in the Reggio Emilia-inspired preschool classroom.

In the Reggio Emilia-inspired preschool, the teachers strongly believed in the power of children to use many different ways to reveal themselves. The preschoolers used a wide array of creative media and activities, and represented their ideas and emotions through many languages (Hundred Languages). The data analysis showed that the preschoolers used two and three dimensional representation of ideas, such as painting, drawing, dancing, talking, discussing, writing, and wearing costumes. Specifically, the Weather and the Growing Things projects, along with their critical events, are examined in terms of the ways the preschoolers expressed themselves.

The image of the child in the Reggio Emilia-inspired preschool could be identified as following: The child was smart, full of potential, competent in science, curious about the world, a strong thinker, a valuable member of the community, and unique in his/her own abilities and background. The child was a protagonist creating the curriculum with the teachers as clearly displayed with the notions of the peer culture and school culture. The child was a team member, and able to work collaboratively with teachers and other children in various science projects. The child was not only a hypothesis maker, but also a competent researcher-scientist who asked questions and then used science process skills and scientific ways of understanding the world, such as looking at sources, observing, and collecting evidence – activities evident during the Weather and Growing Things projects. The role of the child was to construct his/her knowledge and develop skills through exploration.

The lead teachers and student teachers worked collaboratively and played a variety of roles for the children. In contrast to traditional schools where a teacher exclusively has the role of teaching, controlling and disciplining children, in the Reggio Emilia-inspired preschool, the teachers had five roles: those of listener, learner, researcher, helper, and provocateur. As seen in all the projects, including the Weather and Growing Things projects, they moved from a passive role (e.g., listening and observing children's conversation and play to understand them), to an active role during the study (e.g., provoking children's inquiries and creating cognitive dissonance, setting up the environment and asking challenging questions).

The educational philosophy in the preschool of the current study, which was social constructivist, valued and supported relationships between teacher-child, teacher-

teacher, child-child, teacher-parent-child, as well as school-community. Although a teacher indicated that they were individualist, paying the most attention to each child as an individual, they were very successful in creating strong bonds of relationships in all the dyads. Forman (2005) states that even the Reggio projects always reflect a web of relations and coherence in itself, and also connection to the community, and continuity over time. That makes Reggio Emilia unique, special and different from among other approaches to early childhood science education. In summary, since the educational philosophy was based on strong relationships, and a continuous, cooperative interaction between those involved in the school community, collaboration and cooperation took place in all dyadic relationships.

The preschoolers were encouraged to be scientists, who inquire about the world, ask questions, and then actively and collaboratively apply science processes in various ways (e.g., observing, taking care of some pets/plants). In this classroom, the children's inquiry always took priority and was appreciated by the teachers. The teachers wanted children to become strong thinkers. Accordingly, the teachers valued preschoolers' skills of asking questions and looking for answers by checking sources. It is seen that inquiry contributes to children's learning and constitutes their base for making sense of the world (Lindfors, 1999).

The inquiry of a single child often became a shared inquiry and led to various collective investigations. Some projects emerged from those shared questions of the preschoolers. The environment of materials and tools set up by the teachers and the natural environment provoked children's inquiries and led them to ask more questions. The projects continued as long as the children's interests lasted. This study revealed that

the Reggio Emilia-inspired preschool offered a science-rich context that initiated and supported young preschoolers' inquiries about the world and effectively engaged preschoolers with science.

Inquiry shaped the actions of the teachers (e.g., how they planned the next day's curriculum) within the lines of peer culture and school culture. Since using language to make sense of the world was very important in this class, teachers used science terms (e.g., experiment, theory, hypothesis, predictions, temperature, and thermometer) properly in their daily language.

Progettazione, which is the original term for an Italian project approach, had a strong reflection in this Reggio Emilia-inspired preschool classroom in terms of both quantity and quality of the projects conducted by the preschoolers. Within the framework of an emergent and integrated curriculum, children's inquiry shaped the curriculum and the long-term projects over time. It is essential to state that in the Reggio Emilia-inspired preschool classroom "emergent" did not mean randomly working on different things each time, instead works had a meaningful connection with each other.

For example, the pathway of preschoolers' investigation with bubbles was emerging slowly, getting more complicated than just making bubbles, because they were changing some variables. The teachers were careful about changing one variable at a time, so the preschoolers would not be confused, but they worked toward more complicated situations. As a result, the preschoolers, being strong thinkers, brought up new, sophisticated questions, which played an important role in emerging pathway of the investigation with bubbles. It is also essential to state that while the curriculum was

emergent in the Reggio Emilia-inspired preschool and open to changes and new pathways at any time, the daily schedule was consistent and structured with some flexibility.

To decide on the pathway of the curriculum and the projects, the teachers documented preschoolers' work, play and conversations with pictures, notes, tape recordings and sometimes videos. They reviewed these carefully together with student teachers, looked for the ideas with most potential, made decisions and then adjusted the weekly curriculum accordingly. They also made daily changes to the weekly curriculum. As one of the teachers in Reggio Emilia-inspired preschool classroom stated, *the teachers grab onto what promised more potential for the preschoolers and expand on it in the curriculum*. The Weather and Growing Things projects are good examples of long-term projects, which promised more educational possibilities and were based on preschoolers' interest, ideas, and developmental readiness to acquire new skills. The teachers support the children's learning when they provide opportunities for new experiences, use these to provoke inquiry, and challenge preschoolers to test their ideas.

Rinaldi (1998a) uses the metaphor of "taking a journey, where one finds the way using a compass rather than taking a train with its fixed routes and schedules" (p. 119). There was not a straight-forward pathway for a single project in the Reggio Emilia-inspired preschool classroom. Different themes and activities within a project were conducted simultaneously in the classroom. Sometimes a project became a provocation and gave birth to another one, or turned into a completely different idea. From an outsider's point of view, it might seem like there was a huge traffic jam in the classroom in terms of the projects. However, the preschoolers knew the rules, and inquiry was like traffic lights controlling the traffic. The themes were not fragmented but built upon one

another over time, so that everything was smooth, meaningful, and predictable in itself. In short, the projects were not independent from each other, but connected to each other by theme and timeframe. Different projects within the whole curriculum (e.g., natural sciences, art, social studies, and math) were growing and making a *spider web* together.

Just like the process of growing a project, starting and ending a project also happened as a result of negotiation between the teachers and the preschoolers. Rinaldi (1998a), who spent years with Malaguzzi in Reggio schools, indicates that the process of creating the curriculum in Reggio Emilia schools is a dynamic and spiral kind of process bouncing among children, teachers, and parents, not a linear and staged kind of way. Similarly, in the Reggio Emilia-inspired preschool, each party was continually moving back and forth between active and passive roles in shaping the curriculum.

Rather than children's product, or standardized tests or evaluation results, the teachers in the Reggio Emilia-inspired preschool valued and supported children's learning processes, their growth, and their achievements in terms of the quality. When the teachers were focusing on process, they were responsive to children's individual development, created Individual and Group Interest Inventories, conducted teacher meetings each week, and made decisions on how to support children's development based on what the teachers had learned through documentation. They also used documentation to make children's learning visible to other people.

Documentation was a combination of different things, such as children's work, conversations, observations, photographs, the teacher's interpretation, the teacher's reflection and sometimes children's reflection. They performed documentation in their classroom in a variety of ways, such as taking digital photographs, using a video-camera,

using tape records, keeping anecdotal notes and transcribing conversations of children fast at the process, and keeping work samples.

The environment was not static but always responsive and self-initiative. In the words of Lella Gandini, “the environment is the third teacher.” Through documentation and listening carefully to the preschoolers, the teachers made decisions on what would be next in terms of the new pathway of the projects and the curriculum in general. They made a careful selection of materials and tools accordingly, and prepared the environment where the preschoolers could explore and interact with materials. It can be said that the teachers co-created the essential qualities of the space with the children.

Along with a thoughtful selection of materials, the teachers paid much attention to how materials would be presented to create learning possibilities for the preschoolers. They aimed to provoke children’s inquiry about the world by providing materials and tools and a chance to explore them freely. Accordingly, not the curriculum but the environment, which was enriched with science materials and tools as well as alive and natural things, was provocation to interests of the preschoolers in science.

Environment, adult support, and free play— all of those worked together harmoniously. None of them interfered with the other one. The preschoolers were exposed to challenging situations through the carefully arranged environment, free to play and explore their surroundings with joy, and provided the security and enrichment of adult guidance.

5.3.2 Situating the Reggio Emilia Approach in the Preschool Science Literature

The experiences in the Reggio Emilia-inspired preschool classroom also showed a great deal of evidence of including the pedagogies that are stated in the literature as effective specifically in preschool science education. Those are play (e.g., Fromberg, 1999; Hoorn, Nourot, Scales, & Alward, 1993; NRC, 2001), scaffolding (e.g., Fler, 1991; Grieshaber & Diezmann, 2000; Mooney, 2000; NRC, 2001), and hands-on (e.g., Julyan & Duckworth, 2005; NAEYC & NCATE, 2001; Piscitelli, 2000; Rakow & Bell, 1998) as well as the whole child concept with hands-on, minds-on, and hearts-on (e.g., Csikszentmihalyi & Hermanson, cited in Sinker & Russell, 1998, 1995; Russell, 1997; New, 1999). In the following, the experiences in the Reggio Emilia-inspired preschool classroom are discussed in terms of effective pedagogies in preschool science education stated in the literature.

As the curriculum in the Reggio Emilia-inspired preschool classroom was play-based, play was infused in almost every part of the daily activities. However, as Katz and Chard (2000) state, although play is found very effective for children's learning, an adult support, or scaffolding, is also needed for children's learning and development. In terms of scaffolding, teachers' help was one of the main roles of the Reggio Emilia-inspired teachers in this preschool as stated under the domain of teacher roles. Hands-on experiences also appeared to be one major way children engaged themselves with natural sciences. As evidence showed, play, scaffolding and hands-on were just a few things that made the natural sciences education exemplary and strong in this Reggio Emilia-inspired classroom.

Research-based, effective science teaching/learning pedagogies (i.e., play, scaffolding, hands-on active learning) to engage young children with science are included in some science curricula, but usually all pedagogies are not integrated into one curriculum. However, many kinds of pedagogies are included in the Reggio Emilia pedagogy because the Reggio Emilia approach is very rich in terms of the theoretical sources it is derived from. For example, scaffolding is considered effective for science teaching preschoolers, and its origin in Vygotsky's sociocultural theory is a part of Reggio pedagogy.

Moreover, the Reggio Emilia approach provided this classroom a rich pedagogy considering the whole child with hands, head, and heart as a social being and an individual being. Csikszentmihalyi and Hermanson (1995) state that the most effective teaching occurs when learning happens in a way that children are engaged *cognitively*, *motorically*, and *emotionally* (cited in Sinker & Russell, 1998). Minds, hands, and hearts, which make a human being whole, are connected to each other so that they all should be considered for effective science education (Russell, 1997) besides the notion of "whole child" within the larger physical and social environment in which children have a constant interaction (New, 1999). As Reggio Emilia engaged children's hands, minds, and hearts, it created a context in which children could conduct hands-on work with materials and phenomena (e.g., working on the wind in front of a fan using various materials like stone, feather, paper), engage their minds (e.g., asking questions, proposing theories, inquiring about things), and work from their hearts (e.g., thunderstorm project initiated by a child's fear and continued as children's interest persisted, love of the

subject matter “bugs”). Thus, Reggio is described here as hands-on, minds-on, and hearts-on, which constitutes the whole child.

3Hs model with **H***ands-on*, **H***eads-on*, and **H***earts-on* at Figure 5.1 displays the three ways to engage with science and the concept of whole child embedded in the world. The Reggio Emilia-inspired preschool offered a science-rich context that triggered young preschoolers’ inquiries and interests about the world, as well as teachers to support their active work in science, thus effectively engaging preschoolers’ *hands*, *heads*, and *hearts* with science through their interaction with the outside world (which includes both the social and physical environment). The child is considered to be both an individual entity and a social entity interacting with others.

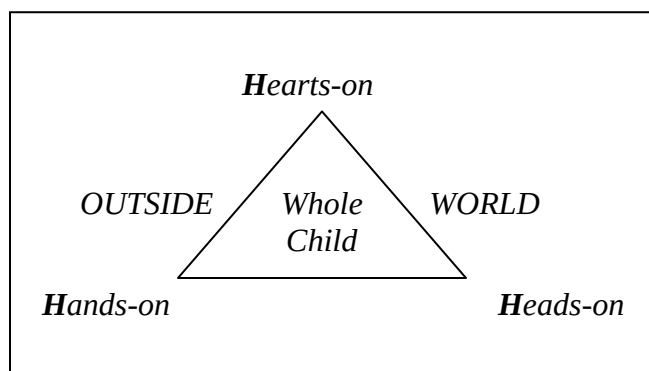


Figure 5.1. **3Hs**: Pre-K science education model.

In the literature, it is frequently stated that Reggio Emilia schools support every aspect of children’s education and development. Malaguzzi (1994) stated, “The important aspect is not just to promote the education of the child but the health and happiness of the child as well” (p. 54). Edwards (1998) also states that one of the roles of

the teachers in Reggio Emilia schools is to promote children learning in cognitive, social, physical, and affective domains. Parallel to the idea of supporting the whole child by Malaguzzi and Edwards, the evidence shows in the current study that the Reggio Emilia-inspired preschool supported the whole child with hands-, heads- and hearts-on while engaging with science.

Results of various research show that children can benefit from science education at an early age. Science education contributes to preschoolers' learning and development (e.g., cognitive, social and emotional development), their skills (e.g., exploratory, inquiry, and self-regulation skills) (Conezio & French, 2002; Eshach & Fried, 2005; French, 2002; French, 2004; Gelman & Brenneman, 2004; MSEB/CFE, 2005; NRC, 2001), their future success in science, and their attitudes toward science and confidence in science (Conezio & French, 2002; Eshach & Fried, 2005; Gillingham, 1993; Mullis & Jenkins, 1988; NAEYC & NAECS/SDE, 2002). As the whole child concept in the current study covers children's learning, development and attitudes toward science, science education in the Reggio Emilia-inspired preschool contributed children's cognitive (e.g., inquiring, reasoning, predicting, hypothesizing), social (e.g., being a valuable part of a community, cooperating, sharing, negotiating, playing and working in a group), language (e.g., communicating ideas in various ways including nonverbal, using science terms), physical (e.g., engaging with both small and large motor skills during science work), and affective skills (e.g., following their interests, working on love of subject matter related to science with others in a playful environment, caring about living things, having fun).

Science happening at multiple places and times, and being integrated into the curriculum, is one of the indicators of how truly science was integrated into the classroom and supported children's development. For example, science happening at multiple places shows how science supported children's development in multiple ways, namely, their creative, social-emotional, cognitive, language/literacy and physical/motor development, which were prominent, but not limited to, at different places within the classroom. For example, creativity was prominent in the art studio, gross motor development was emphasized more in the block-motor area, and social-emotional development was more supported in the dramatic play area. Accordingly, having science at multiple places and times, and integrated with other disciplines in the Reggio Emilia-inspired preschool, helped support children's development in multiple ways. This finding shows that Reggio Emilia-inspired science education considers many aspects of children's development during science education, while there is a criticism toward content standards in terms of ignoring children's emotional development (e.g., Scott-Little, Kagan, & Frelow, cited in NAEYC & NAECS/SDE, 2005).

Standards are mostly related to the cognitive domain, because they usually focus on what children "know" and what children can "do" instead of how children "feel". A survey on the applications of early learning standards in 40 different states of America shows, "social-emotional development and 'approaches to learning' are the areas least commonly included in standards" (Scott-Little, Kagan, & Frelow, cited in NAEYC & NAECS/SDE, 2005, p. 1). However, the Reggio Emilia approach, which is an integrated curriculum derived from early childhood education pedagogies, covers children's whole development in science education including social/emotional development. This is one of

the indicators for science education in the Reggio Emilia-inspired preschool exceeding the pre-K content standards.

The current study shows that preschoolers are competent in science when quality education is provided. The preschoolers in the Reggio Emilia-inspired preschool classroom were very successful in terms of engaging with both science process skills and content. They were able to conduct scientific investigations using science process skills, engaging in science tasks more complex than what some theorists claimed or the standards proposed. Some theorists claim that science education is inappropriate for preschoolers. Working within a Piagetian framework, it is believed that preschool children's learning focuses on here and now, mostly on what's perceptible (NRC, 2001); engaging young children with complex science tasks is thus seen as inappropriate and fruitless (MSEB/CFE, 2005).

However, various research shows that children are more competent than that, and able to process complex and abstract thoughts about ideas beyond what's perceptual. Science education and instructional interventions truly are appropriate and essential for their development and learning (Gelman & Brenneman, 2004; MSEB/CFE, 2005; NRC, 2001). NRC (2001) states that based on modern developmental psychology, children appear to have more competencies, which appear to be universal, than that some stage theorists believed. It is stated that when young children have accumulated substantial knowledge, they can abstract well beyond what is usually observed. The results of the study reveal that preschoolers are very competent in science when quality education is provided. They can even exceed what is proposed in science content standards for pre-K.

5.4 Using Science Notions and Standards in Preschool

In order to answer the third question “*How does the science constructed in this Reggio Emilia-inspired preschool classroom address the science standards?*,” the whole data set is examined using the ELCS of Ohio for pre-K natural sciences.

Early childhood pedagogies come from a developmentally appropriate approach, and one way of teaching science is using those pedagogies in science teaching. This is the way just explained under “Assimilating the Reggio Pedagogy in an American Preschool,” specifically under “Situating the Reggio Emilia Approach in the Preschool Science Literature.” The other way of teaching science is taking science notions and using them in early childhood education. In this part of the conclusion, the focus is the second way: Using science notions (including science standards) in early childhood education.

In the current study, natural science experiences and applications in the Reggio Emilia-inspired preschool classroom are compared and contrasted with ELCS. In the data analysis section, after presenting a broad perspective by analyzing many projects in terms of science standards, one specific project, “Growing Thing” is examined more in detail with the benchmarks of each subgroup of the natural sciences standards, namely, Earth and Space Sciences, Life Science, Physical Sciences, Science and Technology, Scientific Inquiry, and Scientific Ways of Knowing for Early Childhood. In short, the results that were driven from the data set show that the preschoolers met the ELCS pre-K standards and even higher grade standards in a meaningful way through quality science experiences in the Reggio Emilia-inspired preschool classroom.

Moreover, the perspectives of the teachers and their attitude toward standards are examined utilizing the interview transcripts. Upon the question of how the Reggio

Emilia-inspired teachers benefit from the pre-K standards and whether the standards are compatible with the Reggio Emilia Approach, the teachers indicated that it is very compatible and even exceed the standards for pre-K although they do not directly aim to meet standards.

Since standards are designed to consider a particular group of children, standards often do not apply to children's different learning styles (Rakow & Bell, 1998) and children with varied backgrounds (Scott-Little, Kagan, and Frelow, cited in NAEYC & NAECS/SDE, 2005). Although the issue of developmental appropriateness of standards is emphasized a lot in NSES (Rakow & Bell, 1998), in order to reach "all" children teachers should also pay attention to individual differences including cultural, social and historical differences among children. NRC (2001) cautions teachers by stating, "There is the danger that attempts to set common standards, or even to formulate what children need, may reflect the preferences of a particular group rather than the American population as a whole" (p. 277).

In the current study, the teachers indicated that individual children's needs are very important to them. Standards are accepted limits of the typically developing child's capability of doing something and capacity of understanding something in general. The indicators cannot refer to individual child's needs. In this sense, stepping out of standards and identifying individual goals for each child is essential. In the Reggio Emilia-inspired preschool classroom, the teachers used Focused Observation for assessment instead of standards' indicators. They indicated that they create Focus Observation by conducting documentation of children's growth and development. Based upon that, they articulated new ideas and set up goals for each individual child.

Elmore indicates that standards might become superficial, irrelevant, and narrow if teachers aim to achieve those standards (as cited in NAEYC & NAECS/SDE, 2002). The Reggio Emilia-inspired teachers stressed the similar things in terms of the limitations of standards and stated their solution for this. They stressed the fact that not the standards but children's interests drive the curriculum. They stated that, otherwise, focusing on achieving on standards might cause losing sight of "authentic, deeper, and life together" experiences. As evidence shows, all the activities/events were connected to each other and even with other disciplines (e.g., math-counting) meaningfully. The project approach let the preschoolers engage with science in a smooth, natural, coherent way, such as saving seeds from what they ate at snack time and then drying and sorting the seeds by type. They then charted the seeds recording the number they had of each type. The teachers indicated that their school is not mandated to follow standards, but they sometimes use the standards when examining their curriculum. Although they were not mandated by standards, they used it for some good purposes, such as making children's learning visible to other people.

In order to inform educators and families who are concerned about standards, the current study examines and demonstrates how the Reggio Emilia approach met standards. In the Reggio Emilia-inspired preschool classroom, content standards for preschoolers were used properly thus were beneficial for the children and teachers as well as the community. The teachers were cognizant of the limitations and the risks of standards, which are stated under limitations of standards, so that high quality science education was achieved. For example, ignoring the process children go through during learning creates a risk of focusing just on the outcome and missing meaningful, life integrated science

experiences. NAEYC and NAECS/SDE (2005) state that early learning standards focus on “the desired outcomes and content of young children’s education.” If teachers focus solely on achieving those standards, there will be a risk of ignoring and understanding a valuable part, which is the “process” of learning, and children will feel rushed and pressured to achieve standards. However, it is believed that learning is a process with possible outcomes.

The Reggio Emilia-inspired teachers were cognizant of the power of the process not the outcome of early childhood education. The aim was not solely to achieve the standards or teaching the preschoolers “facts,” but to learn how to find information, and to develop a critical, strong mind. So that, rather than focusing on high scores in some standardized tests or standards of which content is prescribed, they were more interested in the preschoolers having meaningful, deep investigations into science topics in which they have interest, so that they inquire about these things, and have more potential to learn. It is seen that a school curriculum does not need to focus on standards to be successful. A curriculum driven from the standards can even be harmful, rather than beneficial for children, but the Reggio Emilia approach, being driven from early childhood education and children’s interest, is the most innovative, effective approach in preschool science education.

Furthermore, the teachers stated that preschool isn't a time to get ready for school, rather it is school. NAEYC and NAECS/SDE (2002) stated that standards are beneficial for preschoolers to get ready for school. The Reggio Emilia-inspired teachers aimed higher than these standards. Instead of achieving standards to get preschoolers ready for school, they stated that it is already school and children are learning. This indicates that

they had a strong belief in preschoolers' competency in science learning. Teachers who are worried about standards and plan to move children from the Reggio Emilia approach to a standards and discipline-based education ought to recognize that the Reggio Emilia approach can meet and even exceed standards for pre-K!

As stated before, one way of teaching science is using early childhood pedagogies in science teaching, and the other way of teaching science is taking science notions and using them in early childhood education. As the focus of this part of the conclusion is “using science notions in early childhood education”, it is essential to discuss some science programs in preschool in addition to science standards.

For example, ScienceStart!, a preschool science curriculum, represents such a way of teaching science in preschools. Whereas the Reggio Emilia approach is not something to implement, there are science curricula, which are packet programs ready to be implemented in preschools. ScienceStart! is one such preschool science curriculum. Taking science notions and creating science curricula brought standards and discipline-based science education into preschools. The Reggio Emilia approach, based on inquiry and developmentally appropriate early childhood education pedagogies, is already rich in science and does not need to artificially borrow science notions to bring into the curriculum and is not a kind of standards and discipline-based approach. The evidence derived from the current research shows how the Reggio pedagogy integrated quality science experiences, and thus met pre-K science standards, specifically ELCS. Accordingly, this supports the idea that taking science notions and movement to a standards and discipline-based educational paradigm in preschools is unnecessary.

Stegelin (2003) states, “ the Reggio Emilia Approach embraces a constructivist approach to teaching and learning and advocates more in-depth project work and problem solving than do many early childhood curricular approaches originating in the United States” (p.168). It is essential to compare some preschool science curricula with the Reggio Emilian science education to see how they differ from each other.

Conezio and French (2002) describe and discuss a science curriculum for preschoolers, called “ScienceStart!,” and point out the essence of science, stating briefly “Real science begins with childhood curiosity, which leads to discovery and exploration with teachers’ help and encouragement” (2002, p. 14). The current study shows that Reggio Emilia-inspired teachers created a flexible curriculum and gave children freedom to explore on their own to be able to truly follow children’s inquiry and interests and to respond individually to the children in the classroom.

In ScienceStart! children follow the following steps of scientific reasoning in the ScienceStart! program: 1) Reflect and ask; 2) Plan and predict; 3) Act and observe; 4) Report and reflect. This is taking science notions and applying them in early childhood education. Different than the science education in the Reggio Emilia-inspired preschool, the ScienceStart! program is a previously-written, adult-prepared curriculum. The ScienceStart! curriculum stresses the importance of teacher help, which is very important in Reggio Emilia. However, Malaguzzi (1998) also stated his concerns about returning to the *old ghosts of teaching* that Reggio teachers tried to chase away, and stressed children’s potential development with the help of adult/more advanced peers. He cautioned people about the old idea of the teacher role, which is passing information to

students, and asked not to mix it with Vygotsky’s idea of the teacher role, which is scaffolding.

The Interactive Approach science model by Biddulph and Osborne for science education focuses especially on “what is in children’s heads” (Kirkwood, 1991). It stresses the importance of focusing on children’s own questions and developing inquiries, which is similar to the Reggio Emilian idea of following children’s inquiry and interest.

Science notions also involve what to teach preschoolers and how to teach (Figure 5.2). In terms of how to teach, different pedagogies and comparisons are stated as well as the whole Reggio pedagogy with its principles. It is concluded that the Reggio pedagogy includes several pedagogies (e.g., play, scaffolding, hands-on). It is the most comprehensive and innovative approach in young preschooler science education.

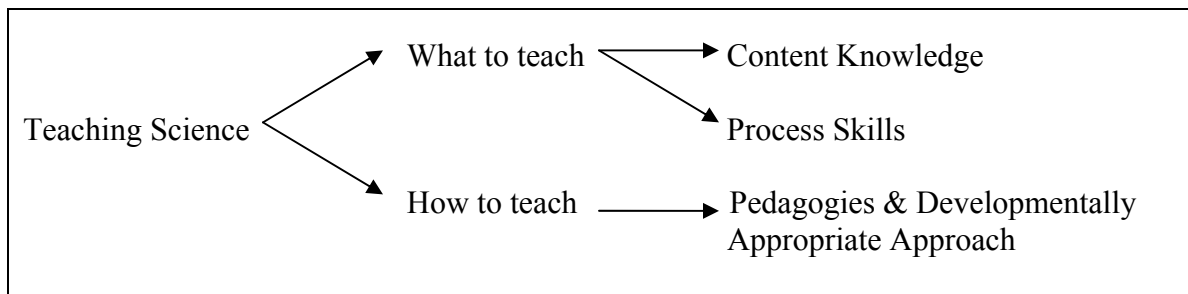


Figure 5.2. Components of teaching science.

What to teach preschoolers involves science content and science process skills. In terms of science content, the natural sciences discipline refers to physical science, life science, and earth/space science (e.g., National Research Council [NRC], 1996; Ohio

Department of Education [ODE], 2004). The preschoolers in the Reggio Emilia-inspired preschool also worked on content-related physical science, life science, and earth/space science, such as magnets, animals, bugs/insects, plants, weather, weight, size, and space. In a short period, the preschoolers engaged with different science themes and met many indicators stated under ELCS. What makes Reggio Emilia unique is its method of selecting content, as opposed to several preschools' applications of choosing science content from books or prescribed curricula. For example, Kallery and Psillos (2002) state that they choose the content of the science activities from units of the curriculum called *cycles of knowledge and experiences* (p. 51), whereas Reggio Emilia teachers consider children's current needs, interests, questions, confusions, and inquiries when deciding what to teach (Rinaldi, 1998a). Similarly, the Reggio teachers in the current study decided on content by looking at children's inquiry, interest, and development. The teachers articulated their own knowledge of child development and the preschoolers' curiosity and excitement in some topics (considering both peer culture and school culture).

Moreover, teachers having strong content knowledge is important, because it allows teachers to be able to provoke children's inquiry and learning in a meaningful pathway. Otherwise, there will be a risk for teachers not knowing how to bring the inquiry further and have deep understanding of science related knowledge. For example, teachers can decide on what questions allow children the most potential for learning.

In terms of science process skills, Kilmer and Hofman state that preschoolers can use basic science process skills, namely observing, identifying, comparing, classifying, communicating, and utilizing (cited in Armga et al., 2002, p. 3). In the Reggio Emilia-

inspired preschool, the preschoolers used all of those science process skills, more specifically observing, predicting, measuring/counting, collecting data/recording data, comparing/contrasting, categorizing/sorting/classifying, and communicating.

Even when we look at Reggio from the perspective of science notions (see Figure 5.2 for broadly what is involved in science education) the evidence shows that the preschoolers in the Reggio Emilia-inspired preschool classroom were very successful in using science process skills and engaged with a wide array of science content, namely physical science, life science, and earth/space science. While the preschoolers were learning about different science content in which they developed inquiry and interest, the teachers were also interested in children developing strong, critical thinking skills. Since they believed that information changes fast, children's ability to be critical, conduct research using various sources, and question facts were very important. They stated that they do not want the preschoolers to memorize things but be able to look for the information they need. Accordingly, even when science notions were targeted for preschoolers, Reggio was a comprehensive approach in pursuing what to teach (both content and process skills) and how to teach (Reggio principles).

Children's natural tendency of inquiring about the world leads them to come up with questions, try to bring pieces of the puzzle together, answer questions, and make explanations as part of their everyday work to understand the world. Accordingly, teachers can support children in pursuing their inquiries and understanding the real world; they can strengthen what is naturally found there using early childhood education pedagogies and providing an environment enriched with materials, tools and natural things.

As evidence showed, the Reggio Emilia-inspired preschool classroom successfully did this and more to nourish children's inquiry skills and science knowledge. Without sacrificing the concerns about standards and discipline-based science education in America, it is possible to be Reggio Emilia-inspired and meet science education goals and standards in preschools.

5.5 Demonstrations for Early Childhood Educators and Science Teachers

Be inspired by the Reggio Emilia approach! Appropriating the approach into your own context enables teachers to reinvent themselves and extend their own children's lives in a meaningful way without importing artificial, out of context kind of "prescribed" science curricula. Accordingly, assimilating the Reggio principles (the image of the child, education based on relationships, the role of the teacher, progettazione, inquiry-based curriculum, documentation, and the role of the environment and materials) in your context can give children opportunities to construct their knowledge of science in interaction with others.

Aim higher! There is no need to worry about meeting standards or a prescribed formula when following children's interest and inquiries within the framework of Reggio Emilia principles. Standards are limited so that they should not become a set of criteria that teachers follow and create the curricula based on. The teachers should aim higher and should be careful about challenging children at their own level, not a level, which is previously prescribed by "experts."

Take individual needs into consideration! Teachers need to conduct necessary accommodations in the classroom to meet individual differences, needs and interests. Reggio Emilia is not about importing an artificial program into your context. However, it

is about growing a curriculum out of your own context, so that individual needs can be met. Standards mostly do not take into consideration the special needs of some children (e.g., disabilities). However, Reggio Emilia provides a context to challenge a child at his or her level instead of standardized criteria or tests. This is more beneficial and fair for ALL children.

Listen to the child! While shaping the curriculum, teachers should be sure that they are following children's interest and inquiry! It is essential to build on children's interests and inquiries, in order to find the most learning opportunities.

Pay attention to shared interests! While taking individual needs and interests into consideration, it is also essential to pay attention to any "shared interests and inquiries" of the children. An individual is a part of a community, not just an individual entity.

Do documentation! Teachers should use documentation to enrich children's learning processes and inform other people about the children's learning and development. However, teachers should never use documentation to judge preschoolers and declare them success or failure. This is merely labeling little children, a process which may stigmatize and cause harm.

Balance peer culture and school culture! Teachers should take both school culture and peer culture into consideration when determining the emerging curriculum. Teachers should be able to turn children's excitement over a topic into a learning opportunity.

Take action! Teachers can rethink their knowledge of child development and revisit their documentation. Based on what appears, they can set up an environment, which stimulates children's learning and provide assistance as needed.

Support hands-on, heads-on, hearts-on experiences! Teachers should consider children's whole development. They should provide a context in which children can follow their inquiries and interests, construct their knowledge of science through hands-on experiences, and have love of the subject matter.

Be flexible! Teachers should never stop listening to children and always be ready to make curriculum changes any time. As the curriculum is emerging, it is essential to make changes according to the shifting interests of the children.

Benefit from standards properly! Standards will be beneficial for children and teachers only if they are used properly. Teachers should avoid the problems, which are given under limitations of standards, so that high quality education can be achieved.

5.6 Recommendations for Future Research

While the ethnographic approach does not allow for generalization of results to large populations, the current study does make unique contributions to the understanding of natural sciences education in a Reggio Emilia-inspired context. This study helps us understand science education in a Reggio Emilia-inspired preschool and its success in terms of the standards and discipline-based educational paradigm. The study does not aim to generalize the results to other contexts. However, transferability of the results to other contexts is possible considering theoretical representativeness of the current context and heterogonous population in a Reggio Emilia-inspired preschool.

In this qualitative research, the whole context was defined, described, analyzed, and interpreted in detail to give better sense of how natural sciences education takes place in a preschool classroom inspired by the Reggio Emilia approach, and to prove that the Reggio Emilia-inspired preschools can exceed the standards for pre-K! In order to

identify different facets of the science life in a Reggio Emilia-inspired preschool, different domains other than where/how/why domains, which are the focus of the current study, can be analyzed, because science is a complex and dynamic phenomena in which both teachers and the children act together to construct meaning and understanding. There will be more to discover.

It can be also beneficial to conduct further research with the same group of children as follow-up. Since it is difficult to speculate on the future attitude development and success of those preschoolers in later years of schooling, further research would be helpful.

Moreover, comparative research can be done to understand how well the preschoolers from Reggio schools do in later schooling, compared to preschoolers, from standards and discipline-based preschool education. This might show a difference between moving from inquiry/interest-based, integrated education versus standards and discipline-based education to standards and discipline-based education in elementary school and later. I believe that students, coming from inquiry/interest-based, integrated education in the Reggio Emilia schools, would be more motivated and successful in terms of using science process skills and understanding the science content. The Reggio kids would have positive attitudes toward understanding and searching about natural sciences, and have strong thinking habits.

APPENDICES

APPENDIX A
CYCLE OF SCIENTIFIC REASONING

Cycle of Scientific Reasoning (French, 2004, p.143):

Ask and reflect

The cycle of inquiry begins with questions. “I wonder what would happen if . . . ?” “I wonder whether . . . ?”

All young children are curious about the world around them, but many preschoolers have not had much experience asking questions (and talking in other ways) about their everyday experiences. They may need adult modeling and support for awhile, but they will quickly learn how to ask open-ended, wondering questions.

Regardless of whether the teacher or child has provided a question, once it is ‘on the table’ it is time to reflect on what is already known that might relate to the question. This is an opportunity for children to think and then to translate these thoughts into language.

It might also be appropriate to consult text in order to learn more about the topic. The teacher can read aloud one or more books about the topic. Listening to the teacher read aloud provides children with the opportunity to create mental representations or knowledge from linguistic input. Children enjoy being read to under almost any circumstance, but listening comprehension is greatly facilitated when they approach text with particular questions they want to answer.

Plan and predict

Once children have a question and have considered what related information they already know, it is time to plan how to address the question. When we see people act, we usually don’t know whether or not they have a plan and are following it. This is because planning usually takes place silently. To learn how to plan, children need to see other people planning. So, it is important that teachers show children their planning process. The teacher can elicit a plan from children with careful questioning or can propose plans herself for the children to evaluate. Again, this process involves translating back and forth between linguistic representations and mental representations.

Once a plan has been formulated, predictions need to be made about what the outcome will be. Different children will have different predictions. The teacher needs to elicit these predictions in a way that helps children think carefully but that does not make them worry about whether they are correct or wrong.

One of the most important functions of language is ‘displaced reference,’ that is, the ability to use language to refer to the future or past or to things that are in other locations. Planning and predicting both involve displaced reference. Practice in this type of language increases children’s discourse competence and better prepares them for the language demands they will encounter later in school.

Act and observe

Finally, it is time to put a plan into action. This is the hands-on part that children enjoy so much. Once a plan has been carried out, it is time to observe the results of the action and to compare what actually happened to the predictions. Again, there are opportunities for expressive language (describing what happened, describing the match between prediction and finding) and for receptive language (listening to other participants’ descriptions, listening carefully to the adult’s questions). Children learn to make and evaluate explanations.

Report and reflect

Sharing observations with others is an important part of the scientific cycle. There are many different types of reports.

Children can tell someone about their findings, they can dictate text about their findings (individually or as a group), they can draw or chart or graph their findings, and they can even put on a skit or create a song to display their findings. All these forms of reporting involve authentic language and literacy opportunities.

The cycle can begin again with reflections—led by the adult or the children—on what was just learned and what new questions it leads to.

APPENDIX B

SCIENCESTART! AIR: AN EXAMPLE SUBUNIT FROM SCIENCESTART!

BOX 5-7
ScienceStart!™ Air

Air is a subunit of a unit on Properties of Matter (dealing with solids, liquids, gas, and change). During Phase 1, Exploration, children explore a variety of features of air, including using straws, hand-held fans, and hair dryers to blow an assortment of objects. During Phase 2, Asking Questions, the teacher guides the students in organizing their explorations and observations into a set of questions. During Phase 3, Follow the Questions, the class carries out a series of activities that address the questions they have developed. During Phase 4, Culmination, children might make and fly kites, use innertubes while going swimming, or invite family members for a Wind Party featuring a dramatic enactment of a book about wind, a garden containing windsocks and pinwheels made in the classroom, and refreshments containing air (e.g., whipped cream and meringues).

APPENDIX C
EARLY LEARNING CONTENT STANDARDS

Earth and Space Sciences for Early Childhood

Young children are naturally interested in everything they see around them – soil, rocks, streams, rain, sand and shells. Science should include experiences that provide for the study of Earth's materials and the discovery of their patterns and changes over time. Since children cannot directly interact with sky or space, learning experiences with the sky or space are based on observing it. Preschool children learn about the earth and space when they play shadow tag, talk about things they do during the day and at night, add water to dirt while making mud pies and paint with water on the sidewalk and notice that the pictures soon disappear. Continuous opportunities to clean up their immediate space, the playground, and to collect and recycle materials support young learners' understanding about their role in respecting, protecting, preserving and caring for the natural world and environment. Children are very interested in the outdoor environment, naturally use it as a laboratory for learning and enjoy drawing or charting what they see and think.

Pre-K - Grade 12 Organizers

The Universe

Processes that Shape the Earth

Indicators

1. Begin to use terms such as night and day, sun and moon to describe personal observations.
2. Observe and represent the pattern of day and night through play, art materials or conversation.
3. Observe, explore and compare changes that animals and plants contribute to in their surroundings (e.g., falling leaves, holes left by worms or squirrels).
4. Explore and compare changes in the environment over time (e.g., leaves changing colors, outdoor temperature, plants growing).
5. Explore how their actions may cause changes in the environment that are sometimes reversible (e.g., hand in flowing water changes the current) and sometimes irreversible (e.g., picked flowers wilt and die).
6. Demonstrate understanding of fast and slow relative to time, motion and phenomena (e.g., ice melting, plant growth).
7. Observe and use language or drawings to describe changes in the weather (e.g., sunny to cloudy day).

Life Science for Early Childhood

Life science is about living things. Young children should be provided direct experiences with living things, their life cycles and their habitats. Although understanding is emerging, children develop concepts of living and non-living things, the behavior and needs of living things and respect for living things. Key ideas emerge from exploring the immediate environment. Therefore, a preschooler in Ohio might explore familiar plants and animals native to their area, studying how living things get food, their characteristics and how they change as they grow.

Pre-K - Grade 12 Organizers

Characteristics and Structure of Life

Diversity and Interdependence of Life

Heredity

Indicators

1. Identify common needs (e.g., food, air, water) of familiar living things.
2. Begin to differentiate between real and pretend through stories, illustrations, play and other media (e.g., talking flowers or animals).
3. Observe and begin to recognize the ways that environments support life by meeting the unique needs of each organism (e.g., plant/soil, birds/air, fish/water).
4. Match familiar adult family members, plants and animals with their young (e.g., horse/colt, cow/calf).
5. Recognize physical differences among the same class of people, plants or animals (e.g., dogs come in many sizes and colors).

Physical Sciences for Early Childhood

Physical science is the study of the physical properties of materials and objects. Through exploration of materials, children learn about weight, shape, size, color and temperature. They explore how things move and change. Beginning concepts develop as young children act on objects to produce a desired effect, put objects together to form new constructions of various kinds and draw conclusions about how the desired effect was produced. When children make a block ramp to race cars, look through a kaleidoscope or pick up objects with magnets, they are learning about the physical properties of objects.

Pre-K - Grade 12 Organizers

Nature of Matter

Forces and Motion

Nature of Energy

Indicators

1. Explore and identify parts and wholes of familiar objects (e.g., books, toys, furniture).
2. Explore and compare materials that provide many different sensory experiences (e.g., sand, water, wood).
3. Sort familiar objects by one or more property (e.g., size, shape, function).
4. Demonstrate understanding of motion related words (e.g., up, down, fast, slow, rolling, jumping, backward, forward).
5. Explore ways of moving objects in different ways (e.g., pushing, pulling, kicking, rolling, throwing, dropping).
6. Explore musical instruments and objects and manipulate one's own voice to recognize the changes in the quality of sound (e.g., talks about loud, soft, high, low, fast, slow).
7. Explore familiar sources of the range of colors and the quality of light in the environment (e.g., prism, rainbow, sun, shadow).

Science and Technology for Early Childhood

For young children, central ideas and skills related to science technology include: identifying simple and familiar tools such as a magnifying glass or hammer; using appropriate tools to explore objects and phenomena or solve a problem; and exploring creative uses for materials or objects. When preschool children appropriately use a hammer and a magnifying glass or use a paper towel roll as a telescope, they are learning about the importance and use of science technology.

Pre-K - Grade 12 Organizers

Understanding Technology

Abilities to do Technological Design

Indicators

1. Identify the intended purpose of familiar tools (e.g., scissors, hammer, paintbrush, cookie cutter).
2. Explore new uses for familiar materials through play, art or drama (e.g., paper towel rolls as kazoos, pan for a hat).
3. Use familiar objects to accomplish a purpose, complete a task or solve a problem (e.g., using scissors to create paper tickets for a puppet show, creating a ramp for a toy truck).
4. Demonstrate the safe use of tools, such as scissors, hammers, writing utensils, with adult guidance.

Scientific Inquiry for Early Childhood

Preschool children learn science by exploring the world around them. They develop an understanding of science as they investigate and interact with real objects and phenomena. Children should be provided with a variety of simple equipment/materials and opportunities for playing, questioning, exploring, demonstrating, investigating and experimenting. Through scientific processes of inquiry or seeking answers based on their curiosities, young children predict, observe, collect or chart information over time, represent and formulate conclusions. Sharing books and stories, engaging in conversations and play provide varied opportunities for exploration, discovery and the communication of findings.

Pre-K - Grade 12 Organizers

Doing Scientific Inquiry

Indicators

1. Ask questions about objects, organisms and events in their environment during shared stories, conversations and play (e.g., ask about how worms eat).
2. Show interest in investigating unfamiliar objects, organisms and phenomena during shared stories, conversations and play (e.g., "Where does hail come from?").
3. Predict what will happen next based on previous experiences (e.g., when a glass falls off the table and hits the tile floor, it most likely will break).
4. Investigate natural laws acting upon objects, events and organisms (e.g., repeatedly dropping objects to observe the laws of gravity, observing the life cycle of insects).
5. Use one or more of the senses to observe and learn about objects, organisms and phenomena for a purpose (e.g., to record, classify, compare, talk about).
6. Explore objects, organisms and events using simple equipment (e.g., magnets and magnifiers, standard and non-standard measuring tools).
7. Begin to make comparisons between objects or organisms based on their characteristics (e.g., animals with four legs, smooth and rough rocks).
8. Record or represent and communicate observations and findings through a variety of methods (e.g., pictures, words, graphs, dramatizations) with assistance.

Scientific Ways of Knowing for Early Childhood

Early impressions about who learns and does science appear to be persistent and lasting. For young children, science should be experienced in ways that actively engage young learners in the construction of ideas and explanations of doing science. Children's ideas and explanations, whether accurate or not, should be valued and serve as a basis for further investigation and discovery. Science should be modeled as an activity for all learners, where they individually and collectively contribute to a growing understanding of the natural world.

Pre-K - Grade 12 Organizers

Nature of Science

Ethical Practices

Science and Society

Indicators

1. Offer ideas and explanations (through drawings, emergent writing, conversation, movement) of objects, organisms and phenomena, which may be correct or incorrect.
2. Recognize the difference between helpful and harmful actions toward living things (e.g., watering or not watering plants).
3. Participate in simple, spontaneous scientific explorations with others (e.g., digging to the bottom of the sandbox, testing materials that sink or float).

APPENDIX D

AN EXAMPLE FROM BENCHMARKS IN ELCS

An example from benchmarks in ELCS (ODE, 2003, p.6)

Life Sciences Standard			
Pre-K – 2 Benchmark			
B. Explain how organisms function and interact with their physical environments.			
Pre-K Indicators	Kindergarten Indicators	Grade 1 Indicators	Grade 2 Indicators
Observe and begin to recognize the ways that environments support life by meeting the unique needs of each organism (e.g., plant/soil, birds/air, fish/water.) (3)	- Investigate observable features of plants and animals that help them live in different kinds of places. (5) - Investigate the habitats of many different kinds of local plants and animals and some of the ways in which animals depend on plants and each other in our community. (6)	- Explain that food comes from sources other than grocery stores (e.g., farm crops, farm animals, oceans, lakes and forests). (2) - Explore that humans and other animals have body parts that help to seek, find and take in food when they are hungry (e.g., sharp teeth, flat teeth, good nose and sharp vision). (3) - Recognize that seasonal changes can influence the health, survival or activities of organisms. (5)	- Identify that there are many different environments that support different kinds of organisms. (2) - Explain why organisms can survive only in environments that meet their needs (e.g., organisms that once lived on Earth have disappeared for different reasons such as natural forces or human-caused effects). (3) - Investigate the different structures of plants and animals that help them live in different environments (e.g., lungs, gills, leaves and roots). (6) - Compare the habitats of many different kinds of Ohio plants and animals and some of the ways animals depend on plants and each other. (7)

APPENDIX E

POSSIBLE RISKS AND BENEFITS OF STANDARDS

Possible risks and benefits of standards stated in NAEYC & NAECS/SDE (2002):

Possible risks

The major risk of any standards movement is that the responsibility for meeting the standards will be placed on children's shoulders rather than on the shoulders of those who should provide opportunities and supports for learning. This risk carries especially great weight in the early years of schooling, which can open or close the door to future opportunities. Negative consequences potentially face children who fail to meet standards, because the data may be used to label children as educational failures, retain them in grade, or deny them educational services.¹⁷ Culturally and linguistically diverse children, and children with disabilities, may be at heightened risk.

Other issues also require thoughtful attention. The development of high-quality curriculum and teaching practices—essential tools in achieving desired results—can be forgotten in a rush from developing standards to assessing whether children meet the standards. Standards can also run the risk of being rigid, superficial, or culturally and educationally narrow. In the K–12 arena, at times standards have driven curriculum toward a more narrowly fact- and skill-driven approach with a resulting loss of depth, coherence, and focus. In the early childhood field, this trend could undermine the use of appropriate, effective curriculum and teaching strategies. Finally, the K–12 experience has shown that even the best-designed standards have minimal benefit when there is minimal investment in professional development, high-quality assessment tools, program or school resources, and a well-financed education system.¹⁸

Benefits

Despite these cautions, past experience also suggests that under the right conditions early learning standards can create significant benefits for children's learning and development.¹⁹ *Eager to Learn*,²⁰ *From Neurons to Neighborhoods*,²¹ and other reports underscore young

children's great capacity to benefit from experiences that are challenging and achievable. Clear, research-based expectations for the content and desired results of early learning experiences can help focus curriculum and instruction, aiding teachers and families in providing appropriate, educationally beneficial opportunities for all children. These opportunities can, in turn, build children's school readiness and increase the likelihood of later positive outcomes.

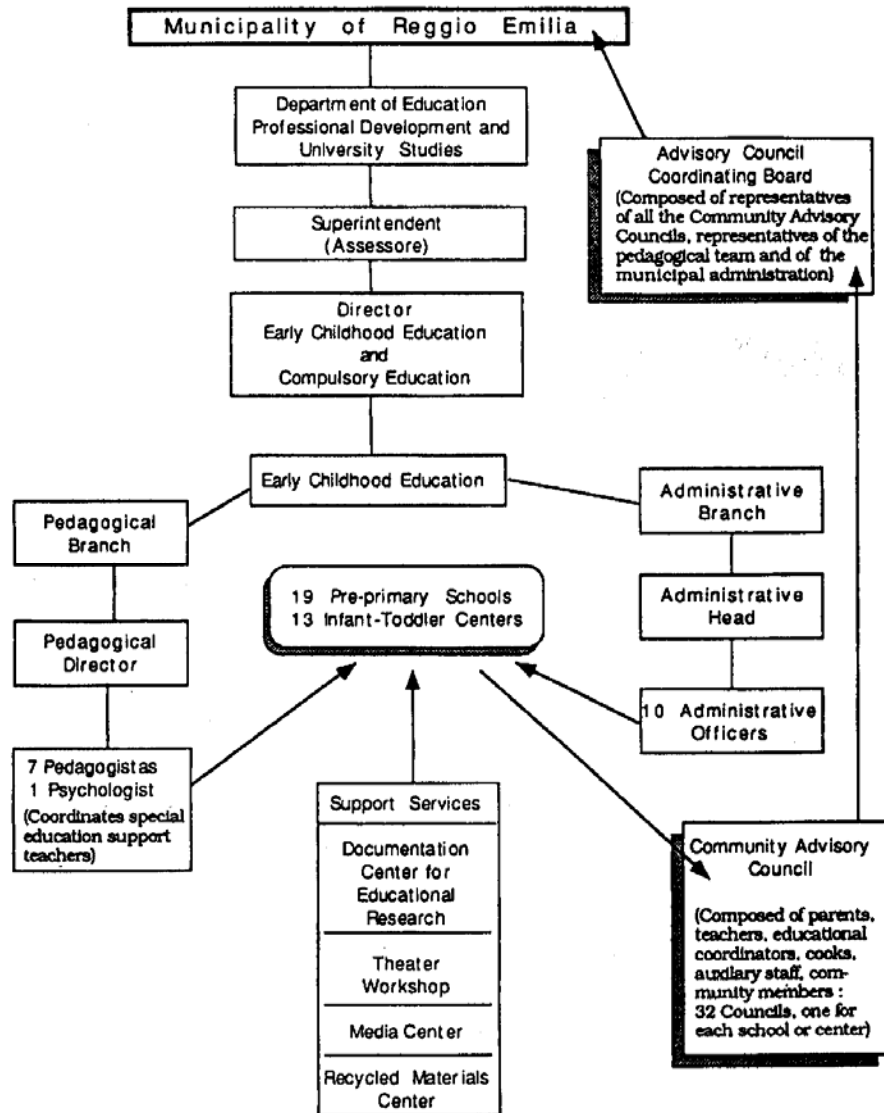
Besides their potential benefits for young children, early learning standards may carry other advantages. The process of discussing what should be included in a standards document, or what is needed to implement standards, can build consensus about important educational outcomes and opportunities. Strong reciprocal relationships with families and with a wide professional community can be established through these discussions. Families can expand their understanding about their own children's development and about the skill development that takes place in early education settings, including learning through play and exploration. Teachers, too, can expand their understanding of families' and others' perspectives on how children learn.

Carefully developed early learning standards, linked to K-12 expectations, can also contribute to a more coherent, unified approach to children's education. Educators, families, and other community members see the connections between early learning opportunities and positive long-term outcomes. For example, they can see that standards emphasizing the value of conversations with toddlers are based on evidence that such conversations promote acquisition and expansion of vocabulary in preschool, which in turn predicts success in meeting reading standards in the early elementary grades.²² Finally, a developmental continuum of standards, curriculum, and assessments, extending from the early years into later schooling, can support better transitions from infant/toddler care through preschool programs to kindergarten and into the primary grades, as teachers work within a consistent framework across educational settings.

APPENDIX F

THE NETWORK OF EDUCATIONAL SERVICES OF THE REGGIO EMILIA MUNICIPAL ADMINISTRATION

The Network of Educational Services of the Reggio Emilia municipal administration
(Spaggiari, 1998, p. 101)



APPENDIX G

SUPPORT LETTER & CONSENT FORMS & RECRUITMENT LETTERS

SUPPORT LETTER

April 26, 2005

*Kathy Cabe Trundle, Ph.D.
Assistant Professor, OSU
1945 N. High Street, 333 Arps Hall
Columbus, Ohio 43210*

Dr. Trundle,

I am writing to express my support of the research proposal, "How are natural sciences represented in the Reggio Emilia classroom?" As Program Director at the [REDACTED] Laboratory for Child and Family Studies, I believe that there are a lot of natural sciences activities going on in Reggio schools either explicitly or implicitly. Therefore, I endorse this research project's attempt to define and understand this issue further. It is important to conduct a research to describe, examine and define explicit and implicit natural sciences education in [REDACTED] Laboratory preschool classroom, which is inspired by the Reggio Emilia Approach, so that we can have more in-depth sight about how natural sciences education and related activities are embedded in classroom practices. If you need further clarification or would you like to discuss the proposal, feel free to contact me at [REDACTED].

Sincerely,

[REDACTED]
Program director of [REDACTED] Laboratory School for Child and Family Studies

CONSENT FORM FOR SUBJECTS WHO ARE YOUNGER THAN 18 YEARS OLD

Parental Consent Agreement

I, _____, agree to allow my child, _____, to participate in the research project titled: “How Are Natural Sciences Represented In Reggio Emilia Classroom?” project number 2005E0277. This project on examination of implicit and explicit natural sciences is being conducted by Hatice Zeynep Inan, of the Ohio State University.

I agree to have my child videotaped. I understand that there are no known risks entailed in participating in the project. For the purposes of confidentiality, all tapes and documents will be kept secured by the researcher for her use only. Any findings from this project will be reported using pseudonyms and the information obtained will be kept confidential.

Hatice Zeynep Inan has explained the purpose of the study, the procedures to be followed, and the expected duration of my child’s participation. Possible benefits of the study have been described.

I acknowledge that I have the opportunity to obtain information regarding the study and that any questions I have raised have been answered to my full satisfaction. Furthermore, I understand my child’s participation is voluntary. I also understand that he/she can withdraw from the project at any time without penalty.

Should I have any further questions about the research, I can contact Hatice Zeynep Inan at inan.1@osu.edu. I can also contact Dr.Kathy Cabe Trundle, Principal Investigator of the Ohio State University (614-292-5820 or trundle.1@osu.edu). If I have questions about my child’s rights as a research participant, I can call the Office of Research Risks Protection at (614) 688-4792.

Parents’ signature

Date

I have explained this project to the best of my ability and answered any questions raised by the participant about his/her participation in the research.

Hatice Zeynep Inan, Co-Investigator

Date

**RECRUITMENT LETTER FOR SUBJECTS WHO ARE YOUNGER THAN 18 YEARS
OLD**

Natural Sciences in [REDACTED] Laboratory School
Hatice Inan
The Ohio State University
College of Education
School of Teaching and Learning

Dear Parents:

I am writing to tell you about an opportunity for your child. I am conducting a science education research project (with the guidance of Dr. Kathy Trundle, an assistant professor at the Ohio State University) about natural sciences education in the preschool where the education philosophy is inspired by the Reggio Emilia Approach.

I am a doctoral student majoring in early childhood education at the Ohio State University. I have been with Dr. Trundle in other science related classes and have had training in research and data collection.

I am interested in investigating explicit and implicit science education in preschools. The purpose of this study is to examine, describe, and define implicit and explicit science in [REDACTED] Laboratory preschool classroom, where the educational philosophy is inspired by the Reggio Emilia Approach.

I will be observing students during regular and normal part of the class time. With your permission, I would like to videotape and audiotape your child at the school.

I will review the videotapes and audiotapes to analyze implicit and explicit natural sciences activities, related conversations, children's trends of interests, and how children express themselves such a way related to science. I will keep all students' names and images confidential. The videotapes and audiotapes will never be shown publicly, and they will be kept in a secure place. Your child may drop out of the study anytime without penalty.

If you agree to allow your child to participate, please sign and return the attached form. Please find enclosed a stamp envelope address to me. If you have any questions related to this study, please feel free to contact me at (614) 886 6621 or inan.2@osu.edu. You may also contact Dr. Kathy Cabe Trundle at 614-292-5820 or trundle.1@osu.edu. If you have any questions concerning rights as a participant in this study, you may contact the Office of Research Risks Protection, the Ohio State University at (614) 688-0389.

Thank you for your consideration,
Hatice Zeynep Inan

CONSENT FORM FOR SUBJECTS WHO ARE OLDER THAN 18 YEARS OLD

Protocol # 2005E0277

I consent to participating in research entitled: HOW ARE NATURAL SCIENCES REPRESENTED IN A REGGIO EMILIA INSPIRED CLASSROOM?

Kathy Cabe Trundle, Principal Investigator, or his/her authorized representative Hatice Zeynep Inan has explained the purpose of the study, the procedures to be followed, and the expected duration of my participation. Possible benefits of the study have been described, as have alternative procedures, if such procedures are applicable and available.

I acknowledge that I have had the opportunity to obtain additional information regarding the study and that any questions I have raised have been answered to my full satisfaction. Furthermore, I understand that I am free to withdraw consent at any time and to discontinue participation in the study without prejudice to me.

I have had a chance to ask questions and to obtain answers to my questions. I can contact the investigators at 1- 614-292-5820. If I have questions about my rights as a research participant, I can call the Office of Research Risks Protection at 1-614-688-4792.

I acknowledge that I have read or I have had it read to me. I fully understand the consent form. I sign it freely and voluntarily. A copy has been given to me.

Print the name of the participant:

Date:

Signed:

(Participant)

Signed:

*(Principal Investigator or his/her authorized
representative)*

HS-027E Consent for Participation in Exempt Research

RECRUITMENT LETTER FOR SUBJECTS WHO ARE OLDER THAN 18 YEARS OLD

Dear (participants' name),

My name is Hatice Zeynep Inan. I am a doctoral student majoring in early childhood education at the Ohio State University. I am interested in investigating explicit and implicit science education in preschools. I am asking for your consent to participate in this study, which will help me to understand how natural sciences education and related activities are embedded in your classroom practices.

The purpose of this study is to examine, describe, and define implicit and explicit science in your preschool classroom where the educational philosophy is inspired by the Reggio Emilia Approach. Your idea and your explanation on this issue are very important for this study. I would like to interview you and this interview will be recorded both on an audiotape and videotape. It will take approximately 30 minutes for each participant. Hours are flexible depending on your schedule.

Your participation in this study is voluntary, and you are free to withdraw from participation at any time during the study. All information will be kept strictly confidential by assigning an anomalous name that will substitute for your name on all materials. No actual names will be used in any report of the research. The videotapes and audiotapes will be used for research purposes only and they will be kept in a secure place.

If you have any questions related to this study, please feel free to contact me at (614) 886 6621. If you have any questions concerning rights as a participant in this study, you may contact the Office of Research Risks Protection, the Ohio State University at (614) 688-0389.

Sincerely,
Hatice Zeynep Inan

APPENDIX H
INTERVIEW PROTOCOL

INTERVIEW PROTOCOL

How Are Natural Sciences Represented In Reggio Emilia Classroom?

Interviewer: *“I would like to begin the interview by briefly describing my research. Then, I will ask you a series of questions about natural sciences education in your class, namely physical science, live science, and earth-space science. If at any time you feel you have already answered the question, please feel free to say so.”*

In this research, natural sciences in a preschool classroom at the [REDACTED] Laboratory School are examined. Specially we are interested in how natural sciences are integrated into the curriculum, what kind of science activities are included, what natural science materials are available in the preschool, what are the teachers’ stances toward natural sciences, and any additional experiences related to natural sciences, such as documentation. In other words, we will examine, define, described and document natural science in a preschool class.

Interview questions

General

In what ways do you see natural sciences included in your classroom?

How do you support children’s learning of natural sciences in your classroom?

How do you decide on “threads of interest” in the domain of natural sciences?

How do you as teachers operate together to make decisions to settle on a project based on natural sciences?

How do you decide on the process and media choices of documentation related to natural sciences?

How do children express themselves in a way that natural sciences are involved?

How do you decide to share the information? How do you choose your audience – families, children, students, the community?

How do you decide to end the project or if the project is finished?

What standards if any are you following (national or regional)? Are the Ohio Academic Content Standards compatible with the Reggio Emilia Approach? If so, how? If not, why not?

Specific

Please tell me about projects from the past 2 years.

Did any of these projects include natural sciences? If no, continue B. If yes, skip B.

B) Have you ever conducted any project related to natural sciences? If yes,

How did this thread of interest (natural science project) begin?

How/why did you decide to pursue this into more of a project?

How did you decide to incorporate this interest in natural sciences project into the curriculum?

What media did you use (such as creating a book) and why did you choose to do that as opposed to other choices?

What are the languages you are choosing to use/introduce in this project for the children to use?

Within this project do the children do any research (comic books, videos, ask parents)? How do they do the research? Within the project do the children make and record observations? If so how?

How are you documenting this particular project? How did you decide on these choices of documentation?

At this point in time, where do you see this thread of interest going?

Lastly, how do you adapt the Reggio Emilia approach into your classroom? For

example, since [REDACTED] Laboratory School has a diverse population compared to Italian Reggio Emilia schools, do you need any changes, and adaptation?

APPENDIX I

TAXONOMY OF THE PLACES CHILDREN DO THE NATURAL SCIENCES

TAXONOMY OF THE PLACES CHILDREN DO THE NATURAL SCIENCES

Schedule-time

Indoor Work/Play Choice Time (Circle time)

Small Group Work

Outdoor Work/Play

Story time

Transition- Quiet room

Table Time

Main Classroom

Activity tables

Science table

Shelf by the entrance

Dramatic play area

Block area

Sensory table

Construction table

Stairs

Exit to Playground

Circle area

Art studio

Pets

Light table

Activity table in art studio

Entrance to art studio

Workstation

Quiet room

Computer

Pets/plants

Loft

Kitchen

Bathroom

Outside the classroom

Playground

Site visit

APPENDIX J

TAXONOMY OF THE WAYS CHILDREN ENGAGE WITH SCIENCE

TAXONOMY OF THE WAYS CHILDREN ENGAGE WITH SCIENCE

Exploring with hands

- Manipulating objects

- Making things

- Planting/growing things

- Building structures

- Projecting images

- Taking care of pets/plants

- Playing

Working in groups or individually

Searching sources

- Reading books

- Searching on Internet

- Calling Time & Temperature

- Asking moms/dads

- Supporting someone visiting the classroom

Using Science Process Skills

- Observing

- Predicting

- Measuring, counting

- Comparing/contrasting

- Categorizing/ sorting/classifying

- Collecting data & Recording data

Communicating

Representing ideas in multiple ways

Painting

Drawing

Dancing

Sharing experiences

Talking/Discussing/Brainstorming

Writing/telling stories to each other/recording into a tape

Movement- jumping

Making sound

Wearing costumes

APPENDIX K

TAXONOMY OF THE REASONS FOR DOING SCIENCE

TAXONOMY OF THE REASONS FOR DOING SCIENCE

Peer Culture

Play

Current interest/excited/shared interest/ interest inventory/shared ideas

Serendipitous/Spontaneous events

Needs and Lived experiences

School Culture

Planned events and activities - Developmentally Appropriate

Serendipitous/Spontaneous events

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