AN INQUIRY INTO THE MATHEMATICS CULTURE OF A PRIMARY CONSTRUCTIVIST CLASSROOM: AN ETHNOGRAPHIC DESCRIPTION

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CHAPTER I

AN INQUIRY INTO ALTERNATIVE APPROACHES TO MATHEMATICS EDUCATION

Introduction

Society is continually calling for school reform. Presently, school reform is viewed through more than one paradigm of possibility (Gage, 1989). In *Reschooling Society: A Conceptual Model* by Macdonald, Wolfson, and Zaret (1973), Harold G. Shane characterized two distinguishing groups of thought and practice beliefs and assumptions. One group represents the far end of a conceptualized continuum and emphasizes ". . . a command of selected responses and a *mastery* [italics added] of predetermined content as a goal for schooling" (foreword). Shane characterized the opposing end of the continuum as a group who sees ". . . a need for education to place greater stress on human development, self-realization, and social reconstruction as desirable ends" (foreword). Regardless of paradigm or conceptual framework, the current educational system is not perceived as adequate because it does not meet the needs of today's children (Brown, 1991b; Dobson, Dobson, & Koetting, 1985; Forester & Powell, 1992; Salz, 1990). Traditional schools embrace an inadequate philosophical and theoretical framework resulting in inappropriate educational implications and practices. These curricular practices are characterized by a desire to control and predict, to approach practice through "effective" teaching strategies that promote direct instruction and external reinforcement, to fragment curriculum that focuses on isolated skills, and to reflect the school as an institution of acculturation and social assimilation. School

change is, therefore, essential. With a new perspective focusing on the growth and development of the whole child, inquiry shifts from if schooling should change to what the changes should be. Along with this new vision of school reform, we must also work to restructure education so that it encompasses the reconceptualization of schooling (Brown, 1991b; Macdonald et al., 1973; Salz, 1990). A starting point for inquiry on re-structuring is an examination of educational philosophy.

Educational Philosophy

In *Reconstruction in Philosophy*, Dewey (1948) recognized the need for philosophical reconstruction driven by a world mired with uncertainty, instability, and a lack of confidence. With the influx of the information age, philosophical examination is more desired today then when Dewey first introduced the concept in 1920. When he argued that current philosophy must deal with the problems that grow out of change, he described the change occurring in his time as being rapid, increasing in geographical range, and deeply penetrating. Due to the world changes, Dewey called for a philosophical reconstruction which would guide man in his new and continually transforming world. His criticism of past philosophies was not aimed at their connections with issues of their own time, but with the relevancy of past philosophical doctrines in application to his own present altered time. He called for the reconstruction of work and subject matter as necessary to give current philosophy the vitality and relevancy which was present in the past. The philosophical works of a pre-scientific time were not appropriate for the moral and ethical principles of Dewey's time.

This same rationale is applicable to educational philosophy. Using Dewey's (1948) argument, there is a need to develop an educational philosophy which does for our time and place what the great doctrines of the past did for their time and place. Educators need to look at the background of past doctrines to decide where to begin the restructuring process. Dewey identified this background as being that of the

theories of knowing. Dewey believed the work of reconstruction involved looking at educational systems and theories of knowing of the past to determine the need for reconstruction in the present.

Dewey (1948) perceived the theories of knowing as different from the pre-scientific notions held by Aristotle, Plato, and Descartes, in that the what and how we "know" is embedded in the scientific method, and interrelated to our experience. The belief that we must look to theories of knowing to guide philosophic restructuring holds true today. With the emergence of current theories of knowing, educational implications are continuously constructed differently from the past. Implications for education founded in current learning theory require a beginner's eye which promotes a philosophical transformation to something entirely new, a reconceptualization (Brown, 1991b). Reconceptualization requires more than what Dewey called for in reconstruction. Fundamental inquiries which advance science require the destruction of old knowledge before the new knowledge emerges (Forester & Powell, 1992). Implicitly understood is the idea or belief that curriculum theorizing changes as scientific reconstruction occurs. With this understanding, critical inquiry into restructuring education becomes essential. Our approach to restructuring is influenced by the lens with which we view educational reform.

The Three Lenses of Restructuring

Brown (1991b) identified three lenses by which to view restructuring of educational philosophy. One approach is to reorganize the existing system by taking what we already have and revising and relabeling it. Another approach changes the existing system to accommodate the needs and demands of today. The third approach reconceptualizes reality, which involves the actual transformation from one conception of philosophy to something entirely new, unattempted, and virtually unimaginable. Brown

stated that this approach requires more than altering existing rules and practices; instead, it requires rejection of tradition resulting in a metamorphosis.

To fully understand the key issues of educational restructuring and the debate surrounding them, an historical view of education is necessary. Educational issues have roots in educational purposes (Schlechty, 1990), philosophies, and practices of the past (Dewey, 1948). An historical presentation for each specific educational issue is beyond the scope and intent of this study. The historical background which follows, however, sheds some light on which issues exist, why the educational issues evolved, and how children and teachers were affected and continue to be affected by these issues.

History and Its Effects

The nineteenth century brought about rapid changes in the manner of education. Charged with the socialization of millions of immigrant children, schools became institutions interested in the amelioration and the acculturation of children into American society (Apple & King, 1990; Forester & Piazza, 1993). The educational influence of Franklin Bobbitt and W. W. Charters, who were inspired by the scientific management movement and social behaviorists, proposed a system that ". . . attempted to guarantee expert and scientific control in socialization to eliminate or socialize unwanted racial or ethnic groups or their characteristics or to produce an economically efficient group of citizens" (Apple & King, 1990, p. 48). "The metaphor of school as factory and children as products to be shaped and molded was born" (Forester & Piazza, 1993, p. 22). This view has left its mark throughout the history of education. It returns to us in the form of *America 2000* (United States Department of Education [USDE], 1991), in which educators are charged with the task of preparing all children to enter school ready to learn by the year 2000 and exit school capable of promoting the global economy.

American public schools are traditionally designed according to this mechanistic, "factory" model (Dobson et al., 1985; Salz, 1990). This metaphorical model views educational institutions as factories that define children as a product which is designed and molded. Dobson et al., who have studied the adverse effects of the industrial model in education, stated that the major goal of this model is to produce or manufacture a standard product. The quality check is one of utility. There is an over dependence on the technocratic-rationale which serves to design children as standardized instruments of society. This model promotes a visage of schooling which is analytic, where educational programs become specialized, curriculum is fragmented, assessment is standardized, and content becomes linear (Forester & Piazza, 1993). Fosnot (1989) blames the application of the industrial model in education on corporate influence. She stated that this factor predominantly affects educational practices, aims, methods, and evaluation tools. This application currently motivated early childhood educators, as members of the National Association for the Education of Young Children (NAEYC), to organize together and present a professional consensus of practices which are developmentally appropriate for the young child, kindergarten through third grade (Bredekamp, 1987; Bredekamp & Rosegrant, 1992).

Still, many educators (e.g., Berliner & Rosenshine, 1987; Canter, 1976; Hunter, 1982) misinterpret the position statements of the NAEYC (Bredekamp, 1987; Bredekamp & Rosegrant, 1992) and continue to capitalize on the factory model by promoting so called "effective" teaching strategies that utilize traditional, systematic or direct instruction in all grades. This instructional methodology regards the learner as an empty vessel to be filled by the teacher with appropriate knowledge which is predetermined by an outside authority. The student is not required nor expected to think or make meaning of the learning experience. This treatment of the learner produces a product which does not contradict or question the system. Critical thinking and logical reasoning are not required of American students, and ultimately, employees. These

qualities are not only undesirable, but they are actually perceived as a hindrance to productivity. A prime example of this is the assembly line foreman who repeatedly reminds his employees that they are there to follow the routine and orders of the management, not to think or act on their own accord even if the products are inferior, marred or inadequate.

Despite alternative recommendations, business continues to dominate education. The metaphor of the school as a factory model and children as products who are shaped and molded contradicts what we currently know about how children learn. Katz and Chard (1989) further contended that these practices are actually counterproductive to the positive growth and development of children. A new conception of schooling, as described by Brown's metamorphic transformation, is a viable resolution possibility.

Curriculum Reconceptualization as a Possible Resolution

In a factory model, children are viewed as objects who are shaped and molded to conform to what society deems relevant and important. The curricular and instructional process implied by the factory metaphor is referred to by Dobson et al. (1985) as the "cloning" of American children. This cloning process reduces children to goods produced by society and diminishes their authenticity (Erikson, 1963). It is vital that children are allowed to contribute to society in meaningful ways. In order to encourage individual authenticity, the manner of schooling must be addressed (Dobson et al., 1985).

To reconceptualize our rationale for schooling, responsible educators begin by examining, understanding, and developing basic systems of educational philosophy, as well as understanding relationships, ethical and logical, between beliefs and practices (Dobson et al., 1985). Implications of current educational theories of knowing suggest that we need to reconceptualize schooling so that it is developmentally appropriate and authentic. Authentic learning, the awareness of one's freedom and the acceptance of responsibility for one's choices occurs through the promotion of autonomy, the ability to

govern oneself (Duckworth, 1987; Fosnot, 1989; Kamii & Joseph, 1989; Katz & Chard, 1989). Authentic educational opportunities actively engage children in developmentally appropriate activities which are personally meaningful and promote the coordination of viewpoints and reflective abstraction necessary for children to develop intellectual and moral autonomy (Bredekamp, 1987; De Vries & Kohlberg, 1987; Duckworth, 1987; Fosnot, 1989; Kamii & DeClark, 1985; Kamii & Joseph, 1989; Katz & Chard, 1989). Appropriate schooling focuses on the children. Schools need to guide children toward developing a sense of confidence in their own initiative and industry in order for authentic learning to occur (Erikson, 1963).

Learning situations which allow children to experience cognitive conflict and resolve such situations independently lead to cognitive growth and autonomy. Knowledge cannot be given; it is constructed by the individual through action and interaction with the environment and other individuals, and reflective abstraction (De Vries & Kohlberg, 1987; Piaget, 1965). Educational rationales which reflect these pedagogical understandings are vital to our future (De Vries & Kohlberg, 1987; Kamii & DeClark, 1985; Kamii & Joseph, 1989; Piaget, 1965).

In rethinking educational constructs so they will promote autonomous individuals, teachers must also possess a sense of professional autonomy and practice it willingly. (Fosnot, 1989; Wilucki, 1990). How can autonomy be promoted by teachers when their own existence lacks authenticity? That is, we fail to attribute and acknowledge professional phronesis and teacher competency. School administrations, when acting as industrial supervisors, extinguish autonomous efforts within the teaching staff. Teachers are encouraged through administrative evaluation and peer competition to implement direct instruction practices which suppress a child's independence. Administrations undermine teacher autonomy by dictating decisions and policies. Governments contribute to this lack of authenticity by legislating educational practice and policy and through funding constraints (Wilucki, 1990).

Fosnot (1989) encouraged resolving educational issues by promoting empowerment, creativity, and professionalism in practicing teachers and prospective teachers through practical applications of philosophical phronesis and constructivism. Kamii and DeClark (1985) declared that professional educators need to reconceptualize educational objectives so that the long range goal for both children and teachers is intellectual and moral autonomy. They further stated that this long range goal is especially important in light of the present epistemological awareness, which explains how children [and teachers] acquire intellect: "In both the intellectual and moral realms, today's schools regrettably reinforce children's [and teachers] heteronomy and unwittingly prevent them from developing autonomy" (Kamii & DeClark, p. 47) through practices employed by professionals lacking an understanding of their own personal autonomy.

Reconceptualizing schools requires examination of educational decision makers, analysis of educational decisions, as well as the analysis of educational values which guide those decisions (Salz, 1990; Wilucki, 1990). No group of people, educators and parents alike, completely and unanimously agrees upon the values which should direct curriculum. The NAEYC (Bredekamp & Rosegrant, 1992) curriculum and assessment guidelines, however, provide a framework for making early childhood, K-3, curriculum and assessment decisions that are related to developmentally appropriate practices. These guidelines provide implications and considerations for the intermediate grades as well. Kamii and DeClark (1985) recognized that ". . . although autonomy as the aim of education does not completely avoid the issue of values, it is powerful because it is derived from scientific theory" (p. 50). When children are encouraged to respond autonomously, they are allowed to interact and coordinate points of view. This interaction leads to higher level thinking (Inhelder, Sinclair, and Bovet, 1974; Perret-Clermont, 1980) and the construction of logico-mathematical knowledge, which Piaget (1965) explained, leads to the further construction of autonomous behavior.

> The constructivist point of view is that if children coordinate points of view, or relationships, they will develop their natural intelligence, and this development can tend only toward autonomy. The history of science amply supports constructivism. Science was not given to scientists from the outside. It was, and continues to be, created by scientists through the exchange of viewpoints among them. Science evolves only in one direction--toward a higher level that integrates previous knowledge (Kamii & DeClark, 1985, p. 50).

The mechanistic factory model brought about a serious inadequacy in education (Salz, 1990). Salz argued that we need to emphasize ". . . the experiential, the personal, the synthesizing, the intuitive, the artistic, and the affective" (p. 398). Dewey (1948) stated that real curriculum emerges through the transaction between the knower and the unknown. The teacher's role in this setting as one of fostering this transaction at each stage (Salz, 1990). Salz believed children need to engage in individual and group inquiry with the goal of synthesizing their results and sharing them with other learners. He further stated that ". . . to know and be able to act requires a breadth of comprehension within and between fields that was previously unrecognized" (p. 399). In society's call for educational reform, educators must select a restructuring approach which ensures a strong, forceful, and stable society in which children's needs are met through developmentally appropriate, authentic education and all society's members are then capable of achieving to their potential. This proposition goes beyond restructuring curriculum to a reconceptualization of educational paradigms.

Mathematics Reform

The National Council of Teachers of Mathematics' (NCTM) (1989) *Curriculum and Evaluation Standards* redirects the content and instructional emphasis of the mathematics curriculum and provides a vision for school mathematics. The document

is a theoretical stance on how children learn mathematics and states several curriculum and evaluation standards which address the K-4, 5-8, and 9-12 grade levels (Whitin, 1992). Although this document is somewhat misguided by the inclusion of industrial metaphors which promote economic advancement, the value of intellectual autonomy as the aim of mathematics education is evident. These standards are defined by the NCTM as statements ". . . that can be used to judge the quality of a mathematics curriculum or methods of evaluation" (p. 2). The standards outlined in this document are statements regarding what is currently valued in the mathematics curriculum. Continuous revision and redefinition are perceived as important if the document, and therefore mathematics curriculum, is to reflect current knowledge of how children learn. The document, however, provides a national philosophical goal for mathematics education which parallels constructivism and is more appropriate than traditional instruction. Kamii and Joseph (1989) find the NCTM (1989) *Standards* a great step in the positive direction; however, they still warn us of the fragmented presentation of curriculum which occurs when we separate mathematics into isolated mathematical content such as geometry, estimation, and measurement.

The mathematics curriculum and instruction required for the young learner is different from that previously thought appropriate by adults. The K-4 and 5-8 standards reflect the importance of understanding the development of mathematical knowledge at these levels and recognize that current mathematics curriculum and instruction is inappropriately emphasizing memorization, rote learning, isolated facts, and paper and pencil tasks. It is the awareness of how children acquire logico-mathematical knowledge, the construction of relationships and interrelationships, which provides educators with a foundation from which to base recommendations for curriculum changes in mathematics that encourage autonomous growth and development. Autonomy leads to the logical thinking and behavior which emanates from a ". . . belief system that says, among other things, that learners construct their own knowledge; that learners grow by

sharing and generating ideas with others; and that learners gain new understandings by representing their ideas in different ways. . . ." (Whitin, 1992, p. 8).

The research of Jean Piaget and the Institute for Epistemological Studies provides direction for mathematics curriculum reform. Piaget (1970) proffered a model which describes intellectual development as passing through four stages: sensorimotor, preoperational, concrete operations and formal operations (Table I).

TABLE I

PIAGETIAN STAGES OF DEVELOPMENT

STAGES	CHARACTERISTICS
Sensorimotor	preverbal; reflex dominated
Preoperational	language develops; manipulation of representations of the physical world; obtain ideas from perception and experience with objects
Concrete Operations	conservation or invariance; logical thought; reversibility of thought; obtain ideas from operations on concrete objects; transformations from one stage to another
Formal Operations	logical thought or reasoning no longer tied to concrete objects; operations carried out in thought; coordination of actions no longer tied to objects

The cognitive structures constructed by individuals at each stage are qualitatively different. These stages occur naturally within the child in a hierarchical

progression and are all-inclusive; that is, all individuals pass through them. Implications of Piagetian research necessitate that educators concerned with the intellectual development of children encourage active participation which engages the child in exploration, experience, manipulation, and investigations of the child's world through the guidance and stimulation of a child's natural tendencies (Bredekamp & Rosegrant, 1992; De Vries & Kohlberg, 1987; Kamii & Joseph, 1989; Katz & Chard, 1989).

Information regarding how children acquire mathematical knowledge was unintentionally a focal point of the research conducted by Piaget (1965; 1973). Copeland (1984), De Vries and Kohlberg (1987), Duckworth (1987), Kamii (1982), Kamii and DeClark (1985), Kamii and Joseph (1989), and others continue to define the teaching implications of Piaget's constructivist theory and to describe the environment which promotes the development of children's natural cognitive processes. The NCTM (1989) process standards (mathematics as communication, problem solving, reasoning, and connections) reflect the relevance of this body of research and imply practices which promote the construction of knowledge. The NCTM incorporated the process standards into the content standards recommended for mathematics learners. The *Standards* (NCTM, 1989) publication relies on the development of educational practices which encourage children to think, and through their own active thought processes, develop higher levels of thinking ability which allow them to further construct their mathematical knowledge. The construction of individual knowledge thereby perpetuates further constructions.

Because the structures of intellect for children are different from the intellectual structures for adults, mathematics instructional practices need to be conceptually oriented, actively involve children, emphasize the development of mathematical thinking and application, and include a broad range of content (Bredekamp & Rosegrant, 1992; De Vries & Kohlberg, 1987; Kamii & DeClark, 1985). Educators who address the needs of young learners turn to nontraditional methods for teaching. The theory of

constructivism implies that teachers release their dominant control and foster autonomous growth in each individual. Teachers and students need to act as conscious partners in the learning process and not to engage in authoritarian behaviors over another's learning (Holt, 1989).

Philosophical Positions Guiding Tradition and Reconceptualization

Various philosophies, psychologies, operations, and definitions which exist in the educational arena guide and direct educational practices (Dobson et al., 1985; Gage, 1989). Constructivist mathematics education is offered as an alternative paradigm to traditional approaches for teaching mathematics. Traditional practices follow a behaviorist philosophy while genetic epistemology guides constructivist education. Table II presents a comparison of the two philosophies with regard to knowledge acquisition, development, mechanism for change, interest, the aim for education, and teaching implications. Constructivist philosophy implies teaching practices that emerge from reconceptualizing our ideas about how children acquire knowledge. Reconceptualization requires educators to examine each practice in light of new professional constructs and to examine the meaning that children derive from those practices. The two philosophies say very different things about children's growth and development. Behaviorism and constructivism are juxtaposed in that they cannot exist together without creating a dichotomous situation in which children are led to confusion by the inherent double message.

Questions Guiding the Study

In consideration of curriculum reconceptualization and mathematics reform, this study inquired into the constructivist alternative to teaching primary mathematics. Ethnographic research was selected as the method of investigation for this study because

TABLE II

KEY POSITIONS HELD BY CONSTRUCTIVISM AND BEHAVIORISM

CONSTRUCTIVISM - can explain knowledge acquisition	BEHAVIORISM - cannot explain knowledge acquisition
Development results in a change in knowledge (Piaget, 1948)	**Development** results in a change in behavior (Miller, 1989)
Knowledge is constructed by the individual through reflective abstraction of interactions with the environment; the child thinks qualitatively different than adults (Piaget, 1948)	**Knowledge** is given to the individual (Miller, 1989); the child is a young adult (Watson, 1928); rote drill and practice necessary to acquire knowledge
Mechanism responsible for developmental change is equilibration by way of assimilation and accommodation (Piaget, 1932)	**Mechanism** responsible for developmental change is the environment (Miller, 1989); change the environment and you change the behavior (Watson, 1928)
Interest is intrinsically derived from the individual's desire to make sense of their world	**Interest** is externally derived from reward and punishment
Autonomous learners - the **aim of education**	Heteronomous learners - the **aim of education**
Implications for teaching active learning interactive learning individualized curriculum mutual respect coordination of viewpoints student choices developmentally appropriate curriculum evolves focus - meaning participatory learning autonomous learners educate whole child internal government errors valued assessment concerned with the construction of knowledge (Bredekamp & Rosegrant, 1992)	**Implications** for teaching individual learning competitive learning one curriculum for all authoritative respect one point of view one assigned task for all scope and sequence curriculum preset focus - skill acquisition rote drill and practice heteronomous learners educate parts of child external reward system errors punished assessment concerned with the acquisition of basic skills and facts (Miller, 1989)

it applies a constructive process to inquiry which reconstructs a cultural reality as it is perceived by the members. It was especially important, as an ethnographic researcher, to enter the cultural setting with the task of understanding the culture as it exists. It was the intent of this project to reconstruct the reality and translate the mathematics culture of a primary constructivist classroom as it was perceived by the members of that classroom.

Subjectivity was unavoidably present due to the nature of qualitative research, and in particular ethnographic inquiry. As an ethnographer and an early childhood educator with a previous interest and commitment to constructivism and the instructional methodologies which emerge from such commitment, I was aware of this subjectivity. My perceptions of the cultural reality in a primary constructivist mathematics classroom emerged from participation in the culture and from interacting with the participants of the study, but unavoidably included a priori perspectives. Serious efforts were made in regard to reliability and validity through the triangulation of data, participant observation, and interviews (Figure 1). Triangulation allowed for the use of more than one form of data collection and analysis procedures.

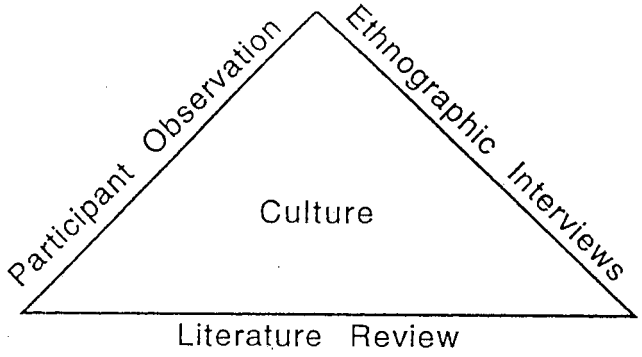

Figure 1. Triangulation of Data

> Ethnographers use many types of collection techniques, so that data collected in one way can be used to cross-check the accuracy of data collected in another way . . . an ethnographer pinpoints the accuracy of conclusions drawn by triangulation with several sources of data. Triangulation prevents the investigator from accepting too readily the validity of initial impressions . . . it also assists in correcting biases that occur when the ethnographer is the only observer. . ." (Goetz & LeCompte, 1984, p. 11).

Certain initial questions directed this study; however, as the research unfolded and field observations were conducted, other questions became prominent and relevant and further guided the collection and analysis of data. For initial consideration, the following questions were of central concern to this study:

1. What influences aid teachers in the formation of a constructivist philosophy?
2. Must a teacher make compromises in order to practice constructivist teaching? If so, what compromises?
3. What educational issues concern a primary constructivist teacher?
4. What are the structures of a mathematics culture in a primary constructivist classroom?
5. What is unique about the mathematics culture in a primary constructivist classroom?
6. What teacher and student behaviors, language, artifacts or products are present in the mathematics culture of a primary constructivist classroom?
7. What are the interactions like during mathematics in a primary constructivist classroom?
8. What is the physical setting of mathematics in a primary constructivist classroom?

The purpose of this study was to explore possible answers to these central questions. In asking these questions, it was the cultural aspects of mathematics as it occurred in a primary constructivist classroom which were of interest. Qualitative research, specifically ethnography, provided the best inquiry into these questions. It was the intent of the inquiry to produce a final product which translated the mathematics culture of a primary constructivist classroom for educators, thereby providing valuable information regarding teaching implications.

I entered the mathematics culture of a primary constructivist classroom in mid-year. Participant observation and ethnographic interviews were conducted in an attempt to reconstruct the cultural reality of the primary constructivist classroom in the form of an ethnographic description for others. An ethnography of the mathematics culture existing in a primary constructivist classroom, participant observation, and ethnographic interviews required a basic understanding of the constructivist classroom from the participants' points of view. It was my goal as an ethnographer that the description of mathematics as it occurred in a primary constructivist classroom serve as a model for future mathematics classrooms.

Mode of Investigation: Ethnography

An ethnography is a research methodology which describes a culture from the members' point of view. In an ethnography, it is the researcher's goal to understand a culture based on the rules and laws, implicit and explicit, governing the culture. Spradley (1980) described ethnography as learning from the people rather than studying the people. He suggested that the researcher become a student of the culture in order to discover the hidden principles of another way of life. The techniques used to conduct an ethnography are varied: case study, interviews, participant observation, and surveys are just a few examples. This investigation utilized participant observation, ethnographic interviews, and collections of artifacts to derive an understanding of the

mathematics culture within a primary constructivist classroom. It was my concern as ethnographer to understand the meaning of behaviors and events as the participants perceived them. Spradley (1980) stated:

> The essential core of ethnography is this concern with the meaning of actions and events to the people we seek to understand. Some of these meanings are directly expressed in language; many are taken for granted and communicated indirectly through word and action. But in every society people make constant use of these complex meaning systems to organize their behavior, to understand themselves and others, and to make sense out of the world in which they live. These systems of meaning constitute their culture; ethnography always implies a theory of culture (p. 5).

There are three aspects important to a culture which require equal consideration in order to completely understand the culture: cultural behavior, cultural knowledge, and cultural artifacts (Spradley, 1979, 1980). Cultural behavior refers to what behaviors are accepted and promoted in a culture. Cultural knowledge encompasses what one should know within a culture, and the cultural artifacts consist of the products and byproducts made to help organize and enhance one's culture (Spradley, 1979, 1980). A more complete definition is found in the discussion of methodology, Chapter II. The data collected during participant observation represented educational processes as they occurred. The information gathered from interviews provided representations of cultural language and beliefs regarding educational processes. Philosophical constructs of educational processes were provided through literature review. The triangulation of this data provided the means for cultural reconstruction.

Assumptions and Limitations

Ethnographic Design Assumptions

Goetz and LeCompte (1984) delineated the assumptive modes to ethnographic research which were assumed by this study. These assumptions are described below:

1. Ethnographic research is inductive. Goetz and LeCompte (1984) explained,

> . . . inductive researchers hope to find a theory that explains their data . . . inductive research starts with examination of phenomenon and then, from successive examinations of similar and dissimilar phenomena, develops a theory to explain what was studied (p. 4).

2. Ethnographic research is generative. It is concerned with discovering constructs or generating propositions.

3. Ethnographic research is constructive. This involves constructing the reality based on what is discovered and the meaning it has for those researched. "A constructive strategy is aimed at discovering what analytical constructs or categories can be elicited from the stream of behavior . . . " (Goetz & LeCompte, 1984, p. 5).

4. Ethnographic research is subjective. Ethnographic data is subjective because it describes the behavioral and cultural patterns of a group as they are perceived by that group. "The goal is to reconstruct the specific categories that participants use to conceptualize their own experiences and world view" (Goetz & LeCompte, 1984, p. 6).

It is denoted that this research is inductive, generative, constructive, and subjective. As ethnographer, I acknowledge all precaution directed by these assumptions. Procedural design and techniques further reflect these assumptions. It is, however, further noted that "pure" ethnographic research is a mental construct and the research, as limited by this construct, only strived for "purity."

This ethnographic study further assumed the following:

1. Knowledge of the mathematics culture of a primary constructivist classroom is valuable.

2. Naive realism was set aside. Spradley (1980) says that there is an ". . . almost universal belief that all people define the real world of objects, events, and living creatures in pretty much the same way" (p. 4). Naive realism imposes outside beliefs on another culture.

3. The questions of this research imply ethnographic inquiry.

Research Assumptions

Educational Assumptions. This inquiry assumes that constructivist education is founded in scientific knowledge regarding how children learn. This study further assumes that logico-mathematical knowledge is essential to meaningful mathematics because it is consistent with children's natural ways of thinking (Kamii, Lewis, & Jones, 1991). Also assumed is the idea that logico-mathematical knowledge is facilitated by constructivist approaches to education.

Teacher Assumptions. The selection of the primary constructivist classroom was based on interviews and seminar discussions which occurred over a four-month period between the researcher and the prospective primary constructivist teacher, (informant), Clara Huneke. During the seminar and discussions, it became evident to me that Clara Huneke engaged her students in nontraditional educational practices. Her methods emerged from constructivist philosophy and she was continuing to develop that philosophy in the seminar. A rapport developed and she responded positively to the research proposal.

Several criteria were used to determine Clara's constructivist nature. The criteria came partially from a list generated in an article, "Constructivism: The Path for Maths in the 90's?" by Hagg (1992). It is assumed that the criteria used are indicative

of a constructivist classroom and are good indicators for assurance in selecting a constructivist environment. The criteria are listed below.

1. Children work in cooperative groups.
2. Children engage in reflective abstraction.
3. Children select activities from several choices offered.
4. The activities are primarily investigative or experiential in nature.
5. Children are active and often use material.
6. The teacher observes and listens carefully, seldom interrupting and then only to assist with the logistics of events.
7. Ongoing assessment involves both student and teacher. Emphasis is given to self-assessment.
8. Language and writing are used to clarify and communicate ideas.
9. Activities are provided which involve all the senses.
10. Students are engaged in activities which allow them to build upon what they know.
11. Children are allowed to experience frustration (disequilibrium) and breakthrough (regained equilibrium) and both are perceived as essential parts of the learning process.
12. Error is valued.
13. Autonomy is the aim of education.

Class Assumptions. Upon choosing the primary constructivist classroom for this inquiry, several assumptions were made regarding the population:

1. The school was considered traditional, yet supportive of new and innovative instructional methods and practices within that traditional setting. Standardized testing assessed achievement, state outcome-based education guided instruction, and the average teacher implemented mathematics through rote drill and practice, with most exceptions to this at the primary level.

2. The children in the primary constructivist mathematics classroom were randomly assigned to the classroom in the general manner for classroom assignments with a few exceptions who were assigned by parental request. The children's school experiences were varied dependent on their cultural background. Their past experiences and home life were culturally thick and this lead to a great degree of diversity among the children.

3. The majority of the children attended school in this classroom for the first semester of the year and were enculturated into the constructivist approach prior to my entry. There were two new children to the classroom.

4. The observations and interviews were routine and randomly scheduled. They were selected based on the typical mathematics schedule of events, my schedule, and the schedule of the children and the teacher involved.

5. The children conducted themselves and reacted naturally while I was present.

Research Limitations

There were several limitations to this ethnographic inquiry:

1. Time was a limitation. In order to conduct an ethnography, one needs to totally surround oneself with the culture under study for a lengthy duration. Many hours are devoted to mathematics concepts as they arise in everyday situations, a fundamental implication of constructivism. The ethnographic contact time, however, was limited due to my personal work and school schedules. The duration of the study was limited due to similar causes.

2. A second limitation involved the scheduling of interviews. The children maintained busy schedules, and classroom participation was essential to cultural understanding and reconstruction. An ethnographer considers this when scheduling interviews with children so that their academic time and understanding is not in jeopardy.

Clara Huneke's schedule was equally demanding for professional reasons. The scheduling of interviews required consideration of the professional responsibilities and duties of the instructor (an informant) as well as the instructor's available patience and time.

3. It is important that subjects' rights are protected and interested persons grant permission for research projects. It is possible, however, that in receiving permission, particularly from school administrations, a subject's anonymity is violated. In qualitative research involving thick descriptions, teachers "stories" are personal and specific to their situation. Thick descriptions of individual or small groups of teachers place these teachers in potentially vulnerable situations. Recognition of this presents a limitation of the study in that information provided during teacher interviews may have been guarded. Anonymity was protected and discussed with the informants throughout the study, and a sound rapport was established, but the threat of risk is nonetheless a possible limitation.

Definition of Terms

It is essential to the clarification and understanding of this inquiry to define several terms. The language of the school reflects its educational purpose. This same language is used to define a school's philosophy and operations. The language provided in the definitions of the educational or "schooling" terms below acknowledge the implications for education.

Traditional Education

Traditional education is structured logically and concerned with the acquisition of information (Apple & King, 1990; Dobson et al., 1985). Subject matter is of prime importance and it is best presented separately and sequentially. There are basic facts that all must know in order to function and benefit society. Educators control and

manipulate students into learning what outside authorities deem important. A child's growth potential is determined by the environment which is easily manipulated to produce desired results.

In the mathematics classroom, traditional education takes the form of rote drill and practice. Students are required to memorize mathematical facts and formulas. Traditional mathematics emphasizes reliance on outside authority while the teacher maintains the role of knowledge keeper. There is minimal mathematics communication other than fill-in-the-blank type worksheets. Students learn isolated topics developing skills out of context. Memorizing rules and procedures for algorithms and finding exact forms of answers are also stressed. There is one correct way to solve a problem and only one correct answer. Standardized evaluation of student progress is necessary for the assignment of grades and for comparison among students and expected progress. Traditional education is guided by behaviorism; traditional methods and practices emerge from behaviorist philosophy.

Constructivist Education

"Educational practices do not flow directly out of constructivism, and it is not possible to conceptualize one 'correct' method that can be called 'constructivist'" (Kamii, Manning, & Manning, 1991, p. 16). Constructivism contrasts traditional philosophies in that it is psychologically and scientifically founded (Kamii & DeClark, 1985). It emphasizes relationships and interrelationships. Learning is relative to the learner and the environment. Education is learner guided and teacher facilitated. Interaction with peers and others is essential to the promotion of intellectual development. Students are engaged in inquiry, investigation, construction, and experimentation. Constructivists focus on how what one has experienced fits into existing schemata and, ultimately, how it extends existing knowledge. Critical thinking and problem solving are important for the promotion of higher level thinking. Constructivism maintains that individuals

create or construct their own reality from their interactions with their environment and reflective abstraction.

Constructivism in mathematics implies teacher as facilitator of learning. Students are actively involved in individual or group explorations. Students conjecture, analyze, and apply mathematics. The use of concrete materials, real life situations, and gaming are stressed. Individual and group investigations provide opportunities for students to test and develop their reasoning. Mathematical relationships and interrelationships are emphasized. Students are encouraged to speak, write, read, and listen to mathematical concepts. Problem solving and critical thinking in natural situations are important. Error is valued for its growth potential in that error creates disequilibrium which motivates individuals to regain a sense of equilibrium. This is done through the coordination of viewpoints or reflective abstraction which promotes the growth and development necessary for equilibration. Assessment is individualized and necessary as an integral part of instruction so that the teacher may better facilitate the individual experiences. Constructivist education is guided by constructivism; constructivist philosophy guides classroom decisions for creating an environment which fosters knowledge construction (Pirie & Kieren, 1992).

Types of Knowledge

Piaget (1973) recognized three types of knowledge: physical knowledge, social knowledge, and logico-mathematical knowledge. It is important to perceive, recognize, and understand the implications of these distinct types of knowledge in order to appreciate the relevance of constructivism and the reconceptualized philosophy which emerges.

Physical Knowledge. Physical knowledge is described by the physical properties or characteristics of an object. For example, a child asked to describe an attribute

block may refer to its color. Color is a physical property of the block and color recognition constitutes physical knowledge (Kamii & DeClark, 1985).

Social Knowledge. Social knowledge is knowledge which is passed via the culture. Mathematical algorithms are a source of social knowledge. They are taught because an external source deems them superior. The external source is generally tradition or society. A standard algorithm for addition which schools present to children represents social knowledge (Kamii & DeClark, 1985).

Logico-mathematical Knowledge. Logico-mathematical knowledge, on the other hand, consists of the relationships and connections the individual constructs which creates a personal reality or an understanding of the world. For example, a child is unable to refer to five objects as five until s/he constructed the relationships among the five objects and fiveness. The child does not see the relationship between the five objects and fiveness until the relationship is personally constructed. This connection constitutes logico-mathematical knowledge. It is the growth and development of logico-mathematical knowledge which promotes the development of intellect. Constructivist implications for mathematics education are concerned with the development of logico-mathematical knowledge (Kamii & DeClark, 1985).

Autonomy

Piaget (1973) declared autonomy, as it promotes continued growth and development, the aim of education. This goal for education is quite different from that of the traditional goal of education, the production of a quality work force. It is again important to understand the meaning of autonomy as Piaget perceives it to appreciate why it is the goal of education for constructivists. "Autonomy means being governed by oneself. It is the opposite of heteronomy, which means being governed by someone else"

(Kamii & DeClark, 1985, p. 40). There are two aspects of autonomy: moral autonomy and intellectual autonomy.

Moral Autonomy. Kamii and DeClark (1985) defined moral autonomy as "the ability to make moral judgments and decisions for oneself, independently of the reward system, by taking into account the points of view of the other people concerned" (p. 40). In morally autonomous individuals, immoral acts are not acceptable because the individual deems them unacceptable independent of other's rewards or punishments. "According to Piaget, children acquire moral values not by internalizing or absorbing them from the environment but by constructing them for themselves, through interaction with other people" (Kamii & DeClark, 1985, p. 44).

Intellectual autonomy. Intellectual autonomy refers to the ability to govern oneself intellectually with the capability of making logical decisions and judgments for the self by taking relevant factors into account (Kamii & Joseph, 1989). Individuals with intellectual autonomy review relevant factors and determine their truth or falsity based on personal logic and reasoning. Autonomous individuals question what they are told and attempt to make sense of the information for themselves. Kamii and DeClark (1985) warned that "Children who are discouraged from thinking autonomously will construct less knowledge than those who are mentally active and confident" (p. 46).

Children who are intellectually and morally autonomous are capable of making intellectual and moral decisions which are considered to be the best decisions given the situation and those concerned. Kamii and DeClark (1985) stated that children should exercise moral decision making when they are younger and the consequences are not as severe. The promotion of intellectual autonomy is viewed through the constructivist philosophy as necessary in the construction of scientific knowledge.

Summary

Traditional education is backed by with many years of historical evidence illustrating the ramifications of its impact. As demonstrated by current reform movements, education is perceived by many as being at an all time low, and fewer and fewer people are willing to support the actions of the educational community. The educational needs of today are not the same as the educational needs of the past. Our schools, however, run on the same philosophical foundation established centuries ago. We are working under an inadequate educational model, guided by inappropriate goals and values. For mathematics education reform to occur, it is necessary to re-examine our educational values and reconceptualize educational philosophy.

Constructivist education provides a scientifically and pedagogically sound alternative which considers the development of the child in regard to his/her own construction of knowledge. To further our understanding of the constructivist philosophical construct so that we provide an educational community designated for the development of intellectual potential, we look to research which informs the educational community. The intent of this inquiry is to provide further knowledge regarding the constructivist paradigm.

CHAPTER II

METHODOLOGY

Introduction

The purpose of this inquiry was to participate in the mathematics culture of a primary constructivist classroom and to translate or interpret the findings as an ethnographic description. The researcher's intent was to add to the pool of knowledge regarding constructivism by offering a meaningful understanding of the mathematical interactions which exist in the primary constructivist classroom culture. This study provides information regarding an alternative approach to teaching mathematics which offers direct implications for education and educational reform. Educators best benefit from ethnographic descriptions of constructivist efforts when considering individual's views about the nature of mathematical activity and its direct bearing on reform in mathematics education (Davis, Maher, & Noddings, 1990). The descriptions provided by this study enhance educational understanding of constructivism and the processes of mathematical thinking. The ethnographic descriptions provided are offered for educators with emergent constructivist beliefs or others interested in ethnographic research of this nature. The descriptions provide valuable information regarding reform in primary mathematics education.

As the ethnographer, I am a certified elementary education teacher. I taught seventh and eighth grade science and social studies in a multicultural inner city setting in the southwest for six years. I then taught second grade in a rural rocky mountain town for four years. During this time, I searched for alternative methods of teaching

which reached "all" children. This search lead me to a minor study emphasis in learning theory. My graduate studies focused, and continue to focus, on alternative approaches to teaching and learning mathematics.

The informants of this study are the 24 members of a primary constructivist classroom and their teacher, Clara Huneke. Their participation was solicited via a letter of consent directed to the school superintendent, principal, and teacher. The parents of the children received a letter requesting consent for their child's participation. The children's consent was requested through a verbal solicitation in which their voluntary cooperation was requested after a brief explanation of their involvement in the study. The children were informed at this time that they were free to leave any study situation anytime without reprisal. The informants were further advised that all responses and actions were voluntary, anonymous and confidential. They were advised that there was no penalty for refusal to participate, and that they were free to withdraw from the study at anytime. Pen names were submitted by the students to engage them in the anonymous reporting of results.

Federal regulations and Oklahoma State University policy require a proposal review and approval of research which involves human study. The review of this project was conducted by the Oklahoma State University Research Services and the Institutional Review Board, IRB, in order to provide the proper surveillance of this research ensuring that the rights and welfare of the human subjects were properly protected. This study received permission to continue on March 5, 1993, and was assigned the following number from the IRB: ED 93059 (see Appendix).

As discussed earlier, the purpose of this study was to participate in the mathematics culture of a primary constructivist classroom and translate or interpret the findings. Noddings (cited in Davis et al., 1990) stated that constructivism is ". . . characterized as both a cognitive position and a methodological perspective" (p. 7). Constructivism assumes that human beings are knowing subjects, human behavior is

mainly purposeful, and that humans have a highly developed capacity for organizing knowledge (Magoon, 1977). "These assumptions suggest methods--ethnography, clinical interviews, overt thinking, and the like--specially designed to study complex semi-autonomous systems" (Noddings in Davis et al., 1990, p. 7). An ethnographic inquiry is guided by a holistic question such as, "What is happening here?", rather than manipulation of an independent variable (Erlandson, Harris, Skipper, & Allen, 1993). Spradley (1980) further stated that ethnographic fieldwork ". . . involves the disciplined study of what the world is like to people who have learned to see, hear, speak, think, and act in ways that are [culturally] different. Rather than *studying people*, ethnography means *learning from people*" (p. 3). This study attempted to learn about constructivist mathematics education from those currently involved in constructivist efforts by applying a constructive process for inquiry.

Working under the mode of learning from the culture rather than manipulating the culture, no tests or written instruments were administered. Participant observation, ethnographic interviews, and literature research were the techniques of data collection. Due to the nature of ethnographic methodology, ethnographic questions emerged as the study evolved. Spradley (1979) stated that ethnographic interviews and questions are different from other forms of interviewing in that,

> . . . the question-answer sequence is a single element in human thinking. Questions always imply answers. Statements of any kind always imply questions. This is true even when the questions and answers remain unstated. In ethnographic interviewing, *both questions and answers must be discovered from informants* (p. 84).

Ethnographic Decisions

A quiet revolution has spread through the social sciences and many applied disciplines. A new appreciation for qualitative research

> has emerged among educators. . . . There has come a profound realization that people everywhere have a way of life, a culture of their own, and if we want to understand humankind we must take these cultures seriously. Qualitative research--called *ethnography* by anthropologists--has come of age (Spradley, 1980, p. v).

An ethnographic study of the mathematics cultural aspects within a primary constructivist classroom provides information and intuitions which are only found out by using such methodology. An ethnography allows the investigator to experience the culture under study and describe it from a participant's perspective.

As Spradley (1980) indicated, it is important to understand the community of constructivism from the members' points of view. He further explained that an ethnography reveals what students think and shows us what cultural meanings they use daily:

> It is the one systematic approach in the social sciences that leads us into those separate realities which others have learned and which they use to make sense out of their worlds . . . it is a pathway to understanding the cultural differences that make us what we are as human beings. Perhaps the most important force behind the quiet ethnographic revolution is the widespread realization that cultural diversity is one of the great gifts bestowed on the human species (Spradley, 1980, pp. vii-viii).

It was the purpose of this study to more fully comprehend the nature of the cultural diversity which exists in the constructivist classroom and utilize this understanding in regard to implications for mathematics education.

Noddings (cited in Davis et al., 1990) stated that ". . . cognitive constructivism implies pedagogical constructivism; that is, acceptance of constructivist premises about knowledge and knowers implies a way of teaching and acknowledges learners as active knowers" (p. 10). The acceptance of these constructivist premises not only implies a pedagogy but implies a qualitative method of study. In order to understand what

the learner actively knows and constructs, the method of inquiry reflects the assumption that the learner is indeed actively engaged in a continual process of constructing cognitive structures. For these reasons, an ethnographic approach was chosen for this inquiry.

Methods Terminology

Ethnography originated with anthropological research and is currently deemed practical in the social science realm (Emerson, 1988; Goetz & LeCompte, 1984; van Manen, 1990). Educators recently developed an appreciation for the practicality of ethnographic research applied to education and this form of inquiry was invited into the educational community. Some educational researchers argue that ethnography does not produce empirical evidence:

> True, it is not statistical, but nothing could be more empirical. Additionally, and more importantly . . . applying the term ethnography to a broad range of studies which utilize some number of ethnographic methods or techniques but do not conform to the rules of ethnography (either in data collection or analysis), and also do not result in an ethnography, is counterproductive to ethnography as a methodology and the educational research which ethnography could produce (Lutz, cited in Hammersley, 1986, p. 107).

Quality ethnographical studies, however, provide descriptive perceptions of life in group settings which are better understood because of this form of inquiry.

A definition of ethnography, culture and the integral aspects of each is necessary at this point. It is also important to define the techniques of data collection: participant observation, ethnographic interview, and literature research. For clarification, the following terms need definition: ethnography, culture, cultural behavior, cultural knowledge, explicit culture, tacit culture, symbolic interactionism, cultural artifacts, participant observation, ethnographic interview, and literature research.

Ethnography

> Lutz (cited in Hammersley, 1986), described ethnography as a
>
> . . . holistic, thick description of the interactive processes involving the discovery of important and recurring variables in the society as they relate to one another, under specified conditions, as they affect or produce certain results and outcomes in the society (p. 108).

Participant observation, case studies, interviews, and such are just a few of the techniques recognized as ethnographic. Emerson (1988) stated that the central aim of ethnographic inquiry is to contribute to the understandings of cultural and social life. His perception of the fundamental ". . . task of fieldwork is to provide rich, empirically based descriptions of the distinctive social life and activities of those studied. Fieldwork thus seeks to produce an ethnography of the people or setting studied . . . " (p. 19). Emerson defined the purpose of ethnographic descriptions as a presentation or representation of ". . . the local meanings and contexts of complex human actions" (p. 26).

Spradley (1980) viewed ethnography as the process of describing a culture. The central aim of ethnographic research is to understand a culture from the participants' viewpoint. The goal, as seen by Malinowski (1922), is to grasp the participants' point of view, ". . . his relation to life, to realize his vision of his world" (p. 25). The ethnographer seeks the construction of hidden principles which govern a culture. "Ethnography studies the culturally shared, common sense perceptions of everyday experiences. Ethnography is the task of describing a particular culture (ethnos) . . ." (van Manen, 1990, p. 177). van Manen (1990) stated that the ethnographic approach is used to study cultural "scenes" or cultural settings. The questions asked are "What do people do here? What kind of people are here?"

The ethnographic design of this inquiry borrows from these definitions or views of ethnography. The task of this study was to participate in the mathematics culture of a primary constructivist classroom and describe what was happening and what the

people were doing. Through participant observation, ethnographic interviews and literature research, the aim was to recreate the reality of the primary constructivist classroom from the participants' point of view.

Culture

"Culture is understood as a cognitive code for attributing meaning. . . . In this sense culture in a specific social setting consists of whatever it is one has to know in order to operate in a manner acceptable to its members" (Emerson, 1988, p. 28). Emerson stated that the major goal of ethnographic description is to recognize and specify the principles, codes, or rules which govern a culture. Culture is defined by Goetz and LeCompte (1984) as ". . . everything having to do with human behavior and belief" (p. 15). This includes customs, ideas, knowledge, behavior, artifacts, and way of life.

Fetterman (1989) referred to Goetz and LeCompte's (1984) view of culture as a holistic perspective in that it considers the ". . . materialistic interpretation of culture which focuses on behavior" and the ideational perspective which specifically excludes behavior (p. 27). Fetterman believed a holistic approach to ethnography presents a more comprehensive reality construction of a social group for the ethnographer seeks to describe ". . . as much as possible about a culture or social group" (p. 29). Spradley (1979) defined culture as ". . . the acquired knowledge that people use to interpret experience and generate social behavior" (p. 5). This involves the detailed observation and interpretation of the behaviors, the knowledge, identified through speech messages, and the artifacts of a social group (Figure 2).

As demonstrated, culture is defined in many different ways. This study used a holistic approach to defining culture, which includes the behavior, knowledge, speech, and artifacts of a social group, a primary constructivist classroom. This ethnographic inquiry was concerned with deriving meaning from those behaviors, knowledge, speech

and artifacts, in regard to mathematics. The emphasis of this inquiry was on understanding the meaning

> The ethnographer observes behavior, but goes beyond it to inquire about the meaning of the behavior. The ethnographer sees artifacts and natural objects and goes beyond them to discover what meanings people assign to these objects. The ethnographer observes and records emotional states, but goes beyond them to discover the meaning of fear, anxiety, anger, and other feelings (Spradley, 1979, p. 6).

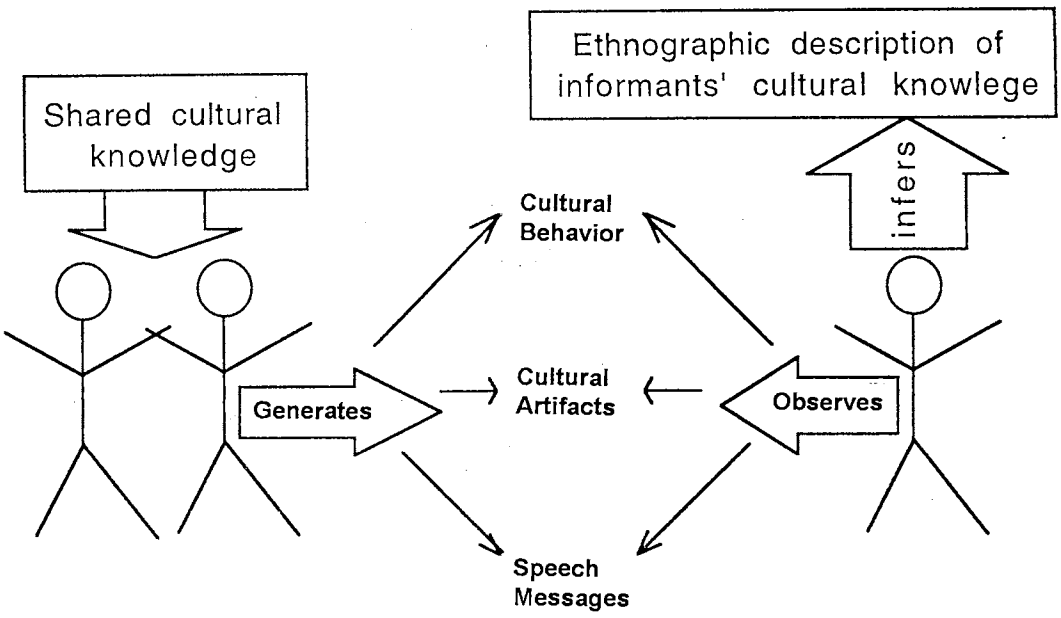

Figure 2. Making Cultural Inferences (From *Participant Observation* (p. 11), by J. P. Spradley, 1980).

This inquiry into a primary constructivist classroom culture was concerned with the acquired knowledge of the participants and the use of that knowledge to interpret their experiences and generate their social behavior.

In order to understand the definition of culture as it is related in this study, it is important at this point to further define culture by determining what is meant by cultural behavior, cultural knowledge, and cultural artifacts. Although these cultural aspects are usually interrelated and intricately bound together, it is important to designate their distinctions.

Cultural Behavior. This refers to the behavior, actions or activities within which one engages, which is accepted by the culture. Cultural behavior is acquired through a system of complex meaning systems which have been cognitively created to help individuals make sense of and participate in their world. Those behaviors, covert and overt, in which we engage as a result of participating in our culture constitute cultural behaviors. An example of this in a traditional classroom setting is a child who recognizes the need to raise a hand before addressing the teacher.

Cultural Knowledge. The learned rules, principles, and codes which govern a way of life constitute cultural knowledge. It is the large body of shared knowledge that people learn and use to engage in behaviors and make proper use of the artifacts connected with those behaviors (Spradley, 1980). One example of American cultural knowledge is the English alphabet. "Cultural knowledge exists at two levels of consciousness: explicit culture and tacit culture" (Spradley, 1980, p. 7). "Explicit culture makes up part of what we know, a level of knowledge people can communicate about with ease" (Spradley, 1980, p. 7). Tacit culture, on the other hand, refers to the cultural knowledge which remains outside our consciousness or our awareness. Ethnography aims to study both the explicit and the tacit culture of a social group.

As stated earlier, the study of a culture is concerned with meaning. This concern and the concept of acquired knowledge has ". . . much in common with symbolic interactionism, a theory that seeks to explain human behavior in terms of meanings" (Spradley, 1980, p. 8). Blumer (1969) identified three premises on which symbolic interactionism lies. These premises support the importance of examining meaning in ethnographic inquiry:

1. The first premise states that, ". . . human beings act toward things on the basis of the meanings that they have for them" (Blumer, 1969, p. 2).

2. The second premise is that the ". . . meaning of such things is derived from or arise out of, the social interaction that one has with one's fellows" (Blumer, 1969, p. 2).

3. The third premise is that ". . . meanings are handled in, and modified through, an interpretive process used by the person dealing with the things he encounters" (Blumer, 1969, p. 2).

"If we take meaning seriously, as symbolic interactionists argue we must, it becomes necessary to study meaning carefully. We need a theory of meaning and a specific methodology designed for the investigation of it" (Spradley, 1980, p. 9). Ethnographic research offers such a theory and methodology (Spradley, 1980).

Cultural Artifacts. Spradley (1980) defined cultural artifacts as the things people shape or make from natural resources. These include the tools they use and the projects they make. In a constructivist classroom, artifacts include the children's, and teacher's, tools, supplies, products, and such, which emerge from the culture due to their usefulness and appreciation. Examples of classroom artifacts include books, student projects, objects of all types, commercial manipulatives and resource materials. The participation in, collection and examination of the artifacts will involve four activities: locating the artifacts, identifying the material, analyzing the artifacts, and evaluating the artifacts (Goetz & LeCompte, 1984).

Participant Observation

Goetz and LeCompte (1984) designated participant observation as a primary technique used for ethnographic research. This technique involves the researcher as much as possible in the actual participation of the culture. The researcher takes part in the daily activities and attempts to function as a member of the culture, learning, experiencing, and using the cultural knowledge, behavior, and artifacts. The investigator reconstructs participant interactions and activities through field notes which are taken on the spot or as soon as possible thereafter (Goetz & LeCompte, 1984). Included in the field notes are the interpretive comments based on researcher perceptions which are translated into the ethnographic description of the culture. "Participant observation serves to elicit from people their definitions of reality and the organizing constructs of the world" (Goetz & LeCompte, 1984, pp. 109-110).

The actual tasks required of participant observation as it was conducted in this study are outlined in a following section on the Developmental Research Sequence Method (Spradley, 1980) which was used throughout this study. Each task is stated and a brief description of task completion is provided.

Ethnographic Interview

Ethnographic interviews are conducted with the informants or the participants of a culture. The interview has an explicit purpose, to understand or gain more knowledge about the informant's culture. Spradley (1979) stated that ethnographic interviews are concerned with explanations regarding the research purpose, recording or documentation explanations, native language explanations which remind informants to use or explain what a word or phrase means in their cultural context, and explanations which describe the nature and purpose of certain questions. There are several question types used in an ethnographic interview: descriptive questions, structural questions, and contrast questions.

Descriptive Questions. Questions which direct the informant to describe something which occurs or occurred in their culture. Could you describe how to play this game?

Structural Questions. These questions allow you to find out how informants structure their culture or organize their knowledge. What are the different ways you could model the quantity 10?

Contrast Questions. These questions aim for the cultural meaning of various terms used in the language of the culture. What is the difference between add and subtract?

Spradley (1979) stated that in ethnographic interviews the ethnographer asks the majority of questions and the informant's role is the relation of experiences. The ethnographer repeats questions and restates them. The ethnographer assumes the role of uninformed and interested and allows the informant to assume the role of expert. The ethnographer encourages expansion on all topics discussed attempting to develop the best reconstruction of the cultural knowledge.

Literature Research

A literature research is conducted as patterns and relationships emerge from participant observation and interviews. The literature research aids in the reconstruction of reality in that it describes and explains "what is happening" and "what people are doing" in a cultural setting. van Manen (1990) stated that when researching lived experiences, ". . . literature may contain material which has already addressed in a descriptive or an interpretive manner the very topic or question which preoccupies us" (p. 74).

Ethical Principles Regarding Ethnography

The Principles of Professional Responsibility outlined by the Council of American Anthropological Association (1971) guided the confidentiality of this study:

1. Consideration of the informants is first.
2. The informants' rights, interests, and sensitivities will be safeguarded.
3. The research goals will be communicated.
4. The informants' privacy will be protected.
5. The informants' will not be exploited.
6. The reports will be made available to the informants.

The Developmental Research Sequence Method

The Developmental Research Sequence Method (D.R.S.), was developed by Spradley (1979, 1980) in order to help students of ethnographic inquiry to conduct such studies. Two companion books were published, *The Ethnographic Interview* (Spradley, 1979) and *Participant Observation* (Spradley, 1980), which involve a sequence of fieldwork tasks and a sequence of writing tasks helpful to the novice ethnographer. Two assumptions underlie Spradley's (D.R.S.) Method. The first, even though ethnographic research is perceived as cyclic it has been observed that some ethnographic fieldwork tasks are best performed prior to others. The second assumption is that ethnographic research is best learned by doing ethnography. These two assumptions direct the design of Spradley's D.R.S. Method.

There are five principles which underlie the D.R.S. Method (Spradley, 1979, 1980). Identification of each principle and a brief description are found below:

1. The single-technique principle--There are several techniques for doing ethnographic research. It is important to understand each single technique first and then develop an appreciation for their connections and interrelationships.

2. The task identification principle--Twelve basic tasks are identified so that one learns basic skills necessary to carry out the specific technique in regard to original research.

3. The developmental sequence principle--The tasks are presented in a developmental sequence that allows the original research to unfold naturally. The sequenced presentation of tasks focuses the novice ethnographer and the research.

4. The original research principle--The D.R.S. Method requires the completion of original research while developing an understanding of the methodology described within the texts, *The Ethnographic Interview* (Spradley, 1979) and *Participant Observation* (Spradley, 1980).

5. The problem-solving principle--The sequence of tasks designated by Spradley (1979, 1980) includes the anticipation of problems which typically arise in original research and applies a problem solving approach throughout its description to help ensure success.

The 12-step D.R.S. Method was used to direct the participant observations and ethnographic interviews utilized throughout this project. The 12 steps required for each technique are outlined below in separate sections. It is important to note that ethnographic research is cyclic and the steps were often completed simultaneously. The field tasks and writing tasks as defined by the D.R.S. Method are described for both participant observation and ethnographic interviewing.

Participant Observation (Spradley, 1980)

Step 1. The field task was to locate a social situation. A social situation we defined as a kind of place in which actors are engaged in activities. The selection of a social place requires one to consider simplicity, accessibility, unobtrusiveness to some degree, permissibleness, and frequency of recurring activities. The writing task was to define the nature of ethnographic research.

Step 2. The field task was to do participant observation with the dual purpose of engaging in activities and observing situations within a social situation. This involved engaging in and observing both student and teacher activities. The writing task was to discuss the role of language in ethnographic research.

Step 3. The field task was to make an ethnographic record for field notes and their analysis and interpretation. The writing task was to begin an ethnographic description of how the project was conceived.

Step 4. The field task was to make descriptive observations of the cultural scene and situations. The writing task was to describe the physical setting of the social situation.

Step 5. The field task was to make a domain analysis. The writing task was to summarize the domains of the cultural scene.

Step 6. The field task was to make focused observations. The writing task was to revise the summary of the cultural scene based on these focused observations.

Step 7. The field task was to make a taxonomic analysis determining categories of meaning from field experiences. The writing task was to describe a specific cultural domain within the culture.

Step 8. The field task was to make selected observations. The writing task was to write a dialogue on a cultural domain.

Step 9. The field task was to make a componential analysis making use of data from all sources. The writing task was to select a different domain and write a formal description making clear the meaning. Specific examples for clarification were necessary.

Step 10. The field task was to discover cultural themes. The writing task was to describe a cultural theme and show how the theme connects several cultural domains.

Step 11. The field task was to take a cultural inventory. The writing task was to describe the development of the research.

Step 12. The task was to write the ethnography including suggestions for future research in the area.

Ethnographic Interview (Spradley, 1979)

Step 1. The field task was to locate an informant. An informant must fulfill five requirements: thorough enculturation, current involvement, an unfamiliar cultural scene, adequate time, and non analytic. The writing task was to define the nature of ethnographic research.

Step 2. The field task was to interview an informant. The writing task was to discuss to role of language in ethnographic research.

Step 3. The field task was to make an ethnographic record. The writing task was to begin an ethnographic description of how the project was conceived.

Step 4. The field task was to ask descriptive questions. The writing task was to describe the physical setting in which the informant carries out routine activities.

Step 5. The field task was to analyze ethnographic interviews. The writing task was to summarize the domains of the cultural scene.

Step 6. The field task was to make a domain analysis. The writing task was to revise the summary of the cultural scene based on these focused observations.

Step 7. The field task was to ask structural questions. The writing task was to describe a specific cultural domain within the culture.

Step 8. The field task was to make a taxonomic analysis. The writing task was to write a dialogue on a cultural domain.

Step 9. The field task was to ask contrast questions. The writing task was to select a different domain and write a formal description making clear the meaning. Specific examples for clarification were necessary.

Step 10. The field task was to make a componential analysis. The writing task was to describe the development of your relationship with the informant.

Step 11. The field task was to discover cultural themes. The writing task was to describe a cultural theme.

Step 12. The task was to write the ethnography including suggestions for future research in the area.

Since ethnographic research is cyclic and not linear these steps served as a guide for this inquiry. The nature of the research, however, necessitated repetition and nonsequential structure of the steps from time to time. It is not the intent of the D.R.S. Method to restrict cyclic research; rather, it intends to provide structure for the novice ethnographer.

Reliability and Validity

The nature of ethnographic inquiry and the techniques of research pose different problems than those of quantitative research. The problems of reliability and validity in research design and implementation affects the quality and credibility of the work. This study ensures reliability and validity through the triangulation of literature research, participant observation, and ethnographic interviews. Reliability and validation were further ensured through the analysis of all three aspects of a culture: behavior, knowledge, and artifacts. Throughout writing this document, and upon completion, Clara examined the report to assure the validity of the inferences made to reconstruct the cultural reality (Janesick, 1991).

Summary and Preview

The methodology and rationale for methodology selection were discussed in detail in this chapter. Throughout ethnography, one walks a fine line between participant and observer in attempt to reconstruct a cultural reality. Much of the personal experiences of a participant observer in a constructivist culture lead to further reflection and reconstruction. The nature of ethnography is very personal. It is necessary for the

ethnographer to personalize experiences in order to completely understand and attempt to reconstruct the culture, while maintaining an observatory lens.

The following chapters evolved naturally from the study. The "awareness" of cultural aspects unfolded in the order of their appearance. Even though it was hard to distinguish or separate certain aspects into isolated parts, the evolution of cultural understanding guided the chapter presentation. Chapter I presented an introduction to the research project and a rationale for looking at alternative approaches to teaching mathematics, specifically a constructivist approach. The method of study and a rationale for qualitative research was presented in this chapter, Chapter II. Chapter III reconstructs the reality of an emerging constructivist teacher. Chapter IV describes the mathematics culture of a primary constructivist classroom. It was through the triangulation of literature research, participant observation, and ethnographic interviews that the primary constructivist reality was reconstructed; therefore, it was important to blend the review of the literature with the results in these two chapters. Chapter V outlines implications and recommendations for mathematics education derived from the research.

CHAPTER III

THE EMERGING CONSTRUCTIVIST TEACHER

Introduction

Educational dialogue is an important part of developing philosophical positions on how children think and learn (De Vries & Kohlberg, 1989). Beliefs about how children think and learn are fundamentally connected to how we teach them. This is one priority to teaching children. Conversely, the manner in which we teach children implies what we believe about learning. If we assign rote worksheets for addition practice, the implied assumptions are that children learn addition from repetitious practice of basic facts which are isolated and unconnected to other curricula or real-life situations (NCTM, 1989; Shoemaker & Lewin, 1993; Tchudi & Tchudi, 1991). If we engage a group of children in cooperative problem solving situations in which addition facts emerge from students' prior experiences, our evident beliefs about children are very different from those presented above.

As educators, it is important to examine what we do in our classrooms to determine if it is consistent with what we believe about learning (Garman, 1987; Tchudi & Tchudi, 1991). It is also important to develop beliefs about how children think and learn that are based in current research, so that appropriate methods are used to promote the intellectual growth and development of children (Bredekamp, 1987; Bredekamp & Rosegrant, 1992). Constructivist philosophy attempts to scientifically explain epistemology and promotes decisions regarding practices (De Vries & Kohlberg, 1987; Kamii, 1981; Piaget, 1970). Given that constructivist practices are implied by constructivist philosophy, the types of knowledge deemed valuable are

different than traditionally thought (De Vries & Kohlberg, 1987; Kamii & DeClark, 1985) as well as the "ways of coming to know" (Pateman, 1993, p. 69). Isolated facts are not perceived beneficial to the meaningful construction of knowledge. The constructivist focus of education is no longer content, rather it is the process of growth and development. Emergent constructivist beliefs foster reflective inquiry into all aspects of curriculum and instruction (Prevost, 1993).

Reflective practice was the catalyst for Clara Huneke's philosophic growth and development. Clara Huneke is the teacher of a second grade classroom in a university town. Her philosophy of learning is an emerging constructivist philosophy and this has direct implications for her curriculum and instruction (Fosnot, 1989; Schifter & Fosnot, 1993). Issues surfaced throughout her teaching years that were not consistent with her intuitive or implicit beliefs (Sanders & McCutcheon, 1986), resulting in her feeling unsettled and undirected. She is very clear and purposeful in her ideas and beliefs today. The socialization process of teachers creates tension and self-questioning that Clara believes ". . . might not occur if others shared my beliefs . . . more others, that is." It is this lack of shared philosophy, founded in how children learn, that Clara perceives is a hindrance at her school and in the educational community at large (Kamii, 1981). The absence of a philosophy founded in how children learn is the core of the issues Clara finds critical in the kindergarten-primary curriculum today.

This chapter focuses on Clara Huneke, her emerging constructivist beliefs, influences that aid in the formation of her constructivist philosophy, and compromising situations of change. It begins with a conversation regarding the critical issues of kindergarten-primary education as Clara perceives them and how these issues influence her professional decisions. The chapter concludes with a personal picture of Clara's professional evolution which describes her emergent beliefs. Clara and I had several long interview sessions in person and on the phone which demonstrated her cultural reality. Participant observation in the classroom culture and the literature

research was congruent with the interview findings. Clara read the presentation of chapters three and four and clarified entries to ensure validity.

Come, Get to Know Me, I'm Quite All Right

One quiet, late spring afternoon Clara and I were able to sit and enjoy a calm conversation together. We sat in her cool farm house and discussed critical issues, historical origins, philosophical positions, and the effects of these positions on her and her perception of the effects on her students. Clara and I had been working together for over a year and had become comfortable with each other. This afternoon was different, though, in that we were able to reach a more personal experience that allowed us to share what I came to experience as her reality; often an exciting, spinning world of new beginnings and intellectual constructions and often a sad, isolated place of rejection, confrontation and self-questioning. The exciting days overshadowed the isolated ones and motivated her to continue to progress and remain committed to her beliefs.

On that quiet afternoon, I sat on the couch across the room from Clara as she proceeded to tell me what she felt were the critical issues prevalent in kindergarten-primary curriculum today:

> The critical issue in kindergarten-primary education today at the local level is outcome-based education. Yes, outcome-based education is an important issue right now . . . and how we are going to check off performances on a 'given day' and still allow the child the growth time they need . . . we are not concerned for the emotional and social needs of these kids . . . we need to focus on the whole child, not just what the child can do on a given day.

This discussion led into the questions of when children should start school and transitional first. Clara views these as two other critical issues upon which educators

need to reflect. (These and other critical issues which surround the kindergarten-primary curriculum are found in Figure 3). On transitional first, Clara reflects that educators ". . . tried to develop these little stepping points to help those whose needs have not been met." She perceives transitional first as negative because it "tracks children." Tracking is a practice we are trying to get away from (Bredekamp, 1987; Bredekamp & Rosegrant, 1992) and the transitional first practice perpetuates tracking under the guise that we are offering children additional time to grow. In reality, "extra year programs" not only track children, but a disproportionate number of children occupying these programs are minority, and/or low socio-economic background (Dobson et al., 1985; Elkind, 1993).

As for when children should start school, Clara says that:

> When placing the children, we shouldn't be as focused on age as we are. We need to compare the child to the child, not to the other children whose ages and development are different. Early childhood education is important because it provides the foundation for future learning that children carry with them into adult life. Current entrance practices are counter to what research says about children's growth and development. I just don't understand why we aren't listening to these important findings!

Clara sighs as she sits back on the couch. These last words had moved her forward in position as if she had to get closer to make me "really" hear what she was saying. Current research indeed indicates that a child's success in school can be predicted, given situational factors, by the end of grade three (McPartland & Slavin, 1990). Reflective educators agree, why aren't we listening to these important findings (Elkind, 1993; Katz & Chard, 1989)?

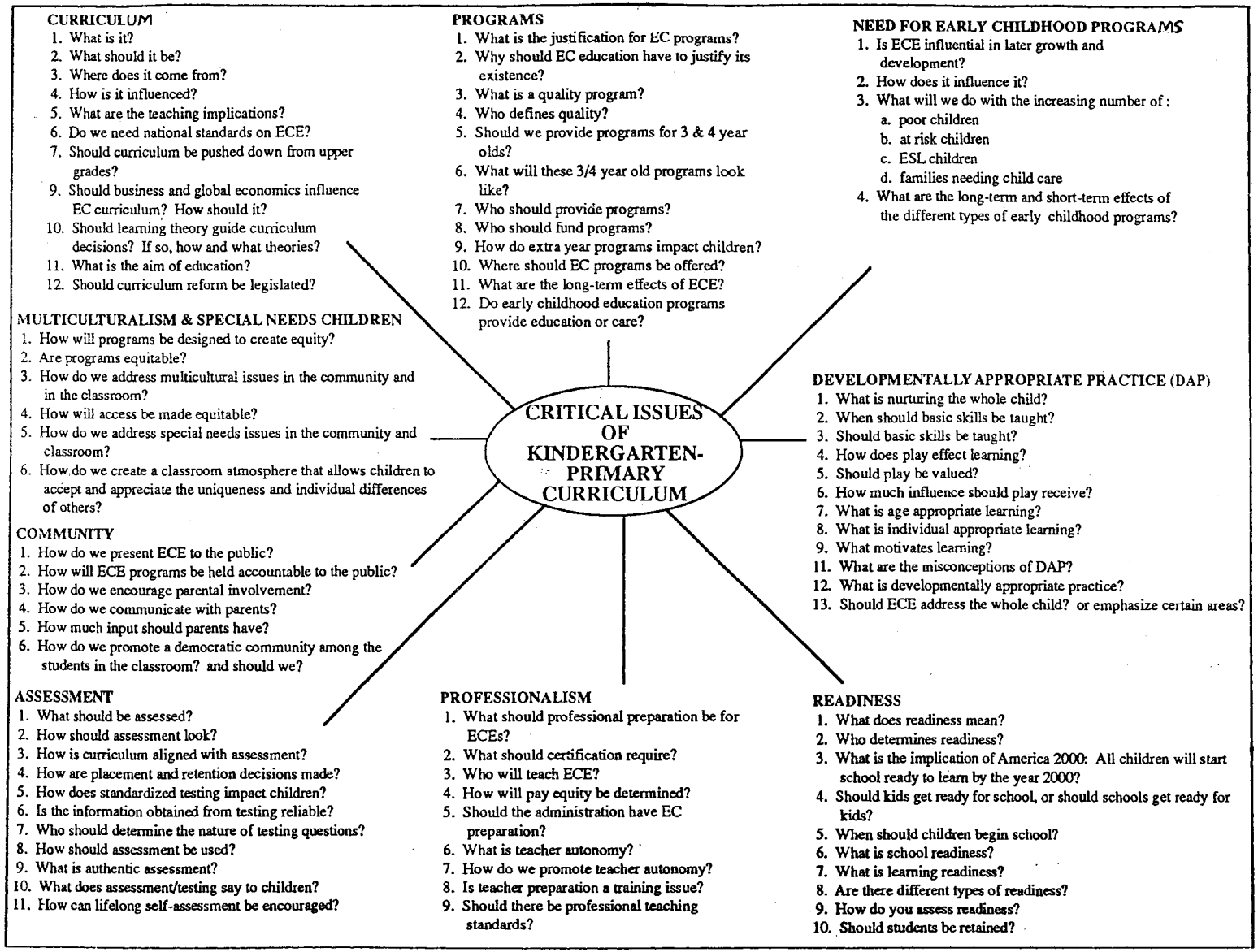

Figure 3. Critical Issues of Kindergarten-Primary Curriculum

The issues Clara cites and the ones found in Figure 3 are not new. The research to support change exists, yet we do not move from our traditional roots. Restructuring education by implementing transitional first grades is a misguided solution for children whose needs have not been met, because it attempts to hold on to past doctrines (Dewey, 1948). Clara explains that:

> Starting school at a certain age was influenced by Gessell . . . he showed where a child could perform mature thoughts and that readiness occurred at a certain age. His method or approach implied that kids are ready at a certain time for learning. Schools were influenced by this 'designated age' and implemented it.

This was an easy answer because it fit into the existing educational system without causing elaborate changes in thinking. Clara asks, "What is ready? Which, I suppose, brings us right back to the issues surrounding outcome-based education." We laugh at the circular reasoning of our conversation and exchange a few shakes of the head as it becomes evident that this circular reasoning occurs often when we talk about educational issues. It is evident that education is not applying what we know about how children learn at <u>any</u> level of decision making (Kamii, 1981). After a few moments of silence, I ask, "Why do you think this entire issue exists?" Clara responds,

> Well, I think it exists because we needed to industrialize our nation . . . this moved us away from meeting the whole child, because I think we used to meet the needs of the whole child in many one room classrooms . . .we needed masses trained and we needed skills and that's when we lost sight of the social and emotional development of children.

Clara finds multi-age classrooms a viable answer to some of these issues. She believes this notion has been around for years and was abandoned due to the need to industrialize the nation (Dobson et al., 1985). Our needs are different for children of the twenty-first century (Schlechty, 1990) and the examination of alternative

approaches are to be commended. We need to ask, though, if reconceptualization as offered by Brown (1991b) would have us examining previous practices in light of tradition, and if multi-age classrooms actually have a chance if imposed in traditional frameworks.

Two philosophic positions are identified by Clara as in opposition with each other. One position emphasizes academic areas of learning and the other emphasizes the whole child. Clara describes the academic emphasis as being:

> . . . controlled, extrinsic in focus and strictly driven by skill and drill. There is one person in charge [the teacher] who dominates authoritatively. The class desks are in rows and the children are quietly learning from books that are all the same, or a 'given' book. The work value is independent. Children fear risk because there is only one option . . . one way.

Clara describes the whole child (Howe, 1993) emphasis as

> . . . an approach that drives teachers to watch children. The focus is on the child and teachers are driven to watch the child, not driven by the curriculum; although, they are always aware of the curriculum. Learning evolves from a child's interest, experience, and play. The children are intrinsically motivated if interested. The classroom looks very different than academic oriented rooms. Students are working together, taking risks, searching, investigating, constructing . . . it is an experience oriented room.

Clara's commitment to education that focuses on the whole child and is driven by the needs of children requires her to constantly ask, "What am I doing and why is this appropriate for this child?" These questions are pedagogical in nature and engage her in what van Manen (1990) referred to as researching lived experiences. Scientific considerations regarding how children grow and develop guide the experiences

promoted in Clara's classroom (Kamii, 1981). She finds that she must continually examine her curriculum and instructional practices as a scientist, so that underlying messages or double messages are not given to children, ensuring that practices are consistent with philosophy (Garman, 1987; van Manen, 1990).

Children have been negatively affected by the issues conjured by the academic emphasis (Katz & Chard, 1989). Clara continues:

> As a result of an academic emphasis, we are not meeting children's needs. We are tracking kids which effects future successes and failures. We are not building self-thinking or autonomy. Children no longer try to please intrinsically they rely on external reward, extrinsic motivation. Children are driven by an authoritarian system that has harmful effects for the future as well . . . we are just not focusing on the children!

Energy generates with this last comment as Clara becomes very charged with the frustrated reality of educational practices that focus on the academic. Her highly energized state leads into the next question, "How have these issues affected you?" Immediately she slumps back in her seat on the couch and takes a deep breath, the energy previously exhibited is suddenly gone as she glances to the floor. When she looks up she quickly says,

> These issues have isolated me. You have to be strong in your beliefs. . . do it discretely, and always be on your guard. You always have to know what you are doing and why you are doing it because you will need to defend it. Even when you called and asked if you could conduct your study in my classroom, I worried that even you thought I was 'so far out there' that you wanted to compare what I do to all those others who are out there 'doing it right.'

As she said this, a much needed tear fell from her eye and was followed by more confessions of self-doubt and system struggles. It was indeed a lonely, isolated

place inside herself that she did not like to visit often, yet was always aware resided within her. The importance of doing what was right for children, however, was so intense that she did not waiver from her commitment even as she continued to share her grief. It was a calm discussion and one that emersed me in her reality. Her momentary discomfort was the clue to her disequilibrium. Disequilibrium is resolved through knowledge construction. Clara remains unresolved because the educational system impedes her current beliefs about children and learning through practices that intrude on her autonomous efforts (Kamii, 1981). The process of change was evident and the recognition that Clara was living within this process which is often filled with uncertainty and pain was also evident (Etchberger & Shaw, 1992). The brief tears concluded, a moment of solitude had demonstrated clearly the cultural nature of an emerging constructivist teacher, some of the forces that drive Clara's educational decisions, and the way she thinks about children. It is okay to be different again and "she was quite all right."

"A person's philosophy or assumptions come from their experiences," Clara explained during another conversation. She went on to say:

> Teachers who come from experiences which were holistic in nature come to the profession with richer backgrounds. They tend to be fore-runners of change. Others who come from a limited, traditional background find it much harder to change.

Research supports the notion that rich constructive experiences are needed for teachers before change occurs (Schifter & Fosnot, 1993). Teachers coming from traditional backgrounds must work ". . . their way through the disequilibrium, disorientation, and confusion of unsettling that which they have always done, and done well" (Ball, in Schifter & Fosnot, foreword, 1993). The process of change is challenging and rewarding as Clara clearly relates. She finds that "You constantly wonder where

you lie on the 'continuum.' If you don't think about teaching, you won't think about growth and change."

Personal Evolution

Clara partially defines philosophy as what one deems is the aim of education. Teacher autonomy, she believes, is needed in order for one to develop that philosophy (Kamii, 1981; Wilucki, 1990). Teachers often act on implicit, personal theory (Combs, 1982; Sanders & McCutcheon, 1986); however, it is professionally important for teachers to purposefully examine how children learn and reflect on what that means for their classroom (Kamii, 1981). This requires scientific investigations in the classroom which generate thoughtful inquiry promoting the evolution of curriculum and instruction (van Manen, 1990). Clara finds this pedagogical inquiry lacking in the education profession and finds it difficult to practice on her own because of administrative and public action toward autonomous efforts of teachers (Kamii, 1981; Wilucki, 1990). Teacher autonomy is something she fights to achieve and describes her path as follows.

Student teaching was a "bad experience" for Clara. She almost quit during her student teaching placement. She attributes some, but not all, of this to age; she was 20 at the time. She described herself as a traditional student attending a major university practicing traditional pre-service development that promoted some alternative approaches to education. She remembers loving education, yet unable to compromise attitudes toward "basals" and the manner of instruction promoted by them (Bolin, 1988). In her student teaching placement, she found the lack of student discourse hard to understand and often wondered what the children were thinking. She did make an A in her student teaching assignment, but describes it as a time of "internal turmoil" because it "went against everything inside me."

In the college Clara attended, pre-service teachers were instructed in how to use basals to teach children. The curriculum and instruction department had "some hands on materials" but they were not used very much. She did, however, get a chance to experience some alternative methods of instruction in math, science, and social studies curriculum and instruction courses. She found social studies to be the most enjoyable because the students engaged in active, project-based instruction throughout the semester. Clara experienced learning in college the types of methods she wanted to use in her classroom, and this encouraged her to stay in education as a profession (Prevost, 1993).

The "problem," as Clara perceives it to be one, started when she began her student teaching in a controlled, quiet traditional classroom environment. This placement shaped her teaching practices the most (Ellis, 1993), while at the same time throwing her into a state of disequilibrium (Bolin, 1988). The educational system, as it is traditionally designed, could not and did not provide the environment which promoted a timely resolution. Clara entered the professional community in kin with many first year teachers (Simmons, 1993) during the present educational reform, greatly imprinted by a traditional cooperating teacher and uncomfortable with previous alternative approaches studied (Ellis, 1993).

Entering her first classroom, a second grade setting, Clara began by using the basal series for all subjects. The teacher's guides were very important to her, even though she did not feel this was "right." She supplemented the basal instruction and some of the curriculum with centers. The centers provided an avenue of individual expression for her and the students. During her first year, she found it very difficult to balance everything she needed to do (Smith, 1993). Katz (1977) referred to this stage of teacher development as survival.

Survive she did, and eventually she reports in recollection that the centers *became* the curriculum. She later made a "deal" with the district to allow her to teach

three days from the basals and two days using children's literature. "I loved literature," she said. There were not many math materials available at the school. She remembers that she did find a science box that had quite a few hands-on items for investigation, and these materials were used in the centers. Through acts of consolidation (Katz, 1977), Clara continued to develop as a professional.

The second year Clara was employed she was relocated to a fourth grade placement. School practices continued much like the previous year except that this time she was in a new district with books that were over 20 years old. She was expected to teach from these outdated materials. She remembers it as a "horrible year," even though "We did do some fun things that year."

She moved again her third year and is currently employed with that same district, the district granting permission for this inquiry. She taught first grade her first two years and moved to K+ for one year. She then taught second grade and was in her third year of second grade when this inquiry occurred. Clara proclaims, "I started to emerge here." She believes professional emergence occurred because she was "surrounded by strong compatible individuals." There were many innovative approaches to teaching occurring in rooms and schools in her direct area (Katz, 1977). She recalls that reading was highly supported and she moved into a literature-based reading curriculum with instructional practices implied by a whole language philosophy.

Clara was unable at this time to connect the philosophy to how children learn and remained limited to the idea that children learn *reading* through experiences that promote literacy construction (Kamii, 1981). Philosophical development emerged as "content isolated" when Clara began efforts of change. This may be due in part to an incomprehensible ability to "do it all at once" (Hart, Schultz, Najee-ullah, & Nash, 1992).

Clara had experienced changes in grade levels, geographic location, size of the district, resources, and peers. She found each of these changes to be a positive force in her professional development and claims the combination promoted her professional

growth and development. Clara had entered the third stage of teacher development, renewal, as identified by Katz (1977).

After her first years in the primary grades, Clara's school began a computer lab. She related that the children "hated" to return to the classroom and she wondered why they were so reluctant to return. Clara explains her thinking, "Through reflection, I determined my math program was the problem (Bolin, 1988). The kids hated to return to class because math was next." She changed her math time and found that regardless of when she scheduled math, the children would perform a variety of distracting behaviors from fighting to deliberate discussion leading off task in order to keep math from starting. Clara even admits to finding math uninteresting herself.

At this point, Clara reflects that she had not read resources that would help to improve her mathematics instruction or promote the construction of relationships between her reading philosophy and mathematics instruction. She was enrolled in several reading courses which were promoting a holistic literacy program (Kamii, Manning, & Manning, 1991).

> . . . the kids were loving the constructions, hands-on active involvement of reading, and they were constructing knowledge about reading, writing . . . Math was so opposed to this. It was traditional drill and practice worksheets that the kids were revolting, rebelling, picketing over!

Clara was engaged in traditional mathematics curriculum and instruction and she felt she lacked the pedagogical knowledge to make the changes or to even recognize that changes could be made (Hart et al., 1992).

Clara embarrassingly admits to teaching language all morning and leaving math to one hour in the afternoon ". . . if they got to it. Well, we did math most of the time but it wasn't very meaningful and certainly not what it is today." During her fourth year of teaching, Clara purchased a *Mathematics Their Way* (Barretta-Lorton, 1976) book at a "big book" workshop she attended. At this workshop, Clara met a woman named

Sarah, to whom she confided her present concerns about her mathematics program. Clara explains that, ironically, her new friend was attending the reading workshop because she had made some fundamental changes in her mathematics curriculum and felt her reading was not consistent with what she wanted to promote in mathematics. Sarah told Clara that if she liked her literature-based literacy program she should try the *Mathematics Their Way* because they were similar in their approaches to teaching. The two, Clara and her new math friend, made a pact to exchange ideas and help each other. Clara would help Sarah with reading changes while Sarah helped Clara with her mathematics program. Clara immediately purchased the *Mathematics Their Way* resource hopeful that things would change and change soon.

Unfortunately, with the busy schedule of classroom teachers, Clara and her new friend found little time to help each other. After purchasing the book, Clara went home and began to read. She was elated with the prospect of positive change; however, excitement quickly turned to confusion. Clara found the book impossible to follow and even harder to implement. She struggled to make sense of even the smallest aspects of the book. Meanwhile she faxed an application she received from Sarah for a local *Mathematics Their Way* (Barretta-Lorton, 1976) workshop. She convinced her principal to purchase four hundred dollars worth of manipulatives, which helped her develop an understanding of several of the activities. She started using several of the games and activities in isolated supplement, a game here and an activity there. She was thrilled with the student interest and even more excited to hear their ideas about the mathematics relationships they were developing.

Also at this time, a reading professor that Clara was taking a course with informed her of a new mathematics curriculum and instruction professor named Dr. Everett. Clara began to work with Dr. Everett. Numerous phone conversations between the two still left Clara unclear and unsettled in attempt to understand the *Mathematics Their Way* (Barretta-Lorton, 1976) program. Conversations with Dr.

Everett are congruent with Clara's relation. It was difficult to follow the program based on the text. Later Clara related that it was really ". . . humorous to go to the *Mathematics Their Way* workshop and realize how 'wrong' I was doing the different games and activities." Clara goes on to explain that a philosophy of emergent knowledge construction guided the program activities and she sometimes violated the basic tenets of the program and that many times the games were actually constructed incorrectly possibly leading to what she thought was inappropriateness. She survives this process of renewal in mathematics and remains here for some issues.

During the spring of this same year, Dr. Everett presented a math tile workshop on site at Clara's school. Clara was stimulated by the ideas presented and found them to have considerable applicability in her emerging beliefs about mathematics instruction. She stayed late after the workshop, which she said was a tremendous sacrifice because she had a new baby at home and found it hard to sacrifice time with her child. Her commitment to change held her there and she relates a crazed set of circumstances beyond her control, yet very much within her control. "After all," she explains the circumstances, "I could have gone home, but yet once I found this stuff [the math tile ideas], I just couldn't, not yet." Clara reflects,

> Dr. Everett fed me through my 'math crisis.' She talked with me and always accepted me at whatever level of math pedagogy I was at. Her help gave me the survival techniques I needed to get through the year. It complimented the literature and gave me some things to please the kids and myself.

Clara began to pedagogically reflect and found that the philosophical assumptions of her literacy program were fundamentally connected to her beliefs about how children become literate (Garman, 1987). It was a subtle notion that needed more thought.

During the summer prior to her fifth year of teaching, Clara enrolled in an independent study with Dr. Everett. As part of the study requirements, Dr. Everett was

to visit Clara's classroom prior to school starting. Clara was to share and demonstrate her personal beliefs about children's mathematical learning by describing a tentative program for promoting the development of mathematical relationships for children to be piloted for the upcoming year. Clara had designed and collected a vast array of constructive materials relevant to providing experiences which promoted mathematical relationships. Clara stated that she was very excited about her professional growth and development. Her thinking about mathematics curriculum and instruction was quite different from what it was the previous years (Kuhn, 1986). These new beliefs began to guide her instructional decisions. Her new ideas or concepts were fragile, however, and she searched for everything she could find to support her changes. The fragility left her vulnerable and she found it hard to wait for Dr. Everett to come to her room for fear that what she constructed would "not be appropriate." In her mind, Dr. Everett was awarded this power, yet there was some part of her that knew she was on the right track and motivated her to invite the meeting.

Clara explained that Dr. Everett found her new program to be innovative and considerate of the current research on how children learn mathematics. Dr. Everett began video-taping Clara's K+ classroom and the activities in which the children were engaged. At this point, Clara reflects that she used the *Mathematics Their Way* (Barretta-Lorton, 1976) program very rigidly with the intention of making adjustments to fit her emerging philosophy for the next year. The problem she encountered with this plan was that by the end of the year in K+, Clara would be reassigned to second grade.

Clara was rejuvenated by her new mathematics program and found that she was as excited about mathematics as she had been about her literacy program. She continued to take classes at the university and completed several special projects which focused on developing mathematical curriculum and instruction knowledge. The *Mathematics Their Way* (Barretta-Lorton, 1976) program remained important in her personal philosophic development, but Clara began to study more about constructivism

and constructivist approaches to teaching mathematics. The more she learned about how children learn mathematics, the more implications for curriculum and instruction she constructed. The *Mathematics Their Way* activities took on another more constructive dimension and she brought in many gaming activities as researched by Kamii and De Vries (1980). Students invented games and activities relevant to their needs and/or units of study. The children actively constructed models of mathematical relationships and ideas with a variety of materials. It did not, however, seem to Clara that she was changing enough. The more she learned, the more she questioned her practices.

Clara continues to use the *Mathematics Their Way* (Barretta-Lorton, 1976) ideas as part of her program, but finds they have a very different meaning and purpose in the classroom than when she first implemented the program. She works as a volunteer for the *Mathematics Their Way* workshops each year when they are presented in the area and serves as an area contact for teachers wanting to change their mathematics instruction. Her mathematics program is continually emerging and,

> . . . is never the same each year because I have new beliefs, new ideas, new children, and different circumstances. It's very exciting to teach math now. I see mathematics as more relevant to their every day lives and something that each child must construct for him/herself in his/her own growth and development time.

Clara Today

Presently, Clara finds herself using constructivist research to guide her curriculum and instruction, but hesitates to call herself a "constructivist." She says Kamii, De Vries, Piaget, and others are constructivists and she has a long way to go before she is one. If one defines constructivism as a philosophy of learning that promotes growth and development through reflective abstraction and interactions with

the environment and others, then it is evident that one is defining Clara's approach to her own professional growth and development as well as her approach to curriculum and instruction in mathematics (Kamii & DeClark, 1985; Kamii & Joseph, 1989; Piaget, 1965). She may not find herself in what she views as "equitable" distance on the continuum with Piaget, De Vries, and Kamii, but she demonstrates engagement in the process of promoting mathematical knowledge construction (Etchberger & Shaw, 1992).

As shall be demonstrated in Chapter IV, Clara's classroom meets the criteria stated for a constructivist classroom (Hagg, 1992). She declares autonomy, intellectual and moral, as the aim of education which has new meanings for her classroom (Kamii & DeClark, 1985; Kamii & Joseph, 1989; Piaget, 1965). Clara describes her classroom in the following ways. The students work in cooperative groups, individually, or in partners at their choice. They engage in reflective discourse both verbally and in writing. Several mathematics options are presented at a time, and children are free to adapt any existing activity or create new experiences. The activities Clara introduces are investigative in nature and every attempt is made to promote the natural emergence of experiences that involve children's senses and derive from experiences and prior knowledge. The children are actively involved in all aspects of learning, and materials are available to promote the construction of mathematical relationships. Many of the materials are everyday items that the children have at home and some are more specific to school settings. Clara is seen observing and listening to children, reflecting professionally on the important responses she will provide so that students are facilitated and not controlled. Error is valued and Clara often models important errors in her own thinking and how they provide information for growth. Children experience frustration (disequilibrium) and break-through (regained equilibrium) without fear (Hagg, 1992). The natural processes of growth and development are celebrated and perceived as essential to the learning process. Assessment is continuous and

ongoing. It is perceived as part of the learning process, and the children engage in self-assessment to the point that they conduct their own parent-teacher conferences at the nine week break. A portfolio of mathematical growth and development is constructed by each student as part of the learning process.

Summary

Clara's emergent philosophy reflects basic tenets of constructivism; however, she remains reluctant to identify herself or her practices as constructivist. She continues to examine her beliefs about how children learn and her findings have direct implications for her instructional practices. She changes or alters the nature of the experiences she promotes as she constructs pedagogical knowledge. Transition from traditional practices to constructivist practices takes many years. It is difficult to denounce previous practices because they are often so deeply engrained that we do not recognize that they are founded in inappropriate beliefs (Wiggins, 1994). Clara continues to engage in critical inquiry so that she can transform her mathematics curriculum and instruction.

Chapter IV presents an inquiry into the social situation of Clara's classroom. The language and environment, which interplay to create the class culture, are described. Vignettes of classroom situations demonstrate the cultural exchanges from which the cultural meanings emerge. It is the goal of education, defined by Clara as the autonomous growth and development of children, which construct cultural meanings as will be demonstrated in Chapter IV.

CHAPTER IV

THE CONSTRUCTIVIST MATHEMATICS CLASSROOM: A SOCIAL SITUATION

Introduction

This chapter addresses the remainder of the questions which guided this inquiry. The social situation, as defined by the interwoven phenomenon of the language and the environment, create the constructivist cultural reality (Maguire & Wolfe, 1993). The cultural layers (van Manen, 1991; Willis, 1991) of mathematics education in Clara's classroom involve more than the language and environment. The different layers of culture are experienced by inquiring into the entire context of the social situation. The environmental structures (van Manen, 1991; Willis, 1991) characterizing mathematics in Clara's classroom are identified for this study as the nature of the physical setting, the nature of the community, the nature of the experiences, the nature of the interactions, the nature of the materials, and the nature of the assessment.

Each of these environmental structures will be addressed separately in at the beginning of this chapter, but it is important to note that these structures, in and of themselves, do not constitute the cultural reality. The language and environmental phenomenon are ". . . embedded in the teaching-learning process, in what and how teachers teach, and what and how learners learn" (Maguire & Wolfe, 1993, p. 38). The interrelationship of the language and environmental structures identified is demonstrated in Figures 4 through 13 and in the descriptions of the environment that follow. The structures of the environment (physical setting, community, experiences,

interactions, materials, and assessment) are not unique to a constructivist classroom or to mathematics (Maguire & Wolfe, 1993). It is the nature of these structures as they are experienced in the social situation, and the meaning they have for the participants, as defined by Clara's classroom goal, autonomous growth and development, that creates the constructivist culture (De Vries & Kohlberg, 1987; Duckworth, 1987; Fosnot, 1989; Janesick, 1991; Kamii & DeClark, 1985; Kamii & Joseph, 1989; Katz & Chard, 1991; Piaget, 1965; 1973; Spodek, Saracho, & Peters, 1988). Classroom "stories" are offered as vignettes, and evident in the vignettes are the unique interrelationships which influence the participants' behaviors, language and artifacts in such subtle and purposeful ways that the construction of knowledge is promoted.

The Constructivist Social Situation

Ethnography occurs in social situations. Schooling is a social situation. "Every social situation can be identified by three primary elements: *a place*, *actors*, and *activities*" (Spradley, 1980, p. 39) (Figure 4).

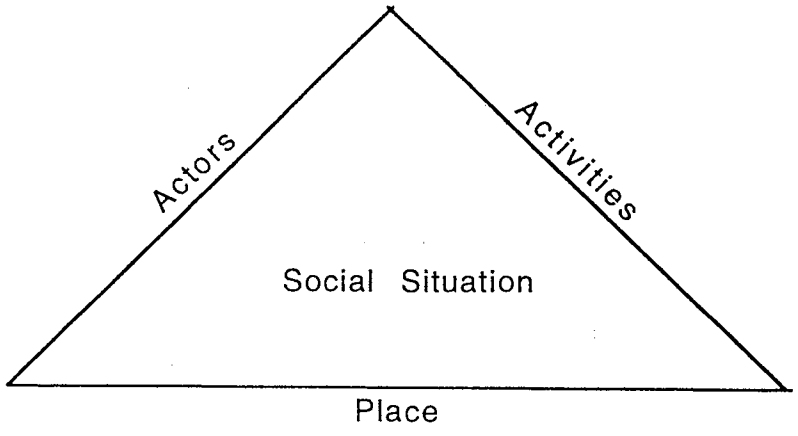

Figure 4. A Social Situation (From *Participant Observation* (p. 40), by J. P. Spradley, 1980).

In Figure 4, the *place* refers to the scene of a given social situation; that is, where a social situation occurs. Schooling is a social situation which has unique cultural behaviors, knowledge, and artifacts and, therefore can be defined by the places, actors, and activities involved (Figure 5). The place of the social situation for this inquiry, for example, was a second grade constructivist mathematics classroom. The *actors* in Figure 4 are the people engaged in social acts within a social situation. Continued participant observation within a social situation will generate cognizance of differences in behavior, language, activities, terms of identification, and a variety of other cultural areas. For example, children in a classroom gaming situation recognize an unspoken code or rule which reflects their social understanding of the culture at the time. Specifically, the second grade constructivist children "know" not to ask to join in a game which is already in progress; they watch until invited, as is demonstrated in the following scenario from class.

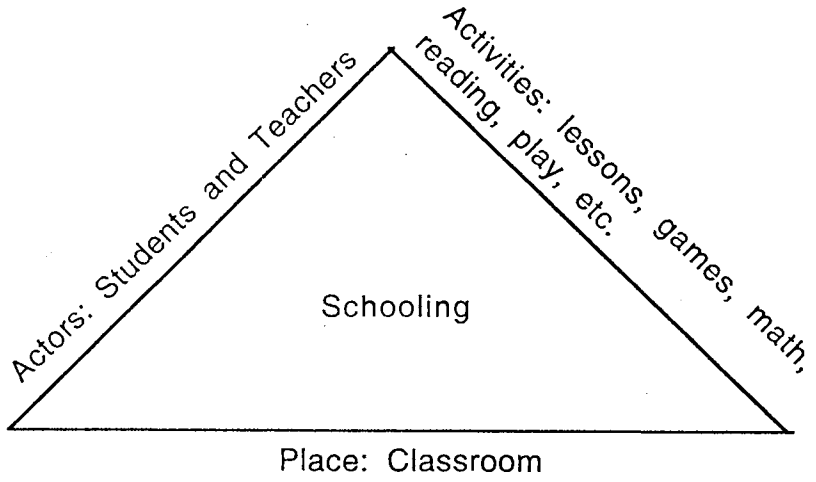

Figure 5. Schooling as a Social Situation

> Alaine and Katie invited me to play a game with them after a class circle-time concluded. We moved to sit on the rug to begin the game. Jilla watched us begin to play and slowly edged her way over to our area of the rug. The two girls, Alaine and Katie, were oblivious to her presence even as she moved close enough to be visible to their peripheral vision. Jilla's interest became obvious to me and as Alaine and Katie noticed me looking kindly her way, they glanced up and quickly exchanged looks with each other. The game continued for one more round. Finally Jilla moved closer, acknowledging some existing, unspoken rule, she did not speak a word to any of us. Alicia then looked at Jilla one more time and glanced back to Katie to say, 'I think Jilla wants to play. Do you want to play, Jilla?' Alaine asked pleasantly as she looked toward Jilla. A smile filled Jilla's face and as she answered by nodding her head positively, she jumped into a spot next to me to play the game. Adjustments in the game were quickly made to accommodate a new player and everyone re-entered the situation without a word about what had just occurred.

Actors of a social situation engage in *activities* which are varied in nature. Individual acts merge into activities in which others engage. Several different activities may occur simultaneously to further define an event (Spradley, 1980). Children in the constructivist mathematics classroom, for example, may participate in four, five, or more activities which occur concurrently and comprise a "mathematics" event. On March 30, 1993, in Clara's classroom, the children engage in a variety of experiences which compromised an event.

> Several girls are playing a mathematics game on the rug called, 'Go Fish,' while several other children worked on number tile activities (Cook, 1987) at a long table located to the side of the room. Three boys played a game on the floor that required them to follow a path after determining

> the sum of two dice. Several other boys and girls clustered around Clara with questions or invitations as they momentarily broke from the activity in which they were engaged. Two other students were sitting at separate tables examining records of their work to determine completion. At another long table, two girls and a boy were constructing basic number facts with jeweled beads of brilliant colors and recording their results in individual, tiny books. Clara walks around the room in discourse at any one of the activities and/or with any one student.

This demonstration of multiple mathematics experiences that occurred simultaneously constituted a "mathematics" event. Mathematics events were common in Clara's classroom (Figures 6 and 7). These mathematics events offer opportunities for a variety of learning groupings and student choice which are both deemed important by Clara for the construction of knowledge.

There were several social situation relationships found within the primary constructivist mathematics classroom studied: clusters, networks, and social situations with similar activities (Spradley, 1980). Figures 6 through 9 demonstrate the social situations apparent during mathematics in the primary constructivist classroom. Further analysis of Figures 6 through 9 suggests the relationships and interrelationships which emerged in the social setting. The figures are limited in that they lack the interpretation of cultural meaning which allows the participant to act and interact in the culture in meaningful ways. As previously identified, Clara's goal of education, autonomous growth and development, creates the cultural meaning which guides her behaviors, knowledge, and artifacts and those of the children.

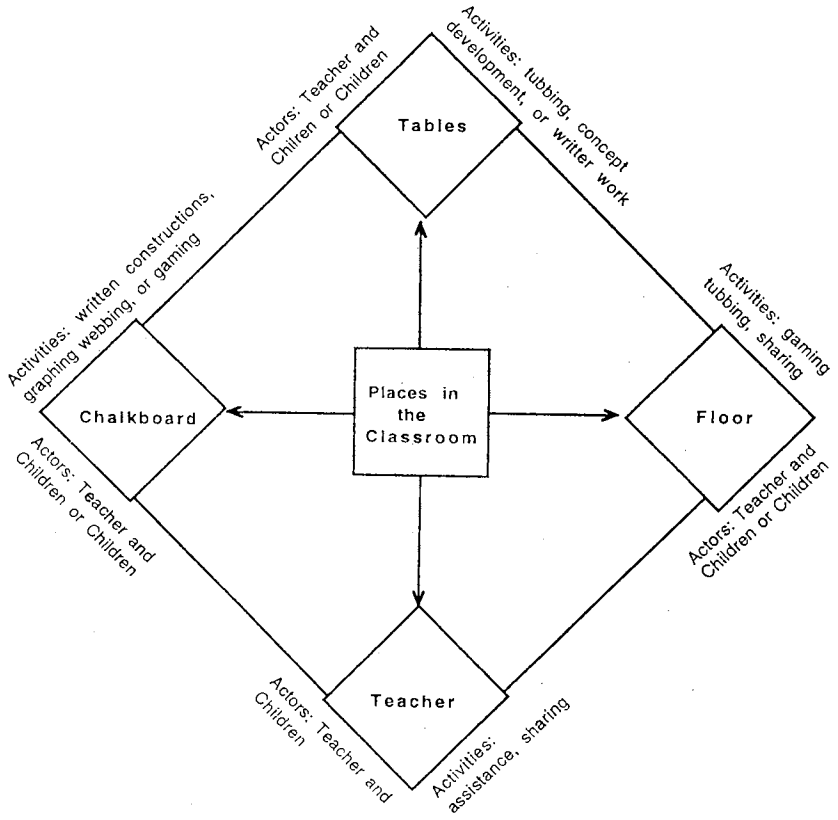

Figure 6. An Emergent Cluster of Social Situations in the Primary Constructivist Mathematics Classroom

The Constructivist Language

Dobson et al. (1985) stated that the language of schooling reflects the beliefs and practices of professional educators and they ". . . attempt to identify and contrast three philosophical and psychological profiles tending to separate into three camps" (p. 36) which are identified through the representative language of the respective camps. "This separation is quite possibly a direct reflection of whether persons are primarily concerned with doing to, for, or with young people. The three camps can be dispersed on a continuum ranging from training to education" (Dobson et al., 1985, p. 36).

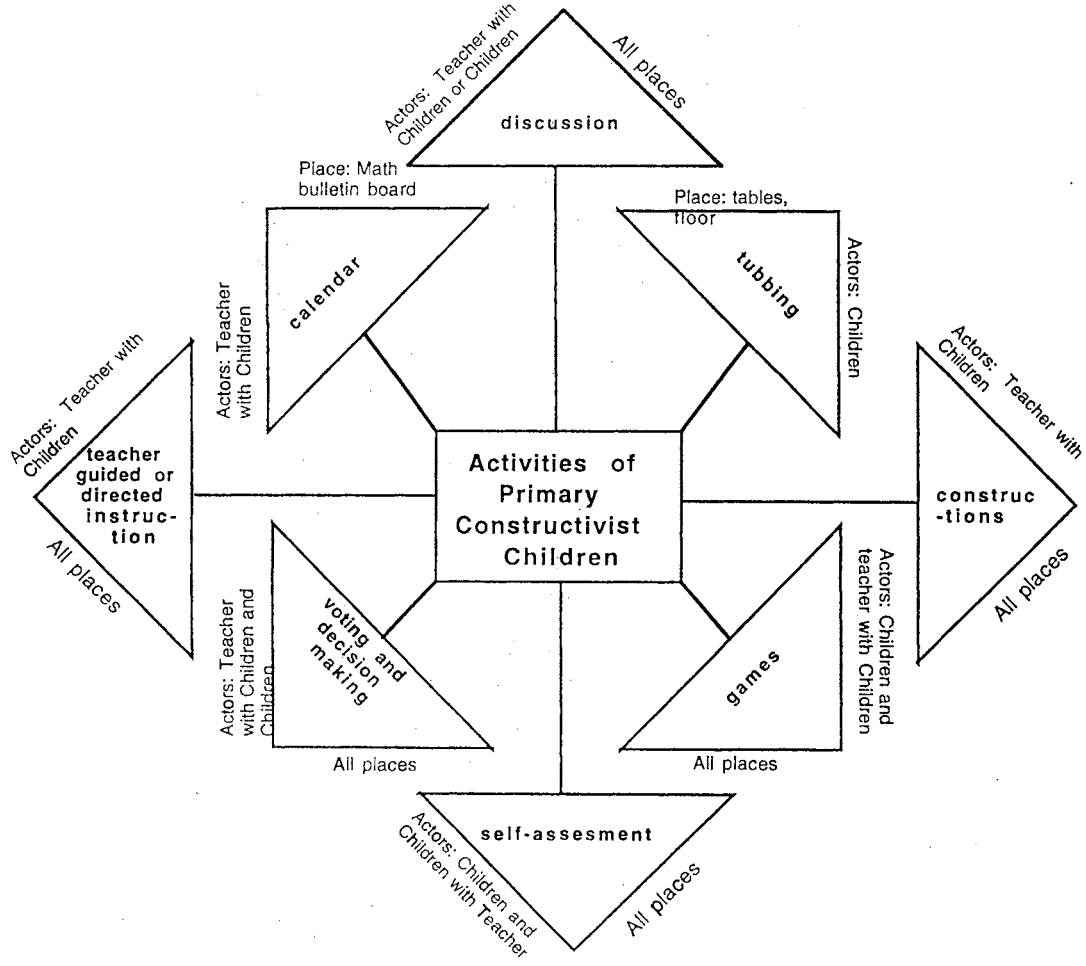

Figure 7. An Emergent Network of Social Situations in the Primary Constructivist Mathematics Classroom

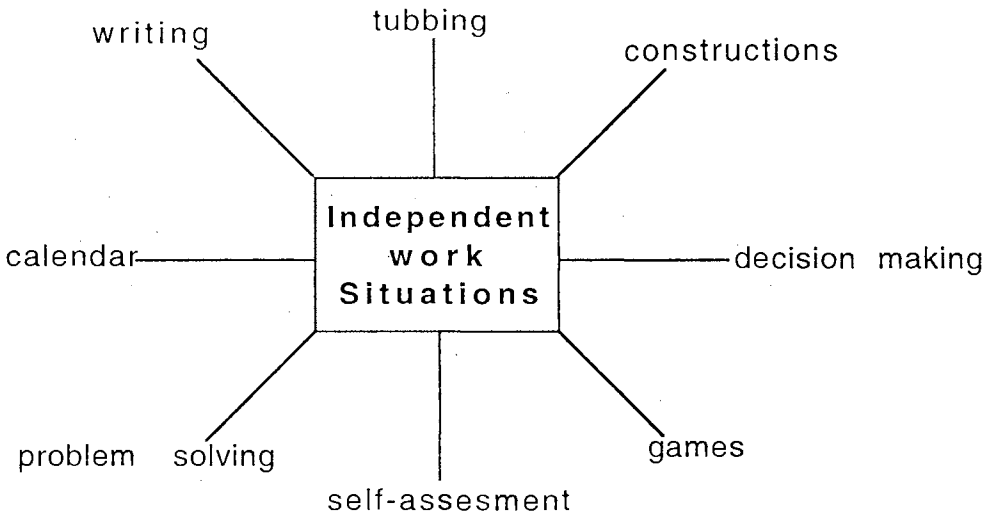

Figure 8. Social Situations Where Children Work Independently in the Primary Constructivist Mathematics Classroom

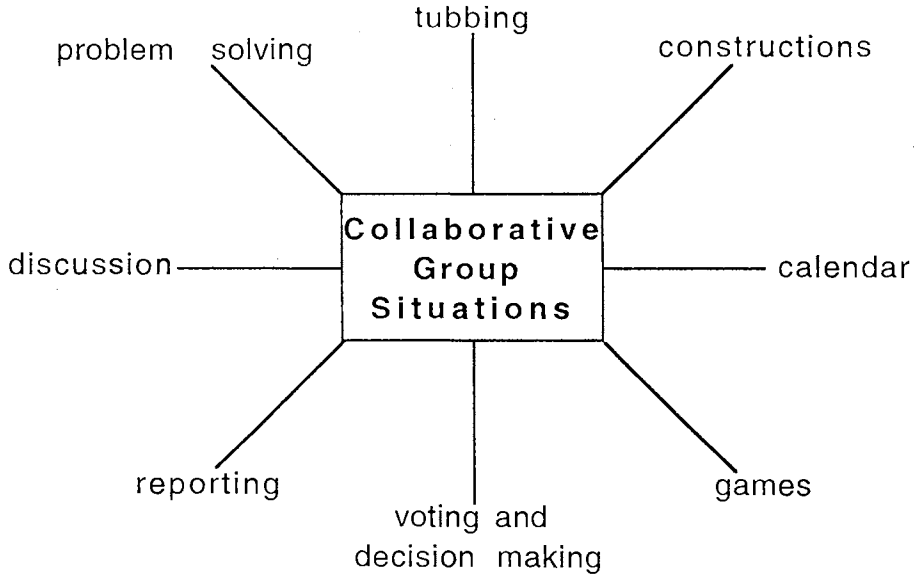

Figure 9. Social Situations Where Children Work in Groups in the Primary Constructivist Mathematics Classroom

Inquiry into the representative language confirms that external control has historically guided and directed traditional education (TABLE III). (See Table 1. of Dobson et al., 1985, p. 41, for complete information.) Dobson et al. (1985) recognized that these three ". . . directions are seldom, if ever, found in pure form; however, most schools are patterned after one of these" (p. 47). Research (De Vries & Kohlberg, 1987; Kamii & DeClark, 1985; Kamii & Joseph, 1989; Katz & Chard, 1989) and the professional position statements of the National Association for the Education of Young Children, NAEYC, (Bredekamp, 1987; Bredekamp & Rosegrant, 1992) and the NCTM (1989, 1991) suggested a need to ". . . bring curriculum and teaching practices closer to our current knowledge about children's development and learning" (Katz & Chard, 1989, p. 17). This involves movement away from the language of external control toward the language of internal control.

"When children come to school they adapt to teacher's invitations to learn, which are usually mediated by language" (Maguire & Wolfe, 1993, p. 42). Ethnographic inferences emerge from the language demonstrated in Clara's curriculum and instruction practices and the meaning of classroom actions and events are expressed in her language. From the information displayed in Table III, and from the conversations presented in Chapter III, we can extrapolate that language representing movement toward internal control is demonstrated in Clara's classroom planning, interactions, and assessment.

In order to facilitate knowledge construction through the promotion of autonomous efforts, Clara is concerned with the prior knowledge which exists within the child (Carpenter, Fennema, Peterson, Chaing, & Loef, 1989; Dykstra, Boyle, & Monarch, 1992). Clara related that she is concerned with children's intrinsic motivation (De Vries & Kohlberg, 1987), personal growth and development (Bredekamp, 1987), individual differences and development (Pirie & Kieren, 1992), the promotion of democratic ideals (Albert, 1989; Gathercoal, 1991), investigation and experimentation which enables the

construction of knowledge (Kamii & DeClark, 1985; Kamii & Joseph, 1989), and various other correlates of internal language. Conversations presented in Chapter III, demonstrated further that Clara's language is representative of language moving from external control into a more internal control.

TABLE III

THE LANGUAGE OF SCHOOLING

BASIC ELEMENTS	DESIGN A	DESIGN B	DESIGN C
	Movement Toward External Control		Movement Toward Internal Control
Representative Language	Structure, Management. Reinforcement. Shaping. Labeling. Performance. Accountability. Objectives. Behavior. Matching. Environment. Cause-Effect. Measurement. Observation. Transmission of Facts. Roles. Function. Control. Intelligence. Reality. Order. Standards. Tests. Grades. Direct.	Sequence. Stages. Growth and Development. Becoming. Correlated. Interest. Programs. Diagnostic. Readiness. Techniques. Skills. Activity. Individual Differences. Rational. Well-Adjusted. Motivation. Progress. Expectations. Understanding. Discipline. Knowledge. Evaluation. Enable. Support. Facilitate. Guide. Help. Meaningful.	Being. Desires. Process. Democratic. Freedom. Feedback. Fulfillment. Experience. Diversity. Perception. Potential. Harmony. Personal Order. Self-Direction. Accepting. Unique. Consequences. Awareness. Sharing. Trusting. Allow. Experiment. Involve. Issues. Options. Natural. Spontaneous. Personal Meaning.

(From *Looking at, Talking About, and Living With Children* (p. 41), by Dobson et al., 1985.)

Clara noted that as students' schooling experiences change from those of external control to those of internal control as a result of participating in her classroom

culture, their language and behaviors also change (Maguire & Wolfe, 1993). This is demonstrated by students who moved into the classroom later in the year as well, Clara relates,

> Jilla just moved in and came from what I suppose was a very traditional educational background. . . . She uses her fingers to count . . . she typically selects more traditional activities . . . feels safer if she has a lot of teacher help or direction. . . . I am trying to promote a meaningful understanding of number so that she doesn't think her fingers are the only way to get an answer . . . her fingers are okay . . . the use of them just indicates to me that she has a poor conceptual framework of number.

As weeks, months passed, Jilla became more responsible for her own learning. Models were constructed for number as her reliance on her fingers faded. Her language and actions began to develop an internal orientation.

The language of both Clara and her students represent this movement toward internal control. Clara stated that she finds that traditional language sometimes seeps into her new beliefs and practices, and this confirms her need for reflective practices (Wiggins, 1994). Reflective practices are also promoted for students so that they begin to think through the connections and relationships being constructed and to think about the process of learning in which they are engaged. Clara states that an internal language is evident in the students' oral and written language. The internal language of Clara and her students guides the constructivist environment.

The Constructivist Environment

Creating a constructivist environment is essential to constructivist education (Feldt, 1993). Teachers create constructivist environments based on their beliefs and commitment to constructivist philosophy. Because teachers are constantly in a state of "becoming" (Feldt, 1993; NCTM, 1990), the constructivist classroom environment is

continually emerging and evolving. Feldt (1993) stated that becoming a teacher of mathematics is a constructive, interactive process. Constructivist mathematics "teaching" emerges as a teacher constructs more and more knowledge about the nature of mathematics and the way children construct mathematical knowledge (Feldt, 1993). As a teacher constructs more knowledge about how children learn mathematics, this new perspective promotes changes within the classroom environment which align the teacher's new beliefs with practice.

> . . . teachers can and do create environments, based on the belief that all knowledge has to be constructed by the individual, in which students' mathematical knowledge-building and understanding is fostered. Such environments are the creations of teachers and follow from elements of their beliefs and knowledge put into action (Pirie & Kieren, 1992, p. 506).

Clara's classroom environment is created by her emerging constructivist beliefs. Changes are made as Clara constructs her own knowledge of mathematics and how children learn. The environment that existed when conducting this study is the result of eight years of teacher growth and development. Clara is committed to the belief that children construct their mathematical knowledge and provides an environment designed to promote children's constructions.

There are six emergent environmental structures which foster knowledge construction found within the primary constructivist classroom studied: the nature of the physical setting, the nature of the community, the nature of the experiences, the nature of the interactions, the nature of the materials, and the nature of the assessment.

> Many educationalists would like to have a list of specific behaviors that they could perform or that they could see in their classroom which would demonstrably label them as 'constructivist teachers.' Such a program of constructivist teaching behaviors does not exist. Just as there are no mathematical understandings 'out there' waiting to be acquired, there is

> no 'constructivist teaching model' out there waiting to be implemented (Pirie & Kieren, 1992, p. 506).

It is a commitment to personal beliefs, personal knowledge, and reflective considerations which guide Clara in her decisions regarding the nature of these environmental structures. In the following sections, each structure is presented, although it is important to restate that each structure does not stand alone and is not necessarily unique to constructivist environments. It is the essence of each structure as it is experienced that demonstrates cultural meaning. It is Clara's goal of education, autonomous growth and development, that is evident in the meaning of these structures (De Vries & Kohlberg, 1987; Duckworth, 1987; Fosnot, 1989; Kamii & DeClark, 1985; Kamii & Joseph, 1989; Katz & Chard, 1989; Piaget, 1965; 1973; Spodek, Saracho, & Peters, 1988).

The Nature of the Physical Setting

The 24 children in Clara's class are socially organized in a variety of social settings and structures (see Figures 6 through 9). There are five large tables that occupy space in the room dependent upon the needs of the activities. Student projects and materials for investigation are found everywhere one looks. Clara's desk is unobtrusive; it is seldom used for anything other than storing resource materials or serving as a central location for children to place "odd" items such as game pieces, stray scissors or tape. It serves as a storage area for children's books, projects, and tools. The counter area under the windows also served this purpose. Clara circulates around the room, the long tables, the rug area, and the classroom library. She often sits to engage in games or projects as a participant. Space in the classroom is rearranged throughout the day given the situational circumstances (Maguire & Wolfe, 1993).

The Nature of the Community

The cultural community is influenced by teacher assumptions, ideologies, features in routines, experiences, meanings, and invitations to construct mathematical relationships (Maguire & Wolfe, 1993). It is evident from this inquiry that the constructivist community is different from that of other classroom communities (De Vries & Kohlberg, 1987; Duckworth, 1987; Fosnot, 1989; Kamii & DeClark, 1985; Kamii & Joseph, 1989; Katz & Chard, 1989; Piaget, 1965; 1973). Clara's educational goal is to promote autonomous growth and development (De Vries & Kohlberg, 1987; Kamii & DeClark, 1985; Kamii & Joseph, 1989; Spodek, Saracho, & Peters, 1988), and her classroom community demonstrates this goal.

A classroom community, Clara describes, is ". . . a group of learning individuals . . . a family, people with similar interests . . . a mini-community within a community. . . depending on how you structure the community." To establish a sense of community which fosters knowledge construction, Clara relates:

> I bring the kids together. . . . I tap into their prior knowledge . . . start with prior knowledge of a familiar community . . . their family . . . through discussion, this is tied into how a classroom is a family . . . the children construct what family rules are by making a list . . . we compare these rules to what classroom rules we might need . . . we vote on the rules we want in the classroom.

Voting and Choice. Clara states that voting is important to promoting democratic ideals (Gathercoal, 1991; Kamii & DeClark, 1985) and the construction of mathematical knowledge (Kamii & DeClark, 1985; Kamii & Joseph, 1989):

> In my class, students have a voice through voting . . . we vote on everything; what they want to study, how to resolve an issue . . . this requires me to be open to all suggestions from the students. I have to relinquish

> authority and examine covert and overt messages of authority. I model community discourse and provide experiences which promote community cooperation . . . teacher expectation needs to meet the child's individual social development . . . the environment must be safe, risk-free.

There is a strong sense of democratic community in Clara's classroom. Children are always provided a choice with whom they work, where they work, and in what activities to engage as is apparent in Figures 6 through 9. The children are treated with mutual respect through the use of a democratic process of discussion and voting which promote personal responsibility and the respect for one another (Albert, 1989; Curwin & Mendler, 1988; Gathercoal, 1991; Gibbs, 1987). Conflicts in behavior and academics are resolved democratically by the students. There are open opportunities to work within a variety of grouping styles: independent, partners, or small groups (Johnson & Johnson, 1991). Engaging experiences are promoted which allow for the active construction of knowledge (Katz & Chard, 1989). Children are challenged to make sense of their experiences both verbally and in writing (Thompson, 1990). The curriculum is designed to be developmentally appropriate (Bredekamp & Rosegrant, 1992) for primary grade children which fosters respect for individual differences in growth and development.

Parental Involvement. At the beginning of the school year, in order to involve the parents in her community development, the parents are informed by Clara of her philosophical position and rationale for teaching mathematics which imply the practices their children will experience. Also at the beginning of the school year, several parent meetings are scheduled which focus on opening communication and inviting parents into the mathematics community of constructing mathematical relationships and connections. These meetings are voluntarily scheduled parent meetings which are not necessarily conducted by the other building teachers. Clara states that parent

communication and engagement of the parents in the process of constructing mathematical thought is essential to changing mathematics education (Stenmark, Thompson, & Cossey, 1986). Initiating this parental involvement demonstrates the commitment made by Clara to assure student success, growth and development.

Student Responsibility. It is important to Clara to keep this sense of community stable and safe for the children. To assure this, Clara communicates regularly with resource teachers, support staff and the administration in regard to the different activities, methodologies and such which might affect them and the children in her class. Children are asked to complete all forms of communication with other teachers, administrators, parents, speakers, and guests, and these people need to be aware of the nature of the student's responsibility in order to understand and promote comfortable situations outside the classroom. The secretarial staff is aware of the non-traditional role of children in Clara's class, and is familiar with the routine visits the children make to the office to make calls or verify messages from home they may have misunderstood, to find out information, to set appointments, and/or to set up conferences with their parents.

> One April morning, I recall a stunning phone call from a young uncertain voice, Michael, reminding me to bring a writing folder, when I came to visit the school, that belonged to him. I had borrowed the folder to review the contents when Michael was absent, and he needed it that morning to complete his work. Michael was responsible for making the call and communicating his need. He was also responsible for making arrangements for the notebooks return.

The purposeful promotion of autonomous acts in an incidence such as this is easily thwarted when other personnel do not understand its relevance. For this reason, Clara views communication with other faculty and staff as vitally important to her entire program.

Coordination of Viewpoint. The coordination of viewpoints engages children in social interaction that promotes mutual construction of morality and intellect (Cobb, Wood, & Yackel, 1991; Cobb, Wood, Yackel, Wheatley, Trigatti, & Perlwitz, 1991). Clara's classroom community offers numerous opportunities to coordinate points of view by placing responsibility into the child's hands. Moral responsibility allows children to exercise their decision-making capabilities at a time in their life when the stakes are not so high (Kamii & DeClark, 1985). Intellectual decision-making celebrates children's existing knowledge (Carpenter et al., 1989) and respects their knowledge as it is deemed important to the children's learning process and important to the teacher as researcher (Cauley, 1993; van Manen, 1990).

Clara's classroom has frequent observers and researchers who are interested in the alternative practices. The children are quick to involve outsiders in whatever they are doing. It is an invitation into their community. Through the promotion of autonomy and a sense of democratic community, the children assume responsibility for guests as well as each other. Guests also provide another ear for listening to the rationale and justifications for their thinking and to engage someone new in the coordination of viewpoints which is essential to the promotion of autonomy (De Vries & Kohlberg, 1987; Kamii & DeClark, 1985; Kamii & Joseph, 1989).

Socialization. There are a variety of experiences in which the children engage and the nature of these experiences promotes the socialization processes which lead to a democratic community (Albert, 1989; Maguire & Wolfe, 1993). Most experiences are promoted to actively or interactively engage the child. Students tend to flock to the games and projects. The children regularly design their own activities, change the rules of a game, assist other children in completing a task, and/or just sit and watch others engage in events. The activities are left around the room, and many previously completed projects are found on display. Games which promote mathematical connections

are available and new experiences involving mathematics are offered. Children may ask for and often do ask for games or activities which are stored or filed.

The children implicitly define certain spaces in the room for certain tasks (Spradley, 1980). Clara is most aware of and interested in observing how the children designate the areas each year and how the space is redefined given the mathematics event. Chalkboard games and activities are initiated by the children and they "police" the space dependent on the activity. The floor space is "reserved" by different children on a regular basis. Most students recognize a student's "preferred" area and conflicts over the issues of space seldom arise. When they do, however the children resolve them through discussion and coordination of view point. Clara rarely needs to offer assistance. When she does, it is to facilitate or guide the resolution process, not to resolve it or to punish it (Albert, 1989; Curwin & Mendler, 1988; Gathercoal, 1991).

A large braided rug is under the chalkboard in an area that traditionally would be defined as "the front of the room." This rug area is where many of the games and activities are placed when children are finished so that they are available for others. The classroom library is often invaded by children playing mathematical games. The children who are reading never seem to mind, and often engage in conversation with those playing the game. Students often work at the tables, but usually are there for shorter periods of time. Most writing activities are completed at the tables.

Clara is always an exciting social "place" for children "to gather." She is never in one place very long unless she is assisting children or engaging in an activity with them. They all flock to her throughout the day to enthusiastically report on their investigations and experiences, or to convince her to join them in their events.

The Democratic Community. Clara explains that all of this is part of the process of "constructing" a democratic community.

> I feel that in order for a community to develop that there has to be a construction of that community. It will not just happen. . . . We must

> construct it from prior knowledge and discourse . . . allow students to have opposing opinions without judging . . . allowing them to resolve issues. . . .

Clara describes what occurs in her classroom community that indicates to her that she has met her goals for constructing a community.

> Children are willing to work with others, cooperatively, without much teacher intervention . . . their suggestions to vote . . . and decisions from voting are accepted . . . kids are risk-takers . . . they bring in materials from home or where ever and feel that what they bring in will have value to the class . . . ownership is valued . . . responsibility for their own learning . . . and the learning of others . . . intrinsic motivation.

The children of this constructivist classroom are developing moral and intellectual autonomy and it is reflected in the community (De Vries & Kohlberg, 1987; Kamii & DeClark, 1985; Kamii & Joseph, 1989; Katz & Chard, 1989). The children share their viewpoints and listen to consider other's points of view. Issues and conflicts are usually resolved peacefully and kindly with consideration of others involved. The children are constructing mathematical knowledge in a variety of self-chosen domains. They make intellectual decisions which promote personal growth and development in mathematics. The children demonstrate positive attitudes toward school, their teacher, guests, and the other children. Clara's goal for education is autonomous learners which emerges from her beliefs about how children learn. The classroom community flourishes with the self-government which promotes the achievement of this goal.

The Nature of the Experiences

Constructivist teachers are aware ". . . that the understanding that students draw from their experiences within the environment is determined by their [the child's]

own structures and histories, by their individual ways of perceiving and acting and organizing" (Pirie & Kieren, 1992, p. 506). When creating a constructivist environment,

> . . . it is the teacher's intentions, not any specific activities which are done or not done, which determine the constructivist nature of the teaching. The environment in that sense is the result of deliberate, active behaviors by the teacher in the full knowledge that constructivism pertains to the actions of the learners (Pirie & Kieren, 1992, p. 506).

Many of the experiences in which Clara's students engage are intentional and carefully considered as they arise out of classroom conversations and informal interest inventories. Other experiences are initiated by what is occurring in the students' lives and world. These spontaneous experiences which often take the students into rich, unplanned directions of intrinsic interest are pursued as purposeful decisions founded in Clara's beliefs about how children learn (Lubinski, 1994). Teacher-initiated experiences are offered upon student invitation. An example of this might be a child asking how to multiply 2 times 4, or Clara might say, "I have just heard about a new book. There is a problem in the story. Would you like me to read it?" Pirie and Kieren (1992) described four tenets of belief which guide the intentions of a teacher who promotes a constructivist environment.

> 1) Although a teacher may have the intention to move students towards particular mathematics learning goals, she will be well aware that such progress may not be achieved by some of the students and may not be achieved as expected by others.
>
> 2) In creating an environment or providing opportunities for children to modify their mathematical understanding, the teacher will act upon the belief that there are different pathways to similar mathematical understanding.

3) The teacher will be aware that different people will hold different mathematical understandings.

4) The teacher will know that for any topic there are different levels of understanding, but that these are never achieved 'once and for all' (pp. 507-508).

These tenets serve as Clara's emergent beliefs and direct her decisions regarding classroom experiences. Evidence of this is found throughout the descriptions of the structures identified within the primary constructivist classroom.

At the beginning of the school year, the children are assumed, by Clara, to come from traditional educational experiences and are, therefore initially guided into investigative study by her. As the year progresses and the students develop and exercise more autonomy, they begin to design and direct the curriculum themselves. The experiences in which the children engage are presented in the descriptions following.

Tubbing. Beginning mathematics experiences involving tubbing focus on the children's free exploration of a variety of everyday and commercial materials; e.g., seashells, buttons, keys, pattern blocks, and mirrors. The tubbing exploration promote investigations and constructions of patterns and relationships, number and numeration, mathematical connections, reasoning, communication, and problem solving (NCTM, 1989). The materials are presented to the students in large plastic "tubs." There are approximately 15 tubs, each with different investigative potential. Later in the year, Clara invites the children to explore ideas of number, patterning, and place value by including activitiy ideas in the tubs. The students self-choose the tubs, but are encouraged to try all the tubs appropriate for them. Opportunities for extension and individual interests are inherent in the tubbing experiences. The tubbing activities are designed after the *Mathematics Their Way* (Barretta-Lorton, 1976) program; however, Clara has adapted many of the tubbing experiences to meet her current belief system.

The tubbing experiences are changed throughout the year to provide varied opportunities to develop mathematical relationships and connections and to meet individual needs and differences (Bredekamp & Rosegrant, 1992; NCTM, 1989). Clara intentionally reintroduces previous experiences during the year so that children are naturally guided to "fold back". Folding back is perceived by Pirie and Kieren (1992) as integral to the development of mathematical understanding and they stated:

> . . . a teacher must be aware that a student will fold back to less formal, less sophisticated actions as part of the normal growth process. In fact, a teacher who is trying to create a constructivist environment might deliberately try to invoke folding back to such previous level action as a means of promoting growth (p. 509).

Mathematics Bulletin Board. This is a bulletin board attached to the side of the chalkboard. This board was patterned after the *Mathematics Their Way* (Barretta-Lorton, 1976) program for calendar activities, but Clara has transformed many of the activities to reflect her emergent beliefs about growth and development. The math bulletin board is comprised of many different activities which promote the construction of mathematical knowledge (NCTM, 1989).

On the bulletin board, there is a "**money magnet board**" where magnetized allotments of coins are set up. On Monday, April, 26, 1993, there are two dimes and four pennies found on the money magnet board. At the beginning of the day, a child chooses a quantity to place on the money magnet board. Throughout the day, other students determine the value of the coins and ask the student if they are correct. In this way, the student who selected the coins becomes the expert of his/her posed problem (Moses, Bjork, & Goldenberg, 1990) and the children have choices as to whether to engage in the activity and when to engage in it (Albert, 1989; Gathercoal, 1991).

Using the real, class-life activity of determining and reporting the **lunch count**, Clara has placed two "frosting" cups which rest on the chalk ledge for the children to organize their results. One cup is labeled "home" and one cup is labeled "school." Children place a counter into the appropriate cup to indicate whether they are eating at home or eating at school. Two students then tally the counters on a card which is sent to the office by another child. After the counters are tallied, Clara usually initiates a discussion (Kamii & Joseph, 1989) which guides the students to make comparisons between the number of students eating at home and the number of students eating at school; "How many more students are eating at school than at home?" These questions are formulated to promote one-to-one correspondence constructions (Copeland, 1984).

There is a "**place value tray**" on the bulletin board that was given to Clara by a math colleague. Straws are grouped and bundled to represent number and numeration concepts (Carpenter & Moser, 1984). The number "156" is displayed in the place value tray on the chalk ledge by the students. There are six single straws, five bundles of ten, and one bundle of tens bundled together. The number of days the children had attended school up to that date was 156. Each day one more straw is given to a child. The child then determines how to combine the straws so that the appropriate number of days that school has been in session is represented by the bundling sticks. This activity is relevant to the children in that it comes from a number that has personal meaning; the number of days school has been in session. When the single's or ten's bundles need to be regrouped, it requires an adjustment in the child's thinking, a "confrontation with a novel problem"--how to distribute the given straws in a place system of ten--a problem that, if regrouping is necessary, does not fit their concept of grouping, leads the "children to expand their notion of what constitutes" the place system "in order to 'accommodate' their understanding of the new situation" (Schifter & Fosnot, 1993, p. 5). The students keep track of the number of days they attend school on a strip of paper

that is displayed around the room as well. On the next day, there will be a new number and an additional straw added.

Next to a calendar, there is a **weather bar graph** that is labeled: sunny, windy, rainy, overcast, foggy, and a blank space for additional information. The students have colored in the number of days in the month which were sunny, rainy, and so forth. Clara initiates discussions that require the students to tell her something about the graph. The students extrapolate information from the graph and share it with others. This generates responses demonstrating relationships regarding the mathematical concepts of number, numeration, addition, subtraction, and other mathematical strands (NCTM, 1989). Students respond with, "There are four sunny days this month. There are two more sunny days than rainy days."

Students are in charge of the class **calendar** and draw pictures that relate to the month (example: bunnies, flowers, and eggs for April) for each day on the calendar. The day's date is displayed in one corner of the bulletin board. A student wrote it, 2/26/93; the three is written backwards. This "error" is accepted, as errors are valued and important to growth and development (De Vries & Kohlberg, 1987; Kamii & DeClark, 1985; Kamii & Joseph, 1989). Clara stated,

> It's funny . . . I never tell them that they wrote backwards, but many times during the day I'll look up and see the child who wrote it 'correcting' it. . . If I ask why they are erasing it, they matter of factly say, 'I wrote it backward.' They correct it themselves . . . it's respectful, too . . . we forget about it after that.

The bulletin board also contained a **problem of the day** which is often derived from the calendar date; i.e., since the date is April 26, the problem of the day would be to create problems with answers of 26. For example, students write 25 + 1, 28 - 2, 1,000,026 - 1,000,000 and so forth. The large number problems like 1, 000, 026 - 26 are the children's favorite problems to write. The children just write these problems on the chalkboard next to the mathematics bulletin board or they include them in their

mathematics notebook or journal. They often share them with one another or talk about them throughout the day, figuring out possible problems together.

There are many other activities displayed on the classroom walls and boards which foster mathematical understandings that derive from the daily lives of the students and the routine of the class. On one wall, there are 12 birthday cakes with children's birthdays displayed as candles. This is a common sight in primary classrooms, however Clara often initiated mathematical discussions promoting comparisons of birthdays occurring in the different months, determining total birthdays, and adding or subtracting candles when someone moves in or out.

There is a large construction paper tooth where children record the number of teeth lost that month. The monthly records were transferred to a larger graph where mathematical questions and statements were generated and written by the students (Figure 10).

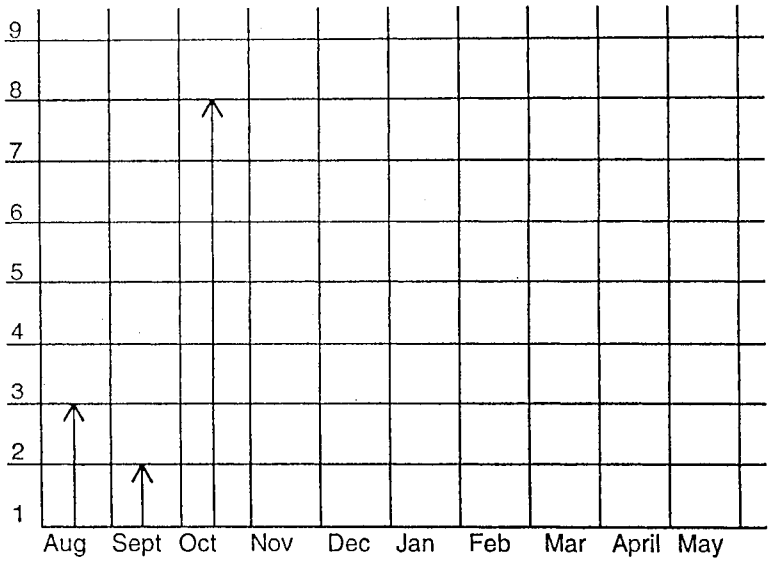

Figure 10. The Lost a Tooth Graph (October, 1992)

There is such an abundance of "mathematics bulletin board" and "calendar" activities, currently in progress or previously completed, that they are over flowing the bulletin board area and lay gathered in the floor space beneath the board. Clara relates that the bulletin board and calendar experiences promote the construction of social, physical, and logico-mathematical knowledge (Kamii & DeClark, 1985; Kamii & Joseph, 1989). She says it is an important step to establishing a sense of community because they do many of the activities as a whole group, offering opportunities for using their social knowledge.

The mathematics bulletin board activities are common to many primary classrooms, as are many of the activities presented in this section. What makes these activities unique is that the children act autonomously in generating the mathematical connections and relationships (Kamii & DeClark, 1985; Kamii & Joseph, 1989). During the class time devoted to the bulletin board activities, mathematical concepts, terminology, procedures, rules or generalizations, and symbols are invented by the students. The large group situation allows for coordination of viewpoint (Kamii & DeClark, 1985; Kamii & Joseph, 1989) in a risk-free environment. Clara's focus is on what the students are thinking, rather than on predetermined answers (Ford & Kuhs, 1991). It is a safe place to start the school day and important to the routine of the children's lives.

Games. Games are an important part of Clara's curriculum and they are located everywhere around the room. There are games on the floor, the tables, the shelves, in the library. A number of games are refiled, to be brought out again later. Kamii and DeClark (1985) recognized group games as an important aspect of a mathematics program. They stated that games give children their own reason for "doing" arithmetic and gaming situations provide immediate peer and self feedback. It also provides opportunities for children to coordinate points of view promoting the development of morality and intellect.

Constructions. Katz and Chard (1989) grouped project activities into three general types: investigations, constructions, and dramatic play. Many of the construction activities which are initiated in this primary constructivist classroom and are displayed around the room, came about after much investigation and dramatic play. A look around the room makes it hard to separate the three types of activities. The projects represent the flow of experiences.

Students are actively and interactively involved with the construction projects which require the investigation and application of mathematical ideas. Items are displayed throughout the classroom which reflect this. Student paintings are hung on the walls. Mathematics journal writings are accessed by the students at their leisure and are on display in a colorful plastic file on the cabinet counter. Students often share these with each other, the teacher, and their parents. Class mathematics books, written and illustrated by the children, are constructed as well as individual books. Children have books of number models for the numbers 1-20, equation books, and "itsy bitsy bean" counting books. The students and teacher create mathematical situations and role play the results. Thematic webs are constructed by the students and the course of study is directed by the interests generated by the webbing event. Students create problems and pose these problems for others to solve (Moses, Bjork, & Goldenberg, 1990). The diagrams, graphs, webs, and charts are constructed by the students to present class information. Students construct games and change the rules of previously constructed games to suit their needs and interests. All of the constructions inherently require the written work of the students in the form of drawings, report writing, diagramming, project proposal, and calculations. Written communication in this classroom is perceived by the children as necessary to the entire learning process (Brown, 1991a). Writing is rarely an isolated event.

Sharing. Discussions between classmates and between the teacher and the children are essential to mathematical communication, language development and the

construction of knowledge. Sharing ideas is important to the process of knowledge acquisition and there are opportunities provided in Clara's class to encourage sharing. Clara sees this as essential to the development of intellect.

Voting and Decision Making. The children in Clara's class are always involved in decision-making. Clara often gathers the students together to discuss class considerations, concerns, or problems. The students discuss the matter and take a vote. In this way, the children have a voice in decisions and policy which directly affected them. Kamii and DeClark (1985) stated that voting is another class situation in which children should engage to develop mathematical understandings. Mathematical concepts traditionally taught through isolated workbook sheets are developed through voting situations which emotionally charged the children and hold their interest (Kamii & DeClark, 1985).

Teacher-Initiated Discussions. Clara initiates mathematical discussions that invite the children to solve problems individually or as a group and share their strategies and solutions (Cauley, 1993). The problems often arise from children's literature, real-life experiences, children's requests for additional information or assistance, or student's create them. Ideas are challenged by other students to promote the coordination of viewpoints so that "Arguments lead children to examine their own thinking and change it" (Cauley, 1993, p. 91) when others' ideas make sense to them.

After working for several months on concepts of telling time, Clara realized that she was not really teaching time appropriately and she determined the children were struggling with it. Several of them expressed that they wanted to know how to tell time better. After deliberating what to do, and reflecting on what she currently believes, Clara decided that she was not tapping into the children's prior knowledge. She initiated an activity promoting the coordination of viewpoints to facilitate their understanding. The next day, Clara called the group together and said:

We need to do some serious talking about time. I have thought a lot about this . . . you have done a lot of work on this in your computer class . . . and the computer probably isn't the best way to help us learn time. Since some of you are still struggling with this, if you like, we can talk about it as a class. . . .

Clara chose to begin with the concept of half-past the hour.

Clara: What does it mean to go half past something? For example, if I am driving from Stillwater to Tulsa and I say I am half past Stillwater, what does that mean to you?

Link: To go half way there . . . you are in the middle

Clara: Does anyone disagree? T. J., what do you think?

T. J. I think you are half way there . . . like with the clock, you are half way around the clock, you are . . . the big hand would be on the six cause that is half way there.

Clara: Would someone like for T. J. to convince them of what he thinks?

Zelda: I want him to show me. [*T. J. goes to the board and draws a circle. He then divides the circle in half with a vertical line. He writes 30 on one side of the line and 30 on the other side of the line.*]

Megan: How did he know that was 30?

As is evident, Clara initiated a discussion that tapped into prior knowledge, she quickly exited, and became a facilitator in a constructivist conversation. The children constructed connections to existing knowledge on fractions, measurement, distance, quantity, and money. As the conversation leads away from half-past into concepts of quarter after and quarter to, Clara used T. J.'s drawing and divided the circle into four equal parts by adding a vertical line.

Clara: Prove to me that this is 60. [*Pointing to the circle.]*

Zack: 25; it equals a quarter.

Ting: I can prove it. [*He walks to the board and writes a problem.*]

$$\begin{array}{r} {}^{2}15 \\ 15 \\ 15 \\ +15 \\ \hline 60 \end{array}$$

[As he worked, everyone was eagerly offering suggestions about what to do. He continued to focus on his idea. Everyone saw the problem and agreed that it did equal 60.]

Kelly: A quarter in time is different than a quarter in money. I understand where you get this. A 'quarter to' means it is 15 minutes until it is 6:00, and 5:45 means 15 minutes until it is 6:00.

Ant: A quarter after is 15 minutes past.

The discussion continued for about 20 minutes, at which time Clara offered them choices of gaming activities dealing with time. The other games and activities were also available to them.

During these teacher initiated discussions, the students do not fear giving wrong answers. When they are unsure of an answer, they look to their sides and discuss the information with someone else. The children are aware that they are not committed to their answers in that they may change a response at any time. They are also aware that they may be called upon to justify why they changed their thinking.

Graphs, Diagrams, Charts, and Webs. There are mathematical components integrated throughout the content areas and evidence of this is in abundance throughout the classroom. During the study of Oklahoma Indian life, students created several graphs to organize their new information. These are displayed around the room. In

teacher-initiated activities, the students are invited to communicate factual statements generated from the information on the student constructed graphs. Clara's goal is to determine student relationships and connections, rather than the "right" answer (Ford & Kuhs, 1991).

In one graph, the children organize information about Indian tribes of Oklahoma (Figure 11). The children fill in the graph as they gather information from books, discussions with parents and community members, films, and etc.

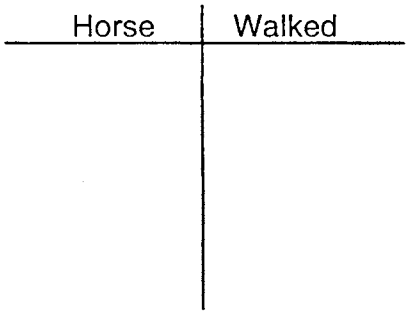

Figure 11. A Student Graph of Oklahoma Indian Modes of Transportation

A thematic web was generated by the students and the teacher to initiate the study of Oklahoma Indian life. The web outlined the students' areas of interest and guided the investigations. Figure 12 shows the brainstormed web in its initial stages. Located to the side of this web is a chart that was generated by the students, titled, "What I Know About Indian Life," that contained information regarding what the students "already knew" about Indian life. This chart and web serve Clara as an indication of existing knowledge so that experiences can be offered which promote a scientific change in knowledge (Dykstra, Boyle, & Monarch, 1992).

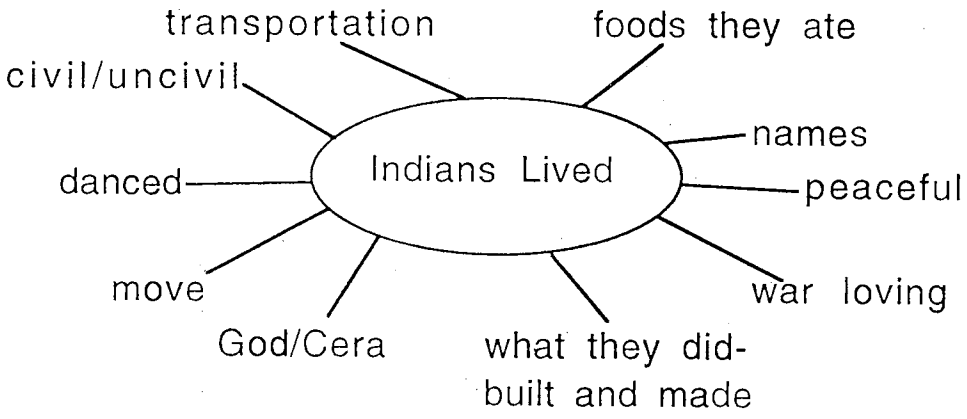

Figure 12. Indian Thematic Web

Students in this classroom construct many graphs diagrams, charts, and webs. Their construction is considered important, but the discussions regarding the interpretation of the graph are equally as important because they demonstrate the relationships children are constructing (Ford & Kuhs, 1991). Students do the majority of the work behind the graphs from researching the information, or brainstorming, to constructing them. The graph information is in the students' handwriting. The students often select the paper on which to record the information. Graphs from previous units of study are also on display around the classroom so that children can continue to extrapolate information. The walls include graphs of favorite fruits, who had a "real" Christmas tree or a "not real" Christmas tree, "yes I have" a tree or "no do not" have a tree, "made" a snowman or "did not make" a snowman (Figure 13).

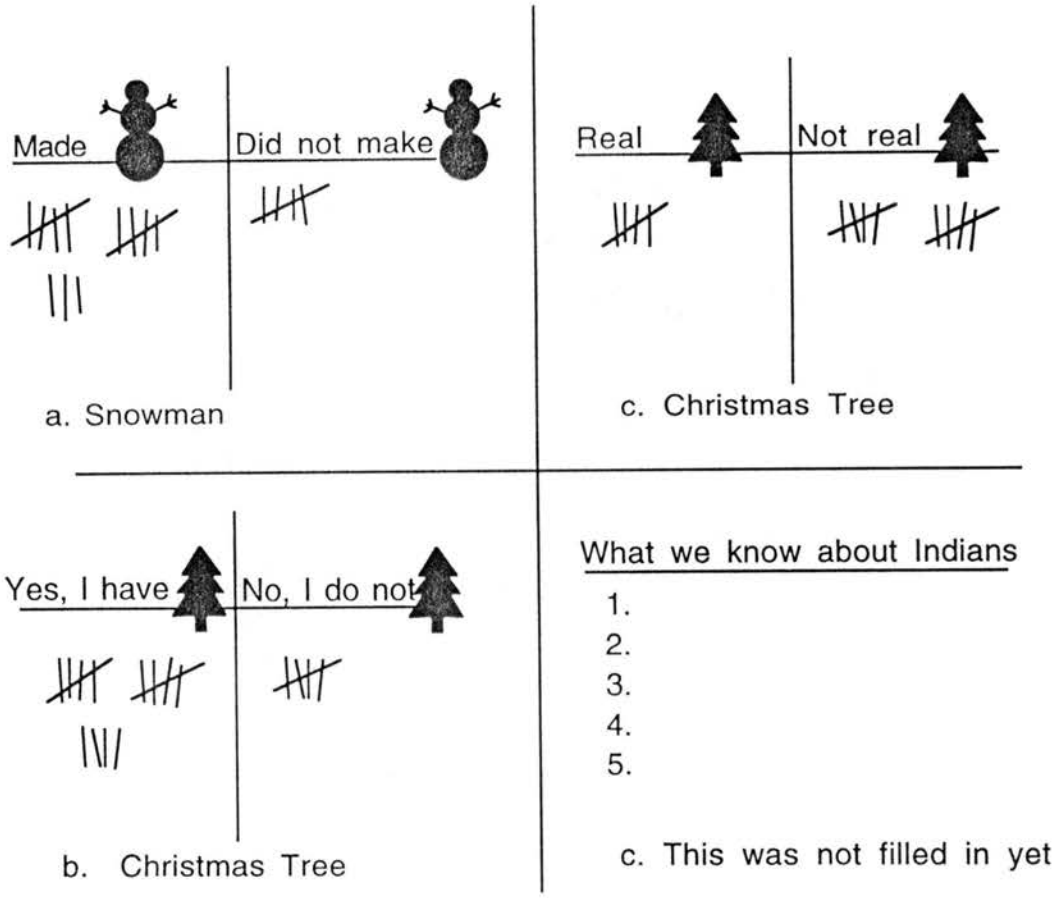

Figure 13. Other Graphing Displays

In summary of the nature of the experiences, it is important to note again that the activities in which the students engage are common to many primary children in traditional educational situations. It is not the activity which promotes knowledge construction, rather the nature of the experience, the meaning the child takes from the experience, which fosters autonomous actions (Kamii & DeClark, 1985). This meaning is culturally defined by Clara's goal for education. The meaning behind these experiences are the meanings that the children bring to them. There are no preconceived answers or responses.

The Nature of the Interactions

Interactions are an integral aspect of the classroom learning process and ". . . offer children different opportunities for making culture and constructing knowledge" (Maguire & Wolfe, 1993, p. 38). An inquiry into the language of a culture offers insight into the cultural meanings. Maguire and Wolfe (1993) defined two types of talk studied in classrooms of teachers with similar belief systems: exploratory talk and constrained talk. Exploratory talk is defined as conversations in which the child's everyday, personal vocabulary is promoted for the children's expressions of scientific concepts. They defined constrained talk as a highly structured questioning sequence identified by the teacher to illicit control over the interaction, scientific content, and flow of knowledge.

Clara promotes the use of exploratory talk during mathematical interactions. Her interactive role is to facilitate this talk by promoting opportunities for it to occur (Schifter & Fosnot,1993), inviting children to express themselves (Maguire & Wolfe, 1993), celebrating existing knowledge, and valuing "errors" in their scientific understandings. Clara does ask students questions, but they do not constrain the talk, rather the questions are aimed at children making sense of their scientific ideas. Children's verbalizations, conceptualizations, and misperceptions are accepted as evidences of their scientific knowledge. Children are encouraged to act on their ideas to offer scientific evidence that supports what makes sense to them. This promotes the disequilibrium necessary for assimilation or accommodation to occur. As participants of this culture, the children begin to challenge each others' thinking and ask the facilitating question themselves.

The "constructivist questioning conversation" aims at challenging children's conscious as well as unconscious assumptions regarding their scientific understandings (Gould, 1992). The constructivist conversation involves open-ended, reflective

questions. The following questions are commonly asked by Clara and by other students to facilitate the learning process (Gould, 1992):

--What do you think?

--What happened when you_____?

--What does this resemble?

--Why do you think that?

--Why doesn't _____ work or make sense?

--Can you explain_____in another way?

--Can you convince me or someone else?

--Why do you agree with another's solution?

--Can you find another way to do _____?

--Can you tell me a story about what happened?

--Can you construct_____?

--What if _____?

--What do you see?

--What can you tell me about_____?

--How do you explain _____?

--What do others think about _____?

--What made you construct _____?

--How did you construct _____?

--Is this important for others to think about?

--Can you share your thoughts on _____?

--What might happen if_____?

Clara's commitment to her beliefs about how children learn and the types of knowledge deemed important guide her questioning strategies. She is interested in children's thinking and her questions are artfully crafted to get at the child's

understandings. "Thoughtful, provocative questions are formed that tap children's iideas and create discussions that lead to learning of substance" (Wassermann, 1991).

The Nature of the Materials

The materials used to promote the construction of knowledge consisted of a variety of common, everyday items to commercially purchased "manipulative." The class was filled with baskets, baggies, boxes, tubs, and bowls of objects in which the students could count, investigate, experiment, and construct; e.g., sea shells, keys, pattern blocks, cuisenaire rods, buttons, attribute blocks, beads, beans, sorting circles, calculators, plastic paper clips, colored cotton balls, mirrors, and much more. Children's literature books are available for mathematics explorations which engage children with "different levels of interest and experience" (Burns, 1993). There are games created by the teacher and gaming pieces for student invented games. There are a variety of supplies that aid in constructive projects; e.g., glue, scissors, tape, paper, toilet paper rolls, onion netting, bottle tops, bottles, brushes, paints, and much more.

The use of hands-on, or manipulative, materials provides a context for students to construct mathematical relationships. Materials are used in Clara's classroom for free exploration, the introduction of new concepts, to pose problems that create disequilibrium, to serve as tools for understanding the world, and to promote creative mathematical thought (Burns, 1993). Clara recognizes that there is nothing inherently mathematical about any of the materials which are used in the classroom to promote mathematical thinking. It is what the child brings to the situation, prior knowledge, and reflective abstraction that promote mathematical knowledge (De Vries & Kohlberg, 1987; Kamii & DeClark, 1985; Kamii & De Vries, 1980; Kamii & Joseph, 1989; Piaget, 1965).

The Nature of the Assessment

The children construct portfolios of their work providing justifications for inclusions. They are responsible for maintaining their portfolios and identifying items to be placed into it based on criteria established as a class. Individuals can negotiate portfolio criteria and contents with the teacher. The students are justify their reasons for including items on the basis of the items representation of personal growth and development. Any item a child chooses to include in the portfolio is warranted through student justifications. These portfolios are shared in conferences with the teacher and the students participate in the parent conferences, explaining their justifications and personal goals to their parents. Involvement in the assessment process promotes understanding of the learning process (Wiggins, 1993) and autonomous actions.

Summary

The primary constructivist mathematics classroom is a social situation characterized by the nature of the physical setting, the community, the experiences, the interactions, the materials, and the assessment. Clara's internal language, as it facilitates curriculum and instruction decisions, directly impacts the mathematics environment. It is evident that the environmental structures of Clara's classroom can be culturally described as having an open, flexible physical setting, a democratic community, experiential learning promoting knowledge construction, interactions focusing on student thinking, materials that promote inquiry, and assessment that is part of the learning process. Evident in the cultural meaning of these structures is the goal of education, autonomous growth and development.

CHAPTER V

EDUCATIONAL IMPLICATIONS AND RECOMMENDATIONS

Summary of Study

The questions guiding this study are addressed throughout Chapters III and IV. These questions promoted the initial entry into the cultural scene. The emergent patterns of ethnography generated inferences which offered insight and understanding as to the meanings of the behaviors, knowledge, and artifacts experienced. The answers to the questions guiding this inquiry suggests a limited view of mathematics in primary constructivist culture; however, they are offered here in summary.

1. Influences that aid teachers in the formation of a constructivist philosophy.

Clara found her pre-service development influential in that some alternative approaches to education were experienced. However, she found the student teaching placement contradictory and counter to her beliefs. This led to such a negative influence that she almost dropped out of her student teaching experience. This suggests that universities play an influential role in sparking interest for alternative approaches as courses are designed. It also suggests that student teaching placements, and therefore cooperating teachers, influence pre-service teachers' philosophical development.

Clara found support and opposition in administrative practices. Her philosophy was influenced through the use of inappropriate materials previously adopted by districts. She found opposition to her practices, which led to self-doubt, and had to "make a deal" with the district to use innovative curriculum and instruction practices. Later, Clara found a support system in teachers who "thought like her." Reflective practices

and sharing stories promoted philosophic growth and development. She notes this as very influential to her philosophic growth. Taking classes at a university and bonding with one of the professors was also important for her sense of support. Attending workshops as a participant and as presenter also influenced her progression.

Scientifically studying how children learn and using that knowledge to promote changes was important. Resources expanding on this knowledge were of great influence and are used in her classroom as curriculum guides. Researching the children's "lived experience" has been an influential aspect in developing her philosophy.

2. Compromises teachers make in order to practice constructivist teaching.

Clara shared feelings of compromise when expressing her feelings of professional isolation. She finds there is pressure to "always know the scientific rationale for practices." This is compromising in that teachers using traditional practices do not seem to her to come under this fire. The nature of defense is compromising in itself because it impedes autonomous actions by fostering self-doubt. Due to the traditional structure of the educational system, Clara compromises some of her beliefs about how children learn because of constraints imposed by working within that system--assigning grades to growth and development is one example.

3. Educational issues that concern a primary constructivist teacher.

Clara's educational concerns deal with issues focusing on child-sensitivity. These issues fall into areas of developmentally appropriate practice, readiness, professionalism, assessment, family and community involvement and curriculum and instruction. She is committed to a philosophy that has answers to some of these issues, but finds that the traditional educational frameworks which currently direct the education do not foster environments that promote change or resolution.

4. Cultural structures of a primary constructivist classroom during mathematics.

In the social situation of mathematics in Clara's classroom, six environmental structures emerged which were influenced by the internal language guiding the class

and the goal for education. The six emergent structures are identified as the physical setting, the community, the experiences, the interactions, the materials, and the assessment. The promotion of autonomous growth and development facilitated the nature of the meanings of these structures.

5. Uniqueness of mathematics cultures in a primary constructivist classroom.

The structures that emerged in Clara's classroom are not unique to constructivist mathematics education. In fact, these structures are found in every classroom. However, what makes these structures unique to constructivist education is the nature of their experience as it derives meaning from the goal for education. The locus of control is no longer the teacher if autonomous acts are to be encouraged. The types of knowledge deemed important shifts from a social and physical emphasis to logico-mathematical. The children's thinking is at the core of interactions and experiences.

6. Behaviors, language, and artifacts present during mathematics in a primary constructivist culture.

Emergent intellectual and moral autonomy guide the children's behaviors and the promotion of autonomy guides Clara's actions. The language represents movement toward internal control. The artifacts or materials are common to most school settings with an emphasis on what students do with those materials and the relationships they construct as they use them.

7. Interactions during mathematics in a primary constructivist classroom.

The interactions are concerned with student understanding and the coordination of viewpoints which leads to knowledge construction. Questions asked focus on getting at a child's understandings. Interactions offer the children opportunities to exercise autonomous acts of morality and intellect which foster the construction of knowledge.

8. The physical setting during mathematics in a primary constructivist classroom.

The physical setting is open and flexible, allowing for a variety of active experiences. Materials, supplies and tools are easily accessed by students at their inclination. The children's work dominates the decor and they create all the displays. There are baskets, boxes, trays, and baggies of all types of everyday and commercially purchased materials on shelves, tables, and counters.

9. Education may be losing quality teachers due to student teaching placements that create contradictions in philosophy which lead to disharmony.

The educational community almost lost Clara during her student teaching, due to personal conflicts and discrepancies. These conflicts emphasized issues which remained with Clara during her first years of teaching. Resolution of teaching stages is perhaps more difficult due to this student teaching experience. If positive placements that support student teachers' philosophies were offered, the entry-year may be more comfortable.

Inferences and Implications

As evident from these brief summaries, and from the descriptions offered in Chapters III and IV, the mathematics culture of a primary constructivist classroom is facilitated by Clara's goal for education. The promotion of autonomous acts influences the cultural meanings the children constructed. Their behaviors, knowledge, and artifacts are interpreted through those cultural meanings. Logico-mathematical knowledge, relationships, and connections constructed from within, is facilitated by autonomous growth and development. It is not the intent of this inquiry to prove or disprove this; rather, this is an assumption of the study.

As intended, the descriptions of mathematics in a primary constructivist classroom offer a basis for understanding the nature of structures that bring meaning to the

culture. Emergent patterns of observation generate inferences which promote the re-construction of reality. Insight and understanding of the participants' behaviors, knowledge, and artifacts is gained through analysis of the interrelated structures of the environment and the language of schooling employed. The criteria of a primary constructivist classroom offered in Chapter I are evident in the descriptions presented. It is assumed that logico-mathematical knowledge is facilitated by constructivist approaches. Given this, the basis for understanding the cultural meanings brought to the experiences by the participants is the goal for education.

As a result of this inquiry, several inferences become apparent. These inferences bring forth many implications for education.

1. A constructivist culture is constructed as meaningful to the construction of knowledge.

The construction of the constructivist culture is guided by what is scientifically founded in epistemological, psychological, philosophical, and sociological rationale in order to promote the construction of knowledge. Autonomous growth and development fosters knowledge construction and is an essential aim for educational approaches fostering the knowledge construction. In order for autonomous acts to flourish, constructivist education is developmentally appropriate. Constructivist mathematics efforts focus on the meaningful construction of logico-mathematical knowledge.

In constructivist mathematics education, constructive error is valued and perceived as meaningful to growth and development in that it initiates the equilibration process. The equilibration process is a source for intrinsic motivation for learning. Learning is an active process that is facilitated by a democratic community. Children's existing knowledge is essential, and mathematics experiences focus on these existing understandings.

The constructivist culture is created by behaviors, language, and artifacts that promote knowledge construction. As teachers develop a scientific understanding of

what is meaningful to knowledge construction, the constructivist culture is promoted. The behaviors found meaningful to the construction of knowledge are autonomous ones. The language is internal and represents knowledge construction. The artifacts generated demonstrate knowledge.

2. Educational goals create cultural meanings for children's schooling experiences.

Maguire and Wolfe (1993) stated that "Schools are not only instructional sites, but cultural and sociopolitical sites as well; thus, classrooms are places that offer children opportunities for making culture and constructing knowledge" (p. 38). Understanding that culture and knowledge are both constructed, invented, or created by individuals participating in culture or knowledge construction has implications for creating environments unlike traditional environments. As we ask what cultural lenses we want our children to use when viewing education, teachers engaged in traditional practices will need to reconstruct their classrooms so that they become quite different from the tradition. Constructivist classroom cultures are promoted by rejecting tradition (Brown, 1991b) and inventing realities that are consistent with what we know about how children grow and develop. Teachers will need to be provided risk-free environments to attempt these changes and they will need to offer children the same environments in order to promote their knowledge construction.

3. Reform efforts focusing on children's growth and development require a reconceptualization of education so that it embraces autonomy as the educational aim.

Autonomy as the aim of education is scientifically founded in that the promotion of autonomy leads to higher levels of thinking. When children have opportunities to act autonomously, they promote their logico-mathematical thinking. When educational systems embrace autonomy as the aim for education, they promote the development of individuals capable of logical thought. Autonomy as the aim of education would require a reconceptualization, as it has for Clara. Clara continually rethinks her educational

practices and views them in lieu of her educational goal. In order for autonomy to become reality, it will require a metamorphosis (Brown, 1991b).

4. Researching the living histories of emerging constructivist teachers may offer insight into the reform of teacher education, professional development, and teacher induction.

Several implications for teacher education and professional development that are supported by Katz's (1977) stages of teacher development are suggested by this inquiry. Katz's stages of teacher development range from survival to maturity: survival, consolidation, renewal, and maturity. Her research found that progressive teacher development generally occurs within the first through fifth years of teaching. If we view teacher progression through a phenomenological lens and accept the stages as transitive layers of progressional movement through layers of understanding, then positive resolutions of transformational movements promote teacher progression.

The essence of a layer involves many structures which in and of themselves may hold different transformational meanings. van Manen (1990) explained that "We are less interested in the factual status of particular instances: whether if something actually happened, how often it tends to happen, or how the occurrence of an experience is related to the other conditions or events" (p. 10). Phenomenology, van Manen suggested, does not ask, "How do teachers learn the what they need to learn to move through the stages?" It asks, "What is the nature or essence of the experience of teacher development so that I can better understand what the experience of teacher development is like?"

When asking this last phenomenological question, and through the recognition that positive resolutions of particular essences promote further positive resolutions of other essences, implications for professional development which provide experiences for teachers to resolve present issues are suggested. During the period Katz (1977) defined as survival, Clara would have benefited from professional development that

allowed her to construct materials for her classroom--experiences offering time for reflection (Dewey, 1904; Kuhn, 1986) on how children learn and on the complex causes for behaviors and dealing with diversity, and experiences promoting baseline information for specific areas of conflict, generally management. A mentor teacher participating in a dialogue journal with Clara may have helped her through this time (Staton, 1984). The administration could have served her by supporting and understanding the trials of first year classroom teaching offering comfort, guidance, and reassurance that promoted her philosophic growth and development.

During the essence of consolidation, Clara benefited from opportunities to explore and examine a wide variety of resources on teaching children. Professional development focusing on workshops which were rich in classroom ideas founded in how children learn that can be immediately applied in the classroom were also helpful. Reflection practices promoting the continuation of a dialogue journal would have offered support. Classroom materials and resources which support new ideas would have been beneficial. Mentor partnerships which allow the mutual exploration of curriculum and instructional practices in a nonthreatening environment are important. Administrators can aid in this process by offering a variety of solution possibilities and supporting the teacher's solution attempts and instructional assistance. Principals could have helped Clara by having cross-graded meetings for collaboration and planning giving beginning teachers time to plan with colleagues. Forester (1993) contended that teacher lore, the stories teacher's live, should be revisited and explored to promote an educational setting that offers the opportunity for teachers to create a vision of meaning that promotes renewal. These stories are neglected resources in the current store of research about teaching and learning. They provide information gained from an "experience near" (Geertz, 1983) perspective that only those immersed in the essence can truly know. This type of knowledge based in connoisseurship of the art and craft of teaching (Eisner, 1985) is essential in teacher development. When utilized,

the potential for teacher research to encourage teachers to seek answers to real questions provides an opportunity to alter the way in which we conduct educational tasks. Through "Research" or the process of looking and looking again (Berthoff, 1987), consolidated teachers can bring theoretical knowledge and practice together as a single powerful unit that promotes renewal.

In renewal, Clara found it exciting to socialize with colleagues in order to develop connections with others going through change. Personal reflective journals, diaries and logs which promote self-awareness are especially helpful during this time. Professional days which allow teachers to visit their colleagues' classrooms and attend conferences promote self-assurance and emergent beliefs. The administration comforted this process through the recognition of change and through providing the support that is necessary in order for change to occur; that is, the recognition that parental discomfort may generate complaints, test scores may falter until equilibrium is restored, and peers may find the changes threatening. The administration's response to these factors will greatly effect the renewal process. Pedagogical tact (van Manen, 1991) comes from the merging of philosophical beliefs about how children learn and classroom management that are consistent. Practice could then be reasonable, respectful and dignified, easy to communicate, consistent, stress free, easy to administer, time efficient, flexible, age appropriate, and consistent with the philosophy.

As demonstrated in this inquiry, the essence of maturity is a constant state of renewal. Clara is at terms with herself, but is in a constant state of "becoming." This becoming process is promoted through the assimilation and accommodation of new information so that it fits into existing ideas about children's learning. Professional materials and organizations serve Clara. Professional development is promoted through the attendance of conferences, seminars, and courses that promote the philosophic development. Presentations of her ideas, participation in research inquiries, service on district committees, and publication partnerships are beneficial to Clara's growth

process and time should be provided for teachers to participate in such events. Empowerment and autonomy are present in mature teaching and should be promoted at each layer so that teacher mature teacher transformation results.

5. Constructivist teachers are potential agents of educational change because they act autonomously.

The autonomous acts that led Clara to a constructivist approach to mathematics education offer hope for the future. Serving as an example for her building site and her district, Clara promotes change in teacher and administrative attitudes. The professionalism of teachers is evident in constructivist approaches because their practices are scientifically founded. Clara's efforts serve to change attitudes toward teacher professionalism through her practices.

Clara and other constructivist teachers further enhance the dispositions of children toward mathematics and mathematics education. Constructivist practices are equitable; i.e., if autonomy is the aim of education, then all children are treated with equity. This has powerful implications for minority participation in mathematics and careers needing mathematics.

6. Constructivist mathematics cultures are constructed after much hard work.

Creating a constructivist culture requires hard work on the part of the teacher and the student. Clara needed to keep ahead of the scientific research and challenge herself with reflective inquiry. "It is much easier and less threatening to follow a teacher's manual, go through reading [mathematics] groups day after day, give and correct worksheets, and make routine lesson plans for the entire week" (Kamii, 1982, p. 8). A constructivist mathematics teacher must understand the nature of mathematical thinking and the nature of the culture in order to foster mathematical growth and development. "The most difficult part of constructivist teaching is that it requires change" (Kamii, 1982, p. 8), a reconceptualization of the teacher role and the aim of

education. Kamii stated that the most difficult thing to relinquish as constructivist teaching emerges is the adult power, and this takes much hard work.

Recommendations

This study provided insight and understanding into the meaning of the educational structures present during mathematics in a primary constructivist classroom. Educational reform efforts in mathematics can benefit from understanding the cultural meanings of mathematics educational practices. It is evident that mathematics education is changing, but the focus of these changes is still founded in traditional meanings of education. The National Council of Teachers of Mathematics' *Curriculum and Evaluation Standards for School Mathematics* (1989) and the *America 2000* (United States Department of Education, 1991) goals continue to emphasis economic rationale for educational reform. Implications from this inquiry suggest that we examine educational goals in light of scientific evidence that explains the origins of knowledge instead of defining educational goals to meet the economic needs of the country.

The ability to think formally at the operational level is not promoted with the traditional goals of education (McKinnon & Renner, 1971; Schwebel, 1975). "If students cannot think logically at the formal-operational level, they can certainly not think critically or autonomously" (Kamii, 1982, p. 6). Educational goals need to be examined at all levels of development, which implies a reconceptualization of education.

I recommend that teacher education programs examine their educational goals for pre-service teachers. If autonomous teachers are needed to promote educational changes, then university programs and courses need to be designed to facilitate this development at all levels of teacher education. These programs and courses should include the scientific study of children in lived experiences, and should be designed in ways that students of education can experience constructivist approaches to education

as part of their study. Establishing professional development schools would facilitate this process.

University professors involved in all aspects of elementary mathematics education need to work closely with public schools to establish partnerships that lead to change. Collaborative efforts where university faculty engage in research and research review to support alternative practices could promote autonomous efforts in teachers. These autonomous efforts would result in educational change founded in research.

Another recommendation is to require that elementary pre-service teachers receive more time in field work during their preparation. This not only includes more time in student teaching, but more time in researching children's lived experiences prior to student teaching. Professional development schools would lend support to this notion. If prospective teachers experienced constructivist cultural communities prior to and during their student teaching, perhaps they could acquire more understanding about how to promote them in their own classrooms.

I also recommend that universities and colleges take pride in their student teaching courses and seek means to strengthen this aspect of the teacher preparation program. Too often universities and colleges assume very passive roles in the fieldwork of pre-service teachers. If universities and colleges value the student teaching assignment as an important and influential aspect of the entire process of teacher development, then faculty loads will need to be adjusted so that quality student teaching supervision can occur. On-campus faculty specializing in supervision are necessary to productive student teaching experiences that promote philosophic growth and development. Too often we see adjunct faculty or graduate assistants that have little connection or position with the university or college serving as the only link between the student teacher and the university. If student teaching is valued, then the supervisors will merit positions of value. This is not to suggest that adjunct faculty or graduate assistants are incapable; rather, there needs to be strong connections with the university

to ensure that communication and information is transferred on a regular basis to program directors and coordinators.

Recommendations for principals, universities, faculty, and interested persons take action in promoting sites that practice constructivist approaches. These sites need to be promoted at the district, state, and national levels and serve as areas where others can come to study. By researching and reporting on such efforts, educators will promote these classrooms of change. By including teachers in these efforts, they further promote teacher autonomy and empowerment. This allows universities to serve as a link to reform communication. There are very few places that teachers can be leaders, and universities and colleges need to be pro-active by promoting the change of this perception of teachers.

Along with this notion, I recommend that national, state, and district policies promote and support autonomous teaching acts. By imposing legislated policy that few, if any, teachers play part in, the nation, states, and districts have harmful effects on the growth and development of teachers as scientists. Teacher autonomy is exercised through decision making and legislative policies impede on teachers' decision-making processes. In order for teachers to act autonomously, legislation needs to quit dictating to teachers.

Further recommendations are for the promotion of teacher development at all levels and that local, area, or regional colleges and universities work collaboratively with the public schools to develop an organizational plan for graduate programs which promote the growth and development of survival, consolidation, renewal, and maturity. This recommendation requires universities to participate in the reconceptualization process of school reform in such a way that the examination of teacher education programs involves the actual transformation from one conception to something entirely new, and virtually unimaginable. This approach for universities and colleges requires more than altering existing rules as Brown (1991b) noted; rather it is a transformation.

Suggestions for universities and colleges interested in helping teachers attempting to survive include entry-year programs which are designed to offer support, understanding, reassurance, comfort and guidance in contrast to entry-year programs which foster anxiety over certification possibilities. Advocacy in the form of teacher networking on e-mail or through beginning teacher support groups in which university faculty and local administrations are active are two other possible recommendations that provide opportunities for first-year teachers to engage in supportive dialogue.

Suggestions for teacher education programs promoting consolidation include professional involvement in on-site development which satisfy teacher's needs for information and promote the reflective practices which lead to renewal and maturation. Universities providing opportunities for teachers to interact with their colleagues and examine educational practices as they occur will promote maturation. Maturation can be further promoted through professor-teacher partnerships that promote growth and development for both parties which leads to empowerment and autonomy.

One issue which evidently surrounds entry-year teachers is the inconsistency of teacher preparation philosophies and the philosophies of cooperating teachers. When this occurs, as it did with Clara, the survival resolutions are more difficult. Professional development schools working under the philosophy supported by current research serve as more appropriate placements for student teachers during educational reform. Along with this idea is site-based teacher education programs, which enhance the cooperating teacher role through the involvement of cooperating teachers in university instruction (Cornbleth & Ellsworth, 1994). This notion can provide potential for more appropriate placements for students of education to interact. These efforts potentially promote a deeper understanding of teaching and learning founded in current research which places an entry-year teacher in positions of positive resolve regarding teacher development.

The intent of this inquiry was to shed light on the cultural aspects that bring meaning to mathematics in a primary constructivist classroom. It was found that the goal of education, autonomous growth and development, created the constructivist social situation. The implications of this study go beyond the classroom to teacher preparation and professional development. If constructivist classrooms are to exist, teachers will need to reconceptualize their constructs of education, starting with the reflective analysis of educational goals. Embracing autonomy as the aim of education for children implies the need for autonomy as the aim for teachers and, therefore, society. If this study has enlightened an educator in such a way that they might choose to reflectively examine their educational practices in lieu of reconceptualization, this inquiry found its purpose.

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APPENDIX

IRB RESEARCH APPROVAL FORM

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
FOR HUMAN SUBJECTS RESEARCH

Date: 03-05-93 **IRB#:** ED-93-059

Proposal Title: THE STUDY OF MATHEMATICS IN A PRIMARY CONSTRUCTIVIST CLASSROOM: AN ETHNOGRAPHIC DESCRIPTION

Principal Investigator(s): Margaret Scott, Jenny Ann Piazza

Reviewed and Processed as: Expedited

Approval Status Recommended by Reviewer(s): Approved

APPROVAL STATUS SUBJECT TO REVIEW BY FULL INSTITUTIONAL REVIEW BOARD AT NEXT MEETING.
APPROVAL STATUS PERIOD VALID FOR ONE CALENDAR YEAR AFTER WHICH A CONTINUATION OR RENEWAL REQUEST IS REQUIRED TO BE SUBMITTED FOR BOARD APPROVAL. ANY MODIFICATIONS TO APPROVED PROJECT MUST ALSO BE SUBMITTED FOR APPROVAL.

Comments, Modifications/Conditions for Approval or Reasons for Deferral or Disapproval are as follows:

PROVISIONS RECEIVED AND APPROVED

Signature: Marcia L. Tilley
Chair of Institutional Review Board

Date: March 5, 1993

VITA

Jenny Ann Piazza

Candidate for the Degree of

Doctor of Education

Thesis: AN INQUIRY INTO THE MATHEMATICS CULTURE OF A PRIMARY CONSTRUCTIVIST CLASSROOM: AN ETHNOGRAPHIC DESCRIPTION

Major Field: Curriculum and Instruction

Biographical:

Personal Data: Born in Kirksville, Missouri, November 3, 1959, the daughter of Nick J., granddaughter of Nick J. and Jenny Piazza.

Education: Graduated from Vandalia Community High School, Vandalia, Illinois, in June, 1977; received Bachelor of Arts degree in Elementary Education from Park College, Parkville, Missouri, in May, 1981; received Master of Arts degree at Adams State college, Alamosa, Colorado, in July, 1989; completed requirements for the Doctor of Education degree at Oklahoma State University in July, 1994.

Professional Experience: Elementary Teacher, Oklahoma City Public Schools, August, 1982-May, 1987; Elementary Teacher, La Veta Public Schools, La Veta, Colorado, August, 1987 to May, 1991; Adjunct Faculty, Department of Curriculum and Instruction, University of Central Oklahoma, Edmond, Oklahoma, January, 1992 to May, 1992; Graduate Assistant, Department of Curriculum and Instruction, Oklahoma State University, June, 1991 to May, 1993; Assistant Professor, Department of Elementary Education and Specialized Studies, Boise State University, Boise, Idaho, August, 1993 to present.