

**USING A CREATIVITY-FOCUSED SCIENCE PROGRAM TO FOSTER  
GENERAL CREATIVITY IN YOUNG CHILDREN: A TEACHER ACTION  
RESEARCH STUDY**

A dissertation submitted

by

Joan J. Mariani Gomes

to

Fielding Graduate University

in partial fulfillment of the  
requirements for the degree of

DOCTOR OF EDUCATION

This dissertation has been accepted for  
the faculty of Fielding Graduate University by:

---

Kitty Kelly Epstein, Ph.D.  
Chair

---

Rodney J. Beaulieu, Ph.D.  
Faculty Reader

---

Jennifer L. Edwards, Ph.D.  
Research Faculty

---

Anissa R. Butler  
Student Reader

## ABSTRACT

### Using a Creativity-Focused Science Program to Foster General Creativity in Young Children: A Teacher Action Research Study

By Joan J. Mariani Gomes

The importance of thinking and problem-solving skills, and the ability to integrate and analyze information has been recognized and yet may be lacking in schools. Creativity is inherently linked to problem finding, problem solving, and divergent thinking (Arieti, 1976; Csikszentmihalyi, 1990; Milgram, 1990).

The importance of early childhood education and its role in the formation of young minds has been recognized (Caine & Caine, 1991; Montessori, 1967a, 1967b; Piaget, 1970). Early childhood education also impacts creativity (Gardner, 1999). The features of brain-based learning (Caine & Caine, 1991; Jensen, 1998; Sousa, 2001; Wolfe, 2001) have a clear connection to nurturing the creative potential in students. Intrinsic motivation and emotions affect student learning and creativity as well (Hennessey & Amabile, 1987).

The purpose of this study was to discern if a creativity-focused science curriculum for the kindergarteners at a Montessori early learning center could increase creativity in students. This action research study included observations of the students in two classrooms, one using the creativity-focused science curriculum, and the other using the existing curriculum. The data collected for this interpretive study included interviews with the students, surveys and interviews with their parents and teachers, teacher

observations, and the administration of Torrance's (1981) Thinking Creatively in Action and Movement (TCAM) test.

The interpretation of the data indicated that the enhanced science curriculum played a role in enhancing the creativity of the children in the creativity-focused group. The results of the TCAM (Torrance, 1981) showed a significant increase in scores for the children in the creativity-focused group. The qualitative data revealed a heightened interest in science and the observation of creative traits, processes, and products in the creativity-focused group children.

The implications of this study included the need for meaningful learning experiences, experiential learning opportunities, critical thinking and problem solving activities, and an emphasis on freedom, independence, and autonomy on the part of the learner. These elements, when combined with an integrated science curriculum, can foster creativity in young children.

Copyright by Joan J. Mariani Gomes

2005

## Dedication

This dissertation is dedicated to my parents, ,  
and my family, Kelley, Kenney, Kerrey, Dax, Zan, and Doug  
for their love, patience, support and understanding.

## Acknowledgements

My sincerest thanks go to Dr. Kitty Epstein, my mentor and dissertation chair, whose gentle guidance challenged and supported me, and whose slant on inequality in our school system has raised my consciousness. Thank you to Dr. Jenny Edwards, whose patience, understanding, and excellence in editing and statistics prompted me to strive toward my goals. I also wish to thank Dr. Rodney Beaulieu, who instilled the importance of the basics of writing and research in me, and Ms. Anissa Butler for giving her time and expertise in this endeavor. I also wish to thank Dr. Harold Berlak for his assistance, wisdom, and expertise. My thanks also go to Dr. Linda Taira, who prompted me to begin my journey.

I also wish to thank my friends, Sheila Makahanaloa, Edgar Ramones, and Leanna Brake, whose dialogue and collegiality made this study possible. Thank you to the kindergartners of the early learning center, whose spirit energized me.

I will never be able to express my thanks to my family, including my mother and father, who instilled the importance of education in me through their sacrifices and constant support. Thank you to my children, grandchildren, and husband whose love, encouragement, and understanding got me through it all. To my daughter, proofreader, and critical friend, Kerrey—I send a special thank you.

## TABLE OF CONTENTS

CHAPTER ONE: INTRODUCTION.....	1
Statement of the Problem.....	3
Purposes of the Study.....	6
The Research Questions.....	8
Statement of the Significance of the Study.....	9
Background of the Study.....	13
Limitations of the Study.....	16
Summary.....	18
CHAPTER TWO: LITERATURE REVIEW.....	19
Introduction.....	19
Theories of Creativity.....	19
Person-Oriented Theories of Creativity.....	20
Process-Oriented Theories.....	23
Product-Oriented Views of Creativity.....	27
Systemic Views of Creativity.....	29
Other Factors.....	34
Heredity and Creativity.....	37
Implications of Current Research on Creativity.....	38
Science and Creativity.....	45

The Importance of Early Childhood.....	51
Early Childhood, Science, and Creativity.....	53
Implications for Education.....	56
Summary.....	70
CHAPTER THREE: METHODOLOGY.....	72
Introduction.....	72
Restatement of the Research Questions.....	73
Culture of Inquiry.....	74
Collaborative Action Research: The Participating Teachers.....	79
The Setting.....	83
The Participants.....	85
Procedures.....	86
The Intervention.....	87
The Curriculum.....	88
The Thinking Creatively in Action and Movement Test.....	93
The Parent Survey and Interview.....	95
Interviews with the Children.....	96
Data from the Teachers.....	96
Quality of the Study.....	97
Data Analysis.....	100
Summary.....	103
CHAPTER FOUR: RESULTS.....	104

TCAM Results.....	104
Parent Survey and Interview Data.....	105
Children’s Interview Data.....	118
Teacher Data.....	126
Staff Interviews.....	126
The Teachers’ Research Logs.....	133
Going One Step Further.....	133
The Regular Group.....	133
The Creativity-Focused Group.....	135
The Verbalization of Thinking Processes.....	137
Emergence of Cooperative Endeavors.....	138
Creative Products.....	139
The Rise of Similes and Metaphors.....	142
Other Observations.....	143
Parental Feedback to Teachers.....	144
Summary.....	145
CHAPTER FIVE: DISCUSSION.....	147
Overview of the Findings.....	147
Discussion.....	150
Findings.....	150
The TCAM Scores.....	151
Parent Responses.....	151

Summary of Findings from Parent Responses.....	154
Children’s Responses.....	155
Summary of Children’s Responses.....	156
Teachers’ Observations of Creativity Traits.....	156
Summary of Teachers’ Observations of Creativity Traits.....	157
Teachers’ Observations of the Creative Process.....	157
Summary of Teachers’ Observations of the Creative Process....	158
Teachers’ Observations of Creative Products.....	158
Summary of Teachers’ Observations of Creative Products.....	159
Other Factors.....	159
Summary of Other Factors.....	164
Practical Applications.....	165
Conclusions about Action Research.....	167
Recommendations for the Early Learning Center.....	169
Recommendations for Practice.....	170
Recommendations for Further Study.....	172
Summary.....	173
References.....	175

## LIST OF APPENDIXES

Appendix A: Written Parent Survey/Oral Parent Interview.....	187
Appendix B: Oral Student Interview.....	188
Appendix C: Staff Interview.....	189
Appendix D: Sample Science Lesson Plan for Both Groups.....	190
Appendix E: Parent Informed Consent Forms.....	191
Appendix F: Student Assent Form.....	194
Appendix G: Staff Informed Consent Form.....	195

## TABLES

Table 1: T-tests for Regular Group and Creativity-Focused Group on the Thinking Creatively in Action and Movement (TCAM) Instrument.....	105
Table 2: Parent Responses of Children in the Creativity-Focused Group to Question 1: “Please relate any increased interests in any curriculum areas that your child has indicated to you during the course of this past year. Include any stories or incidents involving your child that may relate to this question.” .....	108
Table 3: Parent Responses of Children in the Regular Group to Question 1: “Please relate any increased interests in any curriculum areas that your child has indicated to you during the course of this past year. Include any stories or incidents involving your child that may relate to this question.” .....	109
Table 4: Parent Responses of Children in the Creativity-Focused Group to Question 2: “What are your impressions of your child’s creativity?” .....	111
Table 5: Parent Responses of Children in the Regular Group to Question 2: “What are your impressions of your child’s creativity?” .....	112
Table 6: Parent Responses of Children in the Creativity-Focused Group to Question 3: “What feedback has your child conveyed to you regarding his/her science experiences this past year?” .....	114
Table 7: Parent Responses of Children in the Regular Group to Question 3: “What feedback has your child conveyed to you regarding his/her science experiences this past year?” .....	115
Table 8: Parent Responses of Children in the Creativity-Focused Group to Question 4: “Do you think our enhanced science curriculum has been beneficial to your child?” .....	117
Table 9: Parent Responses of Children in the Regular Group to Question 4: “Do you think our enhanced science curriculum has been beneficial to your child?” ...	118
Table 10: Creativity-Focused Group Children’s Responses to Question 1: “Look at all your journals. Which journal did you enjoy doing the most? Tell me about it.” .....	119

Table 11: Regular Group Children’s Responses to Question 1: “Look at all your journals. Which journal did you enjoy doing the most? Tell me about it.” .....	120
Table 12: Creativity-Focused Group Children’s Responses to Item 2: “Tell me about the lesson you liked the best.” .....	121
Table 13: Regular Group Children’s Responses to Item 2: “Tell me about the lesson you liked the best.” .....	122
Table 14: Creativity-Focused Children’s Responses to Question 3: “What kind of new and different ideas have you had as a kindergartner?” .....	123
Table 15: Regular Group Children’s Responses to Question 3: “What kind of new and different ideas have you had as a kindergartner?” .....	124
Table 16: Creativity-Focused Group Children’s Responses to Question 4: “How do you feel about science? Tell me about your feelings and things that you like or do not like about it.” .....	125
Table 17: Regular Group Children’s Responses to Question 4: “How do you feel about science? Tell me about your feelings and things that you like or do not like about it.” .....	126
Table 18: Teacher Responses to Question 1: “How do you think the science curriculum in your room has impacted the creativity in your students this past year? What kinds of changes have you noticed in the children from the other group, if any?” .....	128
Table 19: Teacher Responses to Question 2: “What other elements do you think contributed to this outcome?” .....	129
Table 20: Teacher Responses to Question 3: “What do you feel the benefits of this study have been on the children’s creativity in the regular group, the creativity-focused group, our environment, methods, and curriculum, and our interaction staff?” .....	131
Table 21: Teacher Responses to Question 4: “What recommendations would you have for further study in this area as a result of your experiences?.....	132



## CHAPTER ONE: INTRODUCTION

Education should try to preserve the most remarkable features of the young mind—its adventurousness, its generativity, its resourcefulness, and its flashes of flexibility and creativity. (Gardner, 1991, p. 110)

The characteristics of early learning centers range from a pure playtime and socialization experience to a rigorous academic environment stressing reading, writing, and mathematics (Black, 1998); however, many crucial elements that should exist in an early learning environment can be lacking. These elements include an environment that provides meaningful learning experiences (Caine & Caine, 1991; Gatto, 2002; Healy, 1987; Hutchinson, 2003; Jensen, 1998; Montessori, 1964; Sousa, 2001; Wolfe, 2001), opportunities for independent and cooperative learning (Holt, 1989; Jensen, 1998; Lind, 1997; Montessori, 1964), the cultivation of critical thinking and problem-solving skills (Gatto, 2002; Gross 1999; Jensen, 1998; Lind, 1997; Sousa, 2001; Wolfe, 2001), the facilitation of intrinsic motivation (Caine & Caine, 1991; Jensen, 1998; Maiorana, 1992), as well as student attainment of skills and knowledge that meet standards (Gross, 1999; Perkins, 1992). Experiential learning opportunities, educational methods that involve movement on the part of the learner, and an integration of the arts may also be lacking in schools. These are crucial in aiding learning, understanding, retention, and promoting brain function, as well as intrinsic motivation and meaningful learning experiences (Sousa, 2001; Wolfe, 2001).

Caine and Caine (1991) recognized the importance of the “aha” sensation of illumination and meaning that provides energy and motivation in creative work.

However, they noted that this was an element that was missing in schools. They said that two crucial dimensions of meaning are missing from most education. The first is

creative insight and a sense of what is meant. With Gendlin (1962), we call it *felt meaning*. The other is purpose, which is at the heart of *deep meaning*. Both are indispensable to the acquisition of natural knowledge. (p. 103)

Current brain research has uncovered the importance of meaning in the learning process and memory (Jensen, 1998; Sousa, 2001; Wolfe, 2001).

Independence and cooperation are important elements in a school environment for several reasons with respect to creativity. Hennessey and Amabile (1987) included having children take responsibility for their work in order to foster inner direction and independence as a means of enhancing creativity in children. Cooperative efforts not only aid in the development of socialization and problem-solving skills, but also they have been shown to be a valuable asset in creative efforts, as displayed by Gordon's (1961) work in synectics. Synectics involves the study of the dynamics, methods, and processes involved in finding creative solutions to problems presented to groups formed to collaborate on solving problems, and whose members have been selected based on their expertise and diversity of backgrounds (Gordon, 1961).

The most prominent of these missing elements appears to be critical thinking and problem-solving skills. Maiorana (1992) viewed this as the major challenge of American education. Yet, critical thinking and problem solving are important components of the creative process, especially when one considers the cognitive aspects of the process of creativity, which emphasize problem finding, problem solving, and critical thinking (Feldman, Csikszentmihalyi, & Gardner, 1994; Torrance, 1963). Isaksen and

Treffinger's (1985) definition of creativity involved the thought processes involved in finding solutions and alternatives to problems and "making meaningful new connections" (p. 13).

Intrinsic motivation and meaningful learning experiences are lacking in education. Caine and Caine (1991) noted that "a system of education that is built almost exclusively on a system of rewards and punishment, from smiley stickers to grades for specific outcomes, innately reduces the capacity of a person to engage in creative learning" (p. 78). Hennessey and Amabile's (1987) model of creativity, based on the intrinsic motivation principle of creativity, supported this view. They explained that "the intrinsically motivated state is conducive to creativity, while the extrinsically motivated state is detrimental" (p. 6). It is my contention that these elements are compatible with the cultivation of creativity in students.

#### Statement of the Problem

The importance of thinking skills, problem-solving skills, and the ability to integrate and analyze information has been recognized and yet found to be lacking in American schools (Ackerman, 2003; Beyer, 1984; Roman, 2003; Wolfe, 2001). Roman (2003) suggested that the model of technology education can be one that educators follow to meet this goal. He identified the need for teachers to integrate knowledge in the curriculum, and for a "student-centered, process oriented [sic] approach to problem solving" (Roman, 2003, p. 3).

Thinking creatively is inherently linked to problem finding, problem solving, and divergent thinking (Arieti, 1976; Csikszentmihalyi, 1990; Milgram, 1990). The

kindergarten children from an early childhood center located in Hawaii where I work showed that one area that needed improvement was solving problems and using data when they took their Terra Nova (CTB/McGraw-Hill, 1997) tests upon entering the first grade. Although the Terra Nova is a type of standardized test containing multiple-choice questions, it attempts to go beyond drill worksheets to elicit and evaluate the students' higher-order-thinking skills in a more contextualized format. Students must comprehend the material as they read and understand the questions on the test.

Sample test questions bear a great similarity to the "Word Problems" section of mathematics textbooks that I myself had while attending elementary school. For example, a sample question for the Terra Nova practice test in mathematics for grade 4 read as follows: "At the car factory nine workers each put a different part on the car. If James is the fourth worker in line, how many people still have a part to put on the car?" (EPES Testing Service, 2003, p. 2).

The early learning center contained those elements conducive to promoting creativity, such as providing meaningful learning experiences, fostering independence and cooperation, and promoting critical thinking and problem solving, and the staff did not use a system of punishment and rewards. As a result, the staff questioned why the students were not strong in the problem-solving area. Keeping in mind that perhaps the test itself was not a valid indicator of problem-solving skills, the staff still believed that this issue needed to be addressed. This was particularly important since problem solving was connected to creativity (Feldman, Csikszentmihalyi, & Gardner, 1994; Isaksen & Treffinger, 1985; Torrance, 1963). The faculty began to question if they were doing all

in their power to cultivate creativity and problem solving in the center. They began to reflect on the strengths and weaknesses of the program as far as creativity and problem solving were concerned.

Although the early learning center's upper division consisted of children from the ages of 3 to 6, the focus of this study was on the kindergarten children in this preschool-kindergarten division. The kindergarten children had more class periods devoted to lessons and did numerous activities in conjunction with those lessons. These activities were more extensive and elaborate than preschool activities. The teachers were also concerned with providing students with a successful transition to the first grade program.

The importance of early childhood education and its role in the formation of young minds is widely recognized, especially its impact on creativity. Gardner (1991) stated, "I consider the period from age two to six or seven a fascinating period of human development....Habits of mind and body are set....artistry and creativity in general are unleashed—or blocked—at this time" (p. 82). Yet, it seemed as if we had overlooked the advantages of cultivating problem solving and creativity in young children as a regular and important part of the early childhood curriculum. Sparking creativity involves far more than providing artistic outlets via the art and music in the curriculum; it also involves teaching children problem solving and cognitive processes (Arieti, 1976; Feldman, Csikszentmihalyi, & Gardner, 1994; Isaksen & Treffinger, 1985; Torrance, 1963). Creativity involves children's individual systems, their environment both at home and at school, and an interactive process that is affected by all these factors (Albert, 1990;

Arieti, 1976, Csikszentmihalyi, 1990; Gedo, 1990; Helson, 1990; Hennessey & Amabile, 1987). I felt it imperative to address this weakness at our early learning center.

### Purposes of the Study

The literature revealed that problem solving is part of the creative process (Arieti, 1976; Feldman, Csikszentmihalyi, & Gardner, 1994; Torrance, 1963). The link between science and creativity has also been studied (Amabile, 2001; Bredderman, 1983; Chandler, 1999; Glass, 1993; Inamorato, 1998; Loehle, 1990; Montessori, 1989; Simon, 2001; Spicker, 1996). The main purpose of this study was to address the need to nurture and to enhance creativity and problem solving in the kindergartners at the early learning center using science as a means, and, in the process, improve early childhood practices at the early learning center with regard to curriculum and methods. Its second purpose was to contribute new knowledge in the field of education. The third purpose was to discern if the new creativity-focused science curriculum for the kindergarten children at an early learning center in Hawaii did enhance their creativity and problem solving. The new creativity-focused science curriculum was designed to supplement the educational environment in the hopes of fostering the creative potential in the children.

The creativity-focused science curriculum became a major part of the classroom environment in several ways. More formal lesson time was devoted to this kindergarten curriculum area. Two lesson periods per week were designated for science, rather than just one. The themes in the science curriculum were integrated into the other curriculum and learning areas. Teachers involved in presenting the creativity-focused science curriculum collaborated on changing classroom materials, such as counters, puzzles, and

books, and incorporated themes being explored in science with other curriculum areas and circle activities. Science activities were not only hands-on, inquiry-based, and exploratory, with a focus on problem finding, problem solving, and critical thinking, but also involved artistic elements in follow-through activities, such as art activities, music, and poetry. A conscious effort was made by the teachers presenting the creativity-focused curriculum to ensure that all lessons were experiential, and that hands-on follow-up activities were available for the children to use. Teachers who were involved with the creativity-focused curriculum also focused on problem finding, problem solving, and critical thinking in their methods and lesson delivery as part of the curriculum. Journal work was supplemented by work involving various art media including modeling dough, craft materials, paints, and pastels to enable the students to produce works that were three-dimensional and not confined to journals. The children had access to these materials on a regular basis. Music and poetry experiences that pertained to the subject matter were included in science lessons. These methods were the means to the ultimate purpose.

This study focused on the kindergartners in the classroom's mixed population of 3- to 6-year-olds. The science curriculum was developed for the kindergarten students. This study used a quantitative instrument, the Thinking Creatively in Action and Movement Test (TCAM; Torrance, 1981), and interviews from the students and teachers involved. The parents were also asked to participate in a written survey, except for four parents who were randomly selected to answer the same survey questions, but in an interview. The kindergarten teachers participated in interviews, and contributed their

observations and logs as an additional source of data. The kindergartners were given a TCAM pre-test in January 2004 and a TCAM post-test at the end of May 2004. The surveys and interviews were conducted in May 2004. The entries in teachers' logs and teacher observations were ongoing from January through May 2004. Although the new curriculum was implemented with the kindergartners in the creativity-focused group in November 2003 when their science lessons began, the TCAM was not administered until January, after ethics approval was obtained.

The enhancement of the science curriculum was in sync with our center's Montessori philosophy of following the lead of the child (Montessori, 1964; 1967). Teachers were not bound to a schedule or timetable, but had the flexibility to follow the lead of the children and the children's interests. I expanded the lessons in the science curriculum to include separate lessons on subjects that had captured our students' interest in the past, such as the solar system and life sciences. These changes in subject matter, time devoted to lessons, and a focus on integration, thinking skills, and more artistic endeavors and activities, we hoped, would unlock the creative potential in our students and in ourselves, as well.

### The Research Questions

The research questions for this study were

- Will the scores on Torrance's *Thinking Creatively in Action and Movement* (1981) for the kindergarten children who are exposed to a revised science program increase during a 5-month period more than the kindergartners who are exposed to the regular science program?

- Will the parents of kindergarten children in the group receiving the new science program relate an increase in their child's interest in science or creativity or observe any other benefits that may be attributed to the new science curriculum, as opposed to the parents of children who are experiencing the regular combined cosmic/science program?
- Will kindergarten children who participated in the revised creativity-focused science program notice an increase in their own creativity or ability to generate new ideas, more than students who participated in the regular science program?
- Will the teachers involved in the study observe any differences in the creativity of their students that may be attributed to the different science curricula or methods?

#### Statement of the Significance of the Study

Montessori (1974) stated, "This strength of imagination in the child under six is usually expended on toys and fairy tales, but surely we can give him real things to imagine about" (p. 73). Perhaps exploration of science and the wonders of nature is the vehicle for helping students exercise their creativity, imagination, and divergent thinking.

Gordon (1961) noted that in the field of synectics, "the richest source of Direct Analogy was biology" (p. 56). Gordon explained further that synectics involved facilitating creative problem solving and finding by tapping into the talents of a variety of people working together as a group toward the common goal of finding creative solutions to problems. The dynamics of the group is a major component of synectics, along with

various mechanisms used to attain results. Direct analogy is one of the operational mechanisms used in synectics to facilitate creativity and problem solving. This appears to be another indication that science can be a natural vehicle to develop creativity and problem solving in young children.

Caine and Caine's (1991) model of "Brain-based Learning" (p. 8) provides an excellent means of unlocking the creative potential in students. They stated,

Among the features of brain-based learning are active uncertainty or the tolerance of ambiguity; problem solving; questioning; and patterning by drawing relationships through the use of metaphor, similes, and demonstrations....Brain-based learning is usually experienced as joyful, although the content is rigorous and intellectually challenging; and students experience a high degree of self-motivation....It involves the entire learner in a challenging learning process that simultaneously engages the intellect, creativity, emotions, and physiology....it appreciates the interpenetration of parts and wholes by connecting what is learned to the greater picture....Brain-based learning is meaningful to the learner. (pp.8-9)

The process of brain-based learning appears to be complementary to science. Patterns are obviously inherent in nature. Metaphors are generally grounded in the physical world. Questioning and problem solving are the lifeblood of scientific advancement via hypothetical thinking, testing, and experiments. Most importantly, the children's interest in science seemed natural as well as profound. Montessori's (1964, 1967) philosophy was always to follow the lead of the child.

In today's world of technological advances, scientific exploration, and complexity, a scientific mind is surely an asset. If interest and understanding in the field of science becomes an integral part of educational curriculum beginning in the early years, the impact can prove to be vast.

An emphasis on a science curriculum lends itself to a natural integration with other curriculum areas. According to Sousa (2001), thematic units and an integrated curriculum can “enhance the transfer process” (p. 139). This transfer aids in the processing of new material that is learned (Sousa, 2001). Jensen (1998) supported the use of “universal concepts and core organizing principles” (p. 96) to facilitate the brain’s use of patterns in making meaning. Communication, writing, language, and comprehension are essential parts of the field of science (Chalufour & Worth, 2003; Holt, 1989; Jacob, 2001). Mathematics and its applications, problem solving, and logic are also natural parts of science (Tyler-Wood, Mortenson, Putney, & Cass, 2000). Science and its implications and advances, in some way or another, impact everyone daily. The subject of science lends itself easily to a process of integration and application in other curriculum areas (Polito, 1995), and this integration can facilitate meaningful learning and higher order thinking (Caine & Caine, 1991; Jensen, 1998; Sousa, 2001).

Why should educators be concerned about enhancing creativity and problem-solving skills in young children? Current brain research indicates that an immediacy is involved in promoting creativity and problem solving in young children (Caine & Caine, 1991). Research on the plasticity of the brain and its development suggests that if teachers wish to make the most of children’s potential, addressing brain-based learning at an early age is necessary (Caine & Caine, 1991; Jensen, 1998).

One key item of brain-based learning is the recognition of brain plasticity, which “means that the *physical structure of the brain changes as a result of experience*” (Caine & Caine, 1991, p. 30). Brains can be stimulated and grow as a result of experiences and

the environment. What is the system of education doing to children's brains? Are educators acting as caretakers or cultivators? Surely brain size and growth impact creativity, as do the brain's functioning and the child's experiences. Does a form of *creative plasticity* exist that builds upon itself and its experiences, products, and motivation?

Caine and Caine (1991) stated that the brain has "an inexhaustible capacity to create" (p. 3). It then follows that their model of brain-based learning should augment this capacity for creativity. Cultivating the creative energies in young children relates to brain-based learning not only in this respect, but also because many aspects of brain-based learning also contribute to intrinsic motivation, cooperative learning, independence, higher order thinking, and meaningful learning.

A curriculum grounded in science that facilitates intrinsic motivation, creativity, and problem solving can prove to be extremely important as a mainstream method in education. Could the creativity-focused science curriculum in the early learning program in Hawaii enhance creativity in the children during this critical time of their development? The success of a program such as this could become a model that would facilitate motivation in learners, enhance divergent and critical thinking skills, and help to develop students who find not only meaning in learning, but also a means and motive to create.

The study of these questions at our center could potentially lead to improvement of our environment, methods, assessment practices, and curriculum in service of our students. This study would be a tool to enhance dialogue, cooperation, collegiality, and

professionalization among our staff members. It also would facilitate partnership and communication with the children's parents.

### Background of the Study

At our Montessori early learning center, the curriculum consists of practical life, language, sensorial, math, and "cosmic" areas (Montessori, 1989, p. 1). "Cosmic" education was defined as "a truly integrated view of human-life education for children worldwide" (Trudeau, 1984, p. 2). I realized that we, too, stressed language, mathematics, and basic skills at the center in our daily activities and lessons. I also realized that the kindergarten children were keenly interested in science lessons, which were delivered in conjunction with the cosmic, environmental studies and social studies curriculum, yet science had no place of its own because it shared allocated lesson time slots with the social studies aspect of Montessori's Cosmic Curriculum. The kindergarten teachers had remarked on several occasions that more time should be allotted for children to pursue their keen interest in science and for projects related to science topics.

The kindergartners displayed an overwhelming interest and fascination in this area, and this interest manifested itself in many ways: the books they borrowed from the library, comments from parents, and their work in other areas. The staff became increasingly aware of their great interest in this curriculum area. The kindergarten teachers at the early learning center constantly critique, reflect, and dialogue with regard to curriculum matters. This is usually done in informal weekly meetings. These teachers

make it part of their yearly routine to make changes in the curriculum that they feel would be in the best interest of the children.

All the kindergarten teachers were familiar with the work that I had been doing in the field of science and creativity, so much of the reflection and dialogue concerned the science curriculum, which had just been revised the previous year, and was again being scrutinized. This had become important to us because we had found that our previous kindergartners had displayed that problem solving was an area that could be improved upon on their Terra Nova tests. The kindergarten teachers always addressed issues that the Terra Nova tests of our former kindergartners raised. I had already begun working revisions on the science curriculum for the 2003-2004 school year when the possibility of testing this revised curriculum during the school year arose. The four kindergarten teachers and the director of the center agreed that the creativity-focused curriculum could be tested in the classroom. The kindergarten teachers and the learning center's director decided to implement the creativity-focused curriculum with one group of kindergartners and have the other group use the regular curriculum during the 2003-2004 school year. The study was to provide us with data to determine which curriculum we should pursue for all the children in 2004-2005.

In response to the children's interest and comments by the other kindergarten teachers, I revised the science curriculum, which was already integrated, experiential, and inquiry-based, but focused on these aspects even more. This new creativity-focused science curriculum was implemented, along with revisions in lesson time allocations to provide two lessons per week in science to the creativity-focused group. The teachers

agreed to try this creativity-focused curriculum on the kindergartners in one of the upper-division classrooms, which consisted of preschoolers and kindergartners. The other classroom, which was comprised of children in the same age group, would continue with the regular cosmic/science curriculum with the kindergartners.

The creativity-focused curriculum was different from the regular one in several ways. The creativity-focused science curriculum would be devoted to science alone, rather than being a combination of environmental education, culture studies, and science. The time slots normally devoted to the combination of these subjects would be devoted to only science in the creativity-focused classroom, and a separate lesson time would then be devoted to the cultural aspects of the cosmic curriculum on a bi-weekly basis. The kindergarten follow-up activities in the creativity-focused classroom would provide more choices with different art media, rather than only entailing two-dimensional journal work. It was my contention that the additional focus with the creativity-focused curriculum on an experiential and inquiry-based curriculum, more time devoted to science, and a more creative approach to follow-up activities would result in enhancing creativity and problem solving in the kindergartners in the creativity-focused group.

These follow-up activities were comprised of journal work, group projects, and art projects for the creativity-focused group. The regular group did their follow-up work in their journal using markers, pencils, or crayons. Journal work in the creativity-focused group was not limited to markers, crayons, and pencil work. Journal work in the creativity-focused group included working with various art media, such as paints, water colors, pastels, and craft materials. Group projects completed by the creativity-focused

group included working on a large-scale rainforest diorama with every student contributing something to the construction of the diorama, and creating desert animals from modeling dough that were then displayed in the classroom. Art projects were designated as a “free choice activity” for the creativity-focused group. This meant that they could choose to work with their choice of arts and crafts from the art closet to create whatever they wished after lessons were over, or they could work in other areas.

The teachers in the upper division agreed to assist in this study by contributing their observations, reactions, and anecdotes regarding the kindergartners. It was agreed that the teachers would collaborate in this study to see if enhancing the science curriculum would result in an increase of creativity in the students. Parents were asked for their observations and input regarding their kindergarten children. The issue of gender and ethnicity and how these factors might have impacted the results were also examined. The children were also interviewed to garner their perspectives and feelings about science and creativity. The kindergartners were also asked to take part in Torrance’s (1981) Thinking Creatively in Action and Movement Test (TCAM), both at the beginning of the study and at the end of the study, to aid in the interpretation of the results of the study. Parental consent, along with their child’s assent, was obtained for the kindergartners’ participation.

#### Limitations of the Study

The length of this study limited it in that the scores on the *Thinking Creatively in Action and Movement* (TCAM; 1981) test only reflected a span of 5-months from the administration of the pre-TCAM (1981) test to the administration of the post-TCAM

(1981) test. Ideally, a span the length of the school year would provide a more accurate measurement of the impact of the experience on the kindergartners.

The sample size used in this study was also a limitation. The enrollment at the center predetermined not only the sample size, but also the members belonging to the two groups being studied. Random sampling was not an option because the class groups had already been determined at the start of the year. This necessitated an interpretive study of the TCAM results, which, in turn, made the results only suggestive.

It should also be stated that there was no foolproof means of attributing enhanced creativity to the science curriculum per se. The whole kindergarten experience, as well as other factors ranging from individual traits to home environments, could also have impacted the results. The connection of any gains in the children's creativity to the science curriculum would need to be documented in teacher and parent observations, children's interviews, parent and staff surveys, as well as in the work the children produced.

Dependence on observations, interviews, and surveys, though invaluable, can also have drawbacks. Observations may be subject to bias and selectivity (Miles & Huberman, 1994). Interviews and surveys may garner information that is untrue or misleading (Altrichter, Posch, & Somekh, 1993). Measures taken to enhance the validity and reliability of this study are addressed in the methodology section of this document.

Another limitation is the fact that the Terra Nova (1997) testing results for the children participating in this study will not be available until the end of 2004, and, even then, not all of the participants will be taking the test because many of the students at the

early learning center do not enter the elementary school where the test is administered in the first grade. In addition, standardized tests such as the Terra Nova (1997) may not be a reliable indicator of the students' ability to problem solve and think critically (Goldberg, 2004).

### Summary

This study is an attempt to address the facilitation of creativity in young children. No attempt was made to identify gifted or creative children, but rather, the focus was on enhancing the creative potential in all of the students.

It was my intention to address the inclusion of key elements thought to facilitate creativity, which include meaningful experiences (Caine & Caine, 1991), independence (Davis, 1983; Montessori, 1964), cooperative learning (Gordon, 1961; Holt, 1989; Lind, 1997), problem solving and critical thinking (Arieti, 1976; Csikszentmihalyi, 1990; Feldhusen & Goh, 1995; Milgram, 1990), activities to foster intrinsic motivation (Caine & Caine, 1991; Hennessey & Amabile, 1987), exposure to basic knowledge and skills (Gardner, 1989), the integration of other curriculum areas with science (Caine & Caine, 1991; Jensen, 1998; Sousa, 2001), and an inclusion of various art media, poetry, movement, and music activities (Gardner, 1989; Jensen, 1998; Sousa, 2001; Wolfe, 2001). With all this in mind, I revised the science curriculum at the early learning center.

## CHAPTER TWO: LITERATURE REVIEW

What I am really interested in is the new kind of education which we must develop which moves toward fostering the new kind of human being that we need, the process person, the creative person, the improvising person, the self-trusting, courageous person, the autonomous person. (Maslow, 1971, p. 96)

### Introduction

This chapter contains a review of theories of creativity, current research and its implications on creativity, the study of science and its relationship to creativity, the importance of early childhood experiences with respect to creativity, the connection between early childhood, science, and creativity, and the implications for education with regard to creativity.

### Theories of Creativity

Theories of creativity range from those that focus on the person and the traits of creative people to matrices and schematics that involve all or some of these aspects: cultures, institutions, groups, environmental conditions, chance factors, person, process, and product. In examining various theories—those involving the person, the process, the environment, and the product—patterns emerge that indicate what educational settings should strive to provide.

Definitions of creativity and their focus reveal many perspectives. Davis (1983) noted that definitions and theories of creativity fell into three categories: person, process, and product. Definitions regarding the person focused on traits and characteristics common to creative people. Theories that were process-oriented examined the cognitive aspects of creativity from the germination of ideas to the reporting of the final results.

Theories involving the product focused on the end result of creative endeavors and the ramifications and originality of the creative product.

*Person-Oriented Theories of Creativity*

The very definition of creativity and what it entails appears to have evolved over time. In the early years of the study of creativity, giftedness or genius was considered to be synonymous with creativity (Becker, 1995). These theories asserted “the primacy of individual genius” (Gordon, 1961, p. 8).

Galton’s (1925) view appears to be the most biased because it held that creativity was hereditary and was possessed by those who were genetically superior to others, and that evolution should be nudged along in its selection of the fittest. Fortunately, other theorists were not so myopic in their views. Arieti (1976) noted its drawback, stating that “although eugenics would wipe out degenerations and insanities, it would also eliminate genius” (p. 356). Galton (1883) defined “eugenics” as

the science of improving stock, which is by no means confined to questions of judicious mating, but which, especially in the case of man, takes cognisance [sic] of all influences that tend in however remote a degree to give to the more suitable races or strains of blood a better chance of prevailing speedily over the less suitable than they otherwise would have had. (p. 17)

These early definitions included traits that early theorists considered to be inherent in people of genius, ranging from baldness and degeneration to emaciation (Davis, 1983). The person who was a genius was viewed as a maladjusted eccentric, and theorists “tried to prove that many geniuses had neurological diseases, neuroses, or full-fledged psychoses” (Arieti, 1976, p. 354).

Davis (1983) later formulated a list of common traits of creative people that he compiled from his own recent research and the research of other theorists. These traits include

- Aware of their own creativeness
- Independent
- Self-Confident
- Risk-Taking
- High in Energy
- Enthusiastic
- Spontaneous
- Adventurous
- Thorough
- Curious
- Wide Interests
- Good Sense of Humor
- Playful, Childlike
- Artistic Interests
- Idealistic
- Reflective
- Needs ... Privacy, Alone Time
- Attracted to Novelty, Complexity, and the Mysterious (p. 37)

In more recent years, the creative type was also portrayed as being at the other end of the character spectrum by Maslow. Maslow (1971) wrote, "the concept of creativeness and the concept of the healthy, self-actualizing, fully human person seem to be coming closer and closer together, and may perhaps turn out to be the same thing" (p. 55). He qualified this by making the distinction between "primary creativeness" (p. 57) and "secondary creativeness" (p. 57).

Primary creativeness was creativity that arose from the unconscious mind and inspiration. Secondary creativeness involved the hard work, discipline, and training

needed to see products of creativity to their completion. It was to this primary creativeness that Maslow (1971) referred with regard to self-actualization. He stated,

This kind of primary creativeness is very probably a heritage of every human being. It is a common and universal kind of thing. Certainly it is found in all healthy children. It is the kind of creativeness that any healthy child had and which is then lost by most people when they grow up. (p. 80)

Davis (1983) concurred, but he went further by noting another kind of creativity. He noted the difference between creativity that is a result of self-actualization, and creativity that is a result of some special talent.

Gedo (1990) defined creativity "as the healthy enjoyment of the search for novelty" (p. 35). His views took a psychologist's slant on creativity as being an ongoing process during one's life, one's life search, and turmoil and guilt regarding one's talents, self-esteem, and balance in one's life. Albert (1990) added traits of creative people in other areas, including metaphorical thinking, "interpersonal coping" (p. 23) skills, and being sensitive to problems.

Simonton (1990), whose approach included studies of biographies and history, focused on the creativity and the influence of creative people on civilization. He stated that a creative "genius is one who manifests some exceptional talent, some distinctive, even idiosyncratic capacity in a particular domain. Such individuals are akin to Maslow's (1962) 'self-actualizers,' who devote their lives to the realization of a potential goal, idea, or style" (p. 97). Simonton cited two types of creativity—one psychometric, which correlates with superior IQs, and the other historiometric, which depends on one's contribution to and effect on mankind.

Arieti (1976), who recognized the importance of the process of creativity and forms of thinking, logic, and imagery, believed in the systemic nature of creativity, and that the person was an important part of creativity. He stated, "rather than a single trait, then, it is a special combination of several traits—in a special family environment, in some socio-historical situations, occurring at a given time and place—that produces the synthesis we call creativity" (p. 359). He cited some traits that seemed to recur in creative persons. He wrote, "intelligence *is* required....deviant thinking is prominent....spontaneity is also important, but so are diligence and perseverance... straight thinking is important, but mental illness has not been a deterrent in outstanding cases" (p. 358).

#### *Process-Oriented Theories*

The whole process involved in creativity took precedence in some theories of creativity. Davis (1983) explained the creative process as having three perspectives:

First, it can refer to a sequence of steps through which the creative person proceeds in clarifying a problem, working on it, and producing a solution that resolves the difficulty. Second, it can refer to the relatively rapid perceptual change...when a new idea or problem is suddenly produced or detected. Third, the creative process can refer to the techniques or strategies that creative people use...to produce new idea combinations, relationships, meanings, perceptions and transformations. (p. 60)

Some process-oriented theorists emphasized the influence of problem solving and problem finding. Isaksen and Treffinger (1985) defined creativity as "making and communicating meaningful new connections" (p. 13), and they applied this definition to the process of problem solving, which included techniques to foster the process.

Guilford's (1967) structure of intellect model stressed various cognitive aspects of the person.

It is mainly in the process-oriented theories of creativity that the connection of problem solving, divergent thinking, and critical thinking to creative endeavors is strong. According to Arieti (1976), "The three most important characteristics of divergent thinking are flexibility, originality, and fluency; or the ability to produce, rapidly, a succession of ideas that meet some requirement" (p. 17). The emphasis on problem solving was reflected in this view. Aside from the value placed on divergent thinking in some theories and assessments, problem solving, problem finding, problem stating, and the discovery of problems were an integral part of some creativity theories, especially those that were process-oriented. Feldman, Csikszentmihalyi, and Gardner (1994) also stressed that "Such processes as problem finding and problem formulation are as critical to creativity as problem solving" (p. 3). Torrance (1963) defined creative thinking as "the process of sensing gaps or needed missing elements; of forming ideas or hypotheses concerning them; of testing these hypotheses; and of communicating the results, possibly modifying and retesting the hypotheses" (p. 90).

Arieti (1976) revealed that the creative process needed to be recognized as being composed of several processes: the primary process, which includes the unconscious, the secondary process, "which is the way of functioning of the mind when it is awake and uses common logic" (p. 12-13), and/ or a combination of the two that he specified as being the "tertiary process" (p. 12). This synthesis or process of creativity involved

integrating the primitive or primary mind with the secondary and logical mind. Arieti (1976) explained,

The tertiary process, with specific mechanisms and forms, blends the two worlds of mind and matter, and, in many cases, the rational with the irrational. Instead of rejecting the primitive (or whatever else is archaic, obsolete, or off the beaten path), the creative mind integrates it with normal logical processes in what seems a "magic" synthesis from which the new, the unexpected, and the desirable emerge. (p. 13)

Arieti (1976) also indicated that "paleologic thinking plays an important role in the creative process" (p. 73). This primitive form of thinking has a logic of its own and is different from the conscious form of thought. He best explained it in terms of schizophrenia and how "*A* also becomes non-*A*—that is, *B*—provided *A* and *B* have a predicate (or element) in common. It is the predicate that leads to identification and equivalence" (p. 69). For example, girls have long hair. John has long hair; therefore, he is a girl. This paleologic thinking is primary process thinking. Paleologic thinking is involved in some of the creative processes that become similes and metaphors, once logic takes hold.

Paleologic thinking extends imagination and provides the imagination with many possibilities. However, according to Arieti (1976), this same imagination must be disciplined in order to lead to acceptable results. Arieti also viewed imagery as a means of opening horizons and possibilities to a realm beyond reality. This portal is only available to people. It expands the universe to endless possibilities, solutions, and visions for the future, a future that people can help create. It is in this vein that some may see a genius today as "a human being who has an extraordinary capacity for desirable

originality, or makes a new and profound contribution to some or all of mankind” (Arieti, 1976, p. 293).

Arieti (1976) postulated two prerequisites for the process of creativity to occur. One he termed as “contingencies” (p. 37), and the other, “imagination and amorphous cognition” (p. 37). He defined contingencies as “a category that includes everything external to the creative person” (p. 37). He then defined imagination as “the capacity of the mind to produce or reproduce several symbolic functions while in a state of consciousness, of awakesness, without any deliberate effort to organize these functions” (p. 37). Finally, Arieti defined “amorphous cognition” as “a kind of cognition that occurs without representation—that is, without being expressed in images, words, thoughts, or actions of any kind” (p. 54). These two prerequisites acknowledged both the person, as well as the environment and external influences. The person, with all his/her processes and skills, and his/her environment had an impact on creativity.

When examining the process of creativity, it is important to recognize the “aha” aspect involved. This refers to that point in the process where everything comes together, or the idea is born. The mystery of incubation and intuition are a part of the creative process. Jensen (1998) recognized the importance of the “dream state or rapid eye movement (REM) time” for maximizing learning and memory. Arieti (1976) offered that the need to “sleep on the material” as students study is the part that the unconscious plays in the brain’s quest to make connections and give meaning to what is learned. Arieti (1976) termed this integration of “mind and matter” (p. 13) the “magic synthesis” (p. 13). Perhaps this REM sleep time that facilitates learning, memory, and meaning could be the

period when creativity is generated and cultivated. This unconscious aspect is known by other names such as “incubation” (Caine & Caine, 1991, p. 161; Healy, 1987, p. 325; Gordon, 1961, p. 10) and “illumination” (Davis, 1983, p. 64). Davis (1983) noted illumination in his second perspective of the creative process as a “rapid perceptual change” (p. 60).

Even Gordon’s (1961) model of synectics involved the interaction of the conscious and incubation in the process of creativity. Gordon (1961) stated that one of the advantages of synectics is that the “group can compress into a few hours the kind of semi-conscious mental activity which might take months of incubation for a single person. This ‘efficient use’ of the subconscious leads to our insights” (p. 10).

Gordon’s (1961) work in synectics documented that “[W]hen the goal of invention is achieved; it is preceded, signaled, and accompanied by a pleasurable mental excitement” (p. 28). He noted that this “Hedonic Response is a vital element in the motivation of creative people” (p. 28). These unconscious and motivating aspects of creativity are similar to the need for connections and inner motivation that are conducive to meaningful and successful learning experiences (Caine & Caine, 1991; Jensen, 1998; Sousa, 2001; Wolfe, 2001).

### *Product-Oriented Views of Creativity*

Product-oriented theories of creativity focused on works that were produced, tangible or intangible. This view entailed judgment or evaluation of the product, and, in some cases, the product’s impact on civilization to determine if these works were creative.

Gardner's (1993) definition of creativity included the product aspect of creativity when he stated, "The creative individual is a person who regularly solves problems, fashions products, or defines new questions in a domain in a way that is initially considered novel but that ultimately becomes accepted in a particular cultural setting" (p. 35). Simonton (2003) also noted that creativity must be studied in light of the person, the process, and the products, as well. Hennessey and Amabile (1987) stated that "[A]lthough today, many theorists continue to think of creativity as a *process*, their definitions most frequently cite characteristics of the *product* as the distinguishing signs of creativity" (p. 7).

Although those involved with the Synectics group were committed to "produce descriptions and definitions directly related to the experience of the creative process itself" (Gordon, 1961, p. 25), synectics did recognize the importance of the product with regard to creativity. Gordon indicated this by stating that "there could be but one measure of the results of a research program devoted to Synectics investigation of the creative process, namely, the end product" (p. 24). The proof of accomplishment in the Synectics setting included "valuable solutions to...problems" (Gordon, 1961, p. 74), as well as estimation of the patent value of the work.

Besemer and O'Quin (1999) devised the "Creative Product Analysis Matrix" that involved three factors and nine facets. They explained, "These are, for Novelty, originality and surprise; for Resolution, logical, useful, valuable, and understandable; and for Elaboration and Synthesis, organic, well-crafted, and elegant" (p. 287). Their measure of creativity was found in the product.

Eysenck (1994) noted major variables in the cognitive, environmental, and personality areas that affected creativity as achievement. Achievement was based on what creative product was produced. These variables that affect creative achievement reflect the systemic nature of creativity.

Harrington (1990) explained the systemic nature of detecting creativity from a product-oriented standpoint:

I believe a modern psychology of creativity must begin to view the value, and hence the creativity, of novel human products as a complex function of the properties of the products themselves and the capacities and tendencies of the social world to extract and create value from those novel products. (pp.146-147)

Albert and Runco (1990) noted the realization that the product was indeed important when one considered creativity, but the product could not be isolated when considering a multi-faceted aspect of humanity known as creativity. They recognized the interdependency and systemic quality of creativity when they stated "that the individual, regardless of his or her obvious talent, is only a part of the matrix of change and innovation and is, in part, its product" (Albert & Runco, 1990, p. 259). This tendency toward a view that recognized the impact of environmental factors, as well as others, becomes more evident in current systemic views of creativity.

### *Systemic Views of Creativity*

Even when focused on the individual as the creative source, theorists could not overlook the influence of environment, which included social, cultural, and historical factors. Some viewed creativity to be influenced by one's environment or the process of interaction with one's environment (Albert, 1990; Arieti, 1976; Csikszentmihalyi, 1990;

Helson, 1990; Hennessey & Amabile, 1987). Creativity was viewed as part of one's culture and was subject to the influences, interactions, judgments, and evaluations of those powers that exist in that particular society. Gedo (1990) recognized the influence of one's environment and life experiences on the manifestation of these traits.

Csikszentmihalyi (1990) noted the impact of environment on creativity in his statement:

that in order to understand creativity one must enlarge the conception of what the process is, moving from an exclusive focus on the individual to a systemic perspective that includes the social and cultural context in which the "creative" person operates. (p. 190)

He recognized the importance of the entire system: the person, the field, and the domain as interdependently affecting each other in the process of creativity.

In Csikszentmihalyi's (1994) systemic model, creativity was an external process involving the interaction among the three subsystems, the person, the field, and the domain. He defined the field as being "that part of the social system that has the power to determine the structure of the domain" (Csikszentmihalyi, 1994, p. 151). He defined the domain as "any symbolic system that has a set of rules for representing thought and action" (Csikszentmihalyi, 1994, p. 151).

Albert and Runco (1990) recognized the environment as one of three sub-systems that included the person and product, as well as contributing to creativity as a shared experience. Albert (1990) also cited the influence of family and culture on creative people and the formation of their identities.

Arieti (1976) used historical documentation to chronicle the occurrences of high

instances of creativity occurring in different locations at different periods of time. This indicated the probability that environmental forces were at work that could prove to be conducive to creativity at that time and place. He cited examples of Greeks, the Renaissance, the American Revolution, and the large number of Jewish people involved in the realm of creativity.

Arieti (1976) stated that he concurred with Kroeber regarding the possibility of high instances of creativity that exist in certain populations. Arieti also agreed that the environment does have an impact on the manifestation of creativity. He conceded that there are times when genius and obvious forms of creativity emerge, regardless of environmental influences, but these are exceptions. He further stated that “the potentiality for creativity is deemed more frequent than its occurrence” (p. 303) and it is the environment that influences the reaping of this potential.

Arieti (1976) viewed creativity as an open system similar to von Bertalanffy’s (1968) conception. He stated that creativity “is an open system, both as an intrapsychic phenomenon and as the outcome of environmental factors....In the creative process, as well as in any open system, the initial conditions do not determine the final outcome” (p. 409).

In her study of creativity in women, Helson (1990) viewed creativity as being generated by oneself and subject to influences that the environment and society exerted on that person. Home life, development of identity, and cultural and societal influence and opportunities all played a role in the development and emergence of creativity in individuals.

Hennessey and Amabile (1987) supported the importance of other factors related to creativity that were impacted by the environment. These included “domain-relevant skills, creativity-relevant skills, and intrinsic task motivation” (p. 9). They recognized the significant impact that environmental factors have on creativity and also believed in the creative potential of *all* people. Maslow (1971) concurred with Hennessey and Amabile by recognizing that all people have creative potential.

Harrington (1990) took the impact of others and the environment a step further in his investigation of “collaborative creativity,” defined by him as creative acts that “are neither the products of historical geniuses but instead are the products of several people working in intended or unintended collaboration” (p. 144). A prime example he gave was the development of the personal computer. Although recognizing private creativity, Harrington’s view of social creativity addressed products and performances to which people are exposed. He stated,

creativity must begin to view the value, and hence the creativity, of novel human products as a complex function of the properties of the products themselves and the capacities and tendencies of the social world to extract and create value from those novel products....I believe acts of social creativity must be viewed as the products of a human ecosystem as well as the products of an individual or two. (pp. 146-147)

It is in this view of social creativity and systems that synectics has its foundation.

“Synectics theory applies to the integration of diverse individuals into a problem-solving problem solving group” (Gordon, 1961, p. 3). Synectics theory holds creativity in a systemic view where a diversity of agents enhance possibilities and variations.

Gordon’s basic “hypothesis was that a general level of novelty (as opposed to marginal

improvements) depends on the widest variety of skill, knowledge, and interest being brought to bear" (p. 12). It focused on the problem-finding and problem-solving aspects of creativity. Synectics also relied on collective creativity in its use of groups and the process involved in creativity.

Gordon (1961) suggested that the major contribution of synectics theory was the use of metaphorical thinking and analogies in techniques of "making the familiar strange" (p. 33) and "the strange familiar" (p. 33) as mechanisms to generate creativity. He stated, "Synectics has identified four mechanisms for making the familiar strange, each metaphorical in character: (i) Personal Analogy; (ii) Direct Analogy; (iii) Symbolic Analogy; (iv) Fantasy Analogy" (Gordon, 1961, p. 36). According to Gordon, these mechanisms helped facilitate psychological states that, in turn, promoted creative analysis, problem viewing, solutions, and products.

There are those who seemingly negate the idea of creativity altogether. Behaviorists, such as Skinner, viewed novel behavior as resulting from responses to stimulus and reinforcement. Epstein's (1990) work with reinforcement and novel behavior in animals in which he elicited novel behaviors in pigeons with positive reinforcement techniques, tends to reduce the wonder and mystery of creativity to a set of responses to stimuli and problem solving. Work along these lines overlooks crucial elements of humans, who have a magnificent capacity for imagery, imagination, memory, and a spirituality that makes them capable of unselfish and humanitarian acts. Humans possess a potential for so much and have exhibited such creativity in the course of history

that it would seem incredulous to relegate these acts to responses to stimuli or to deny their existence.

I believe that every human being possesses creative potential. Sometimes, if the conditions are right, creativity will flourish, and at other times, creativity will remain dormant. These theories of creativity help to identify the traits and characteristics of the person, environmental factors, and processes that may facilitate or impair the pursuit of creativity. Instead of unknowingly repressing traits or stifling conditions that are facilitative, an awareness of these theories of creativity may allow for their realization, instead. Educators and their environment and methods do impact the learner and the learner's potential in the creative field.

#### *Other Factors*

One factor that is given prominence in theories of creativity is motivation. The overriding sentiment in the study of creativity is that motivation, specifically motivation that is intrinsic in nature, is a driving force behind creativity (Albert, 1990; Amabile, 1990; Helson, 1990; Hennessey & Amabile, 1987). It can mean the difference between creativity being generated and remaining dormant. It can also be a critical factor in affecting creativity and the degree to which it is manifested.

Arieti (1976) stated, "motivation, although necessary, is not the specific ingredient of creativity....Early experiences can play a determining role in stimulating and directing the individual toward a certain kind of activity" (pp. 28-29). The sources of motivation vary among theorists, as well as their impact.

Gordon (1961) recognized the importance of motivation when he cited the source of motivation for those involved in synectics. He stated that the “energy to implement a Synectics project in our culture must be grounded in conviction about morality and social value” (p. 76). He also noted that “the thrill of arriving—of participation in constructing a solution” (p. 77) contributed to intrinsic motivation for the synectics group. Other motivating factors recognized in synectics work involved belonging to the group, morality, crises, responsibility, and excitement produced by accomplishments.

Davis (1983) suggested that two of the characteristics of creative people were having a “high energy level” (p. 39) and being consumed in their work, both stemming from intrinsic motivation. Albert (1990) noted that motivation was one of the things that characterized eminent people. Helson’s (1990) study of the impact of societal and cultural factors on the manifestation of creativity in women revealed that these factors contributed to motivational issues.

Amabile’s (1990) investigation into the role of intrinsic motivation on creativity used both Einstein and Sylvia Plath as examples of creative people who have experienced the important influence of motivation in their endeavors. Amabile cited intrinsic motivation as being one of the three major components of creativity. Csikszentmihalyi (1990) recognized the necessity of motivation in creativity as affecting not only the thought processes involved, but also persistence in finding a creative solution for problems uncovered in the process.

Hennessey and Amabile's (1987) theory of creativity is based on "*the intrinsic motivation principle of creativity*" (p. 6), which stated that "the intrinsically motivated state is conducive to creativity, while the extrinsically motivated state is detrimental" (p. 6). Not only is the lack of motivation a detriment to creativity, it is also a detriment to education and cognitive processes. The traditional models of education, such as lecture and memorization, result in students lacking motivation (Maiorana, 1992). Gardner (1991) has also recognized the role of traditional classrooms in quelling that very motivation in students that is necessary for creativity.

Another factor that many writers investigated—with respect to creativity—is intelligence (Albert, 1990; Davis, 1983; Runco, 1990). Arieti (1976) stated, "The prevailing opinion is that highly intelligent persons are not necessarily creative. Although creative people are intelligent persons, an exceptionally high IQ is not a prerequisite for creativity" (p. 342). Csikszentmihalyi (1990) "failed to find any relationship between traditional measures of intelligence and criteria of creative accomplishment" (p. 193). This may be due in part to the validity of standard intelligence tests. Davis (1983) also noticed the lack of correlation between intelligence and creativity in his "threshold concept...above an IQ of 120, neither a person's IQ score nor his college grades will predict his or her level of creativeness" (p. 53). Runco (1990) concurred that some intelligence and knowledge are necessary for creativity, "but not sufficient for creative performance" (p. 241).

Milgram's (1990) theory connected intelligence with academic achievement, rather than with creative endeavors. Milgram found that "leisure activities" (p. 226)

correlated with creativity. He viewed a person's leisure activities as being indicative of creative potential. Intelligence was indicative of success in a school setting.

Feldhusen and Goh (1995) clarified the role of intelligence by stating that creativity is "often defined as a parallel construct to intelligence, but it differs from intelligence in that it is not restricted to cognitive or intellectual functioning or behavior" (p. 232).

Hennessey and Amabile (1987) also recognized that some level of intelligence was necessary; however, many levels of creativity can be found in those possessing "higher levels of intelligence" (p. 10). Therefore, one can surmise that some level of intelligence is necessary for creativity to occur, but the amount of intelligence does not have a direct correlation to creativity itself.

#### *Heredity and Creativity*

The question of intelligence and creativity has gone hand in hand with the question of whether or not creativity is hereditary. Theories regarding the study of "genius," such as those in the early 19<sup>th</sup> century, stressed heredity (Becker, 1995). Certainly there have been cases of families with impressive achievements in the area of creativity and giftedness, but perhaps these instances may be due to other factors such as environment and the influences of family and culture.

Granted, some examples of creative genius where exceptionally high intellect or talent is evident seem to indicate that heredity and genetics do play a contributing role. However, the overall consensus seems to indicate that some intelligence, knowledge,

and/or skills are needed, but they do not insure that creativity will materialize (Davis, 1983; Hennessey & Amabile, 1987).

### Implications of Current Research on Creativity

Current brain research (Caine & Caine, 1991; Jensen, 1998; Sousa, 2001; Wolfe, 2001) and Gardner's (1991) views of apprenticeships and children's museums as models for learning environments, as well as his theory of multiple intelligences, all have a deep connection to creativity. Caine and Caine's (1991) theories, as well as the works of other theorists, regarding how the brain works and develops have much in common with key concepts regarding creativity. Gardner's theory coincides with views on creativity and methods for facilitating its emergence. Healy's (1987) views on "the creative brain" (p. 311) are synonymous with both Caine and Caine and Gardner.

The features of brain-based learning (Caine & Caine, 1991; Jensen, 1998; Sousa, 2001; Wolfe, 2001) have a clear connection to creative endeavors. The problem-solving and questioning aspect is a major part of the creativity process. Patterning, metaphors, similes, and connections reflect the major techniques practiced by those in synectics work (Gordon, 1961). Hennessey and Amabile's (1987) research revealed the importance of motivation and engagement with one's work with respect to creativity. The ability to see parts, wholes, and how things fit is a major key in analysis and synthesis in the creative process. All of these key ingredients of creativity emerge from this brain-based learning model.

The important role that meaning plays in the learning process, as well as with memory, has been documented (Caine & Caine, 1991; Jensen, 1998; Sousa, 2001; Wolfe,

2001), and, as Wolfe put it, “the two are so inextricably linked that a study of one becomes a study of the other” (p. 74). It is noteworthy to add that using metaphors, analogies, and similes is a technique that can be used to make learning more meaningful, just as it is a technique for creative endeavors used by synectics groups (Gordon, 1961).

Caine and Caine’s (1991) research on two different types of memory, locale memory and taxon memory, rendered a clue as to methods and practices and their impact both on meaningful learning and on learner motivation. Taxon memory, which depends on practice and review, is the one most utilized in schools. Lists and categories characterize this type of memory. Taxon memory is fueled by extrinsic motivation, such as stickers and rewards, because what is memorized holds no true meaning for the learner in that there is no context or connection, and information is committed to the memory by rote and rehearsal (Caine & Caine, 1991). Rote rehearsal is valuable for the attainment of skills or habits, but “standard curriculum, however, falls into the semantic memory category, where rote rehearsal is not as effective a method of practice” (Wolfe, 2001, p. 102). Both Sousa (2001) and Wolfe (2001) necessitated the presence of sense and meaning in learning situations, and, as did Caine and Caine (1991), supported the making of connections to oneself and one’s previous experiences.

Sousa’s (2001) concept of “*transfer*,” describes a two-part process: (1) the effect that past learning has on the processing of new learning, and (2) the degree to which the new learning will be useful to the learner in the future” (p. 136). This ability to transfer is the essence of creativity and “is the core of problem solving, creative thinking, and all other higher mental processes, inventions, and artistic products” (Sousa, 2001, p. 136).

Sousa went further, stating, "Metaphors, analogies, and similes are useful devices for promoting abstract transfer" (p. 148). This bears a striking similarity to Gordon's (1961) mechanisms used with the synectics group and Caine and Caine's (1991) concept of "making connections" (p. 3).

The locale memory is systemic in nature in that it "exist[s] in relationship to where we are in space...there is always a complex set of relationships among all these items" (Caine & Caine, 1991, p. 45). This memory is experienced via the senses and is intrinsically motivated. The locale memory is engaged when the brain utilizes "stories, metaphors, celebrations, imagery, and music" (p. 47) to learn. Caine and Caine (1991) suggested that use of the locale memory is closely tied to creativity in that both focus on patterns, autonomy, intrinsic motivation, and relaxation. These are key ingredients in creativity.

It is this precious locale memory that is disengaged when the brain "downshifts" (p. 69) in response to perceived threats (Caine & Caine, 1991). They explained,

We define downshifting as a psychophysiological response to perceived threat accompanied by a sense of helplessness and lack of self-efficacy. In addition, downshifting often accompanies fatigue...We also seem less able to engage in complex intellectual tasks, those requiring creativity and the ability to engage in open-ended thinking and questioning...Downshifting, then, appears to affect many higher-order cognitive functions of the brain and thus can prevent us from learning and generating solutions for new problems. (Caine & Caine, 1991, p. 70)

When this happens, creativity suffers. Threats that produce downshifting need not be life threatening and can be stimulated by teachers' attitudes, classroom situations, or whatever is perceived to be threatening by the learner. Sousa (2001) also recognized

the interplay between emotions and feelings of security and successful learning.

Jensen (1998) expressed that “stress and threat in the school environment may be the single greatest contributor to impaired academic learning” (p. 52), and that they are detrimental to creativity, as well. The use of rewards can contribute to the loss of creativity, as well as to the functioning of the locale memory system, because the possibility of not receiving a reward may be threatening in some cases. Jensen (1998) also negated the value of extrinsic rewards suggesting that the brain is capable of making its own rewards, and that intrinsic motivation is the one most conducive to learning.

Another key element of brain-based learning is brain plasticity. Sousa (2001) referred to this characteristic when he stated that the brain “constantly shapes and reshapes itself as a result of experience” (p. 1). Perhaps there exists some form of *creative plasticity* because creativity is a way of life, and its potential, growth, and expression are so dependent on and shaped by experiences and environment.

Current research on the brain (Caine & Caine, 1991; Healy, 1987; Jensen, 1998; Sousa, 2001; Wolfe, 2001) and multiple intelligences (Gardner, 1991) support the techniques of metaphorical thinking, integration, the importance of helping learners seek patterns in their experiences, and an experiential and constructive approach to learning. These techniques and their ramifications are conducive to creative efforts. Wolfe (2001) stated that “concrete experience is one of the best ways to make strong, long-lasting neural connections” (p. 188). Sousa (2001) deemed movement as being extremely important to brain function and learning, stating “that movement and learning are inescapably linked” (p. 230).

Healy's (1987) emphasis on the importance of how the child's brain grows and develops is reflected in her beliefs that young children should be given the opportunity to play, explore, discover, and have experiences in school rather than being expected to remember, practice, drill, and work in workbooks. The former facilitates creativity and brain growth, whereas the latter may actually impede learning and proper development. Wolfe (2001) related the value of experiential learning with regard to brain research when she noted that "sensory abilities are powerful components of brain understanding and retention of information" (p. 151). Jensen (1998) expanded this idea by stating that in the early years, "learning has simply got to be hands-on, experiential, and relevant for patterns to develop" (p. 96), and that patterning was critical to learning and intelligence.

Gardner's (1991) views on apprenticeships and museums convey the idea of a hands-on and experiential learning experience. Apprenticeships render a contextualized and meaningful format. Children's museums offer experiential and constructive learning experiences. Both scenarios are compatible with a brain-based learning approach. Both scenarios promote active learning and intrinsic motivation, which are also conducive to creativity (Healy, 1987; Hennessey & Amabile, 1987).

Gardner (1991), in his theory of multiple intelligences, recognized the diversity among learners and the uniqueness of each one's potential. The nurturing of these different styles not only fosters an array of perspectives and talents, it also promotes different forms of expression and performances. It respects the gifts and contributions of individuals, and this development of multiple perspectives is "the best antidote to

stereotypical thinking" (Gardner, 1991, p. 245). Synectics emphasized the use of a diverse array of people to provide an array of perspectives (Gordon, 1961).

Healy's (1987) views on the creative brain documented the importance of emotions and the environment with respect to creativity, as did Wolfe (2001). Jensen (1998) related, "There is no separation of mind and emotions; emotions, thinking, and learning are all linked" (p. 71). Healy (1987) proffered that the right hemisphere of the brain, the artistic side, was positively affected by "alpha" rhythms in contrast to "beta" rhythms, which were conducive to the analytical thinking characteristic of the left hemisphere. She stated that "reflection, relaxation, biofeedback, and imagery techniques appear to be effective in activating alpha frequencies" (p. 323). These techniques are aligned with techniques used in synectics (Gordon, 1961), Caine and Caine's (1991) state of "*relaxed alertness*" (p. 70), and the importance of reflection in the cognitive process of creativity (Caine & Caine, 1991).

Sousa (2001) concurred with Healy (1987) with respect to the role that emotions play in learning, memory, and brain function. He maintained that the "two structures in the brain mainly responsible for long-term remembering are located in the emotional system" (p. 19), and that "emotions play an important role in human processing and creativity" (p. 39).

Healy (1987) further indicated that the skills and information that are being drilled and memorized in schools today may prove to be unnecessary when one considers today's technology. Healy (1987) added that "different forms of intelligence—the ability to solve problems, think reflectively, and actively pursue learning throughout life—will

become more important" (p. 191). Roman (2003) concurred, citing the need for analogies, integration, and divergent thinking in the future. Darling-Hammond (2001) cited the need for creative critical thinkers and problem solvers in the future. These views require an active rather than a passive learner.

Healy (1987) has indicated some qualities that creative students may exhibit:

- Intense absorption in activities....
- An unusual ability to see patterns or relationships....
- An ability to combine things or ideas in new ways....
- The use of analogies in speech....
- Seeing things in a new or different way....
- A tendency to challenge assumptions or authorities....
- Independent decision-making and the ability to take action.
- An ability to shift from one idea to another.
- Strong intuition. "Seeing" answers to problems.
- An ability to...take risks.
- Insightful observations or questions....
- A tendency to create and test hypotheses....
- An ability to tolerate ambiguity while exploring alternatives....
- An interest in new ideas....
- Enjoyment in thinking and working alone. (pp. 315-316)

These qualities and abilities, which are similar to those mentioned by other creativity theorists (Albert, 1990; Arieti, 1976; Feldman, Csikszentmihalyi, & Gardner, 1994; Torrance, 1963), should then be fostered and nurtured in educational settings.

Such a list can easily be applied to working with a science curriculum geared for early learners. Using concentration skills, exploring areas of interest, making discoveries, using metaphors to describe things or events, observing, questioning, and testing hypotheses and new ideas are all indispensable ingredients for an experiential and inquiry-based science program. Current research indicates the need for meaning (Caine & Caine, 1991; Jensen, 1998; Sousa, 2001; Wolfe, 2001) and pattern making (Caine &

Caine, 1991; Jensen, 1998) in learning situations. Problem solving, patterning, metaphors, and imagery are keys to maximizing the brain's potential (Caine & Caine, 1991; Healy, 1987; Jensen, 1998; Sousa, 2001), as well as key aspects of creativity (Arieti, 1976; Gordon, 1961; Healy, 1987; Torrance, 1963). The impact of emotions (Caine & Caine, 1991; Healy, 1987; Sousa, 2001) and intrinsic motivation (Hennessey & Amabile, 1987) on learners also indicate the need for learning that is enjoyable, experiential, and connected to the learner and the learner's interests. This impacts learning, as well as creativity (Healy, 1987; Hennessey & Amabile, 1987; Jensen, 1998). It is my contention that an experiential and inquiry-based science program can meet these needs in a school setting and, in doing so, foster creativity.

### Science and Creativity

Science is generally viewed as a domain for the expression of creativity or genius. Technical breakthroughs and immense leaps of knowledge regarding the universe have been traced through time by means of hallmarks in scientific achievement. The industrial revolution, quantum physics, the discovery of radium, inhibitors for AIDS, and the discovery of DNA and atomic energy call to mind names of creative people, such as Ford, Einstein, Watson and Crick, Madame Curie, Ho, and Bohr. The arts have also been vitalized by creative masters whose works will inspire countless people through the end of time. Michelangelo, Van Gogh, Picasso, Ruben, Angelou, Mozart, and Bach are names that evoke visions of artistic splendor and talent.

Notable instances of creativity are generally associated with the field of art and the field of science. Jacob (2001) documented the similarities in art and science as

having imagination as their roots, analogy and metaphor as a means, and a base in nature. Innamorato (1998) concurred, noting the importance of the cultivation of imagination, the ability to theorize and see patterns, and the possession of the necessary knowledge and skills to enhance creativity in both fields.

Simon (2001) suggested that the cognitive processes involved in scientific creativity and artistic creativity were one and the same. He recognized expertise in a chosen domain, the influence of patterns in both fields, and the importance of prior work in the field as contributing factors to creativity. Simon's investigation into these two areas, art and science, blended the work of very different types of creative genius into a process that is similar not only across domains, but also to everyday thought processes, as well.

Chandler (1999) has likewise detected "a natural synergy between the arts and sciences in the domains of theory, methodology, and the development of practical applications...like twins separated at birth" (p. 3). He proposed that "the parallel spaces of science and art are magnetized by the educational needs of the twenty-first century" (p. 9).

Innamorato (1998) perceived a strong relationship between science and creativity. He stated, "imagination and creativity have been considered a substantive foundation from which scientific skills develop" (p. 2). Rayl's (1995) study documented gains in preschoolers' math and science potential when preschoolers received keyboard instruction.

Studies linking science with creativity have been done, but mostly in an effort to enhance the performance of gifted learners in the field of science. Tyler-Wood, Mortenson, Putney, and Cass (2000) found an increase in standardized test scores for gifted students when they were exposed to an integrated mathematics and science program designed for them. Eighth grade students who were considered to be academically talented were selected to participate in this 2-year study. An enhanced math and science curriculum, which concentrated on higher level thinking skills and an experiential and integrated curriculum, was developed for this study. The data from the standardized science and math test scores revealed a significant increase ( $p < .05$ ). The researchers in this study concluded that the results warranted providing gifted students with an enhanced math and science curriculum.

Spicker (1996) was intent on identifying gifted children and presenting an integrated and experiential science curriculum to them in an effort to increase creativity in students from grades 3 to 8. Spicker's aim was to identify gifted students who came from culturally and economically diverse backgrounds. Elementary children in grades 4 and 5 from two schools in New Mexico participated in the study. South Carolina participants included students from grades 3 to 5 from three schools. Participants in Indiana were selected from the sixth through eighth grades from two schools because these students had participated in this first study when they were in the fourth and fifth grades. Pretests and posttests were administered to the children engaged in the study. The outcome of Spicker's study showed an increase in the problem-solving ability of elementary-aged children. However, the seventh and eighth grade students who had

participated in Spicker's previous study showed gains only in the creative writing measure. The study also revealed no gains in problem solving and a decrease in standardized science test scores for the participants in secondary school.

Other researchers (Amabile, 2001; Loehle, 1990) who investigated science and creativity rejected the idea of identifying gifted students and offering them specialized educational opportunities, but instead called for enhancing the curriculum of all learners. Amabile countered identifying and focusing on gifted students with the purpose of enhancing their creativity by maintaining that creativity and genius had more to do with hard work and intrinsic motivation than with brilliance.

Ryan's (2000) study, which sought to increase creativity and confidence in girls, aged 8 to 13 in the field of science, also aimed to counter the inequalities that females may encounter while studying science in school. Ryan portrayed science as a male-dominated field. Ryan also remarked that teachers' attitudes were a contributing factor that propagated this domination. Ryan's study, although proving to be quite beneficial in improving confidence and interest of girls in the field of science, did not reveal any measures or results that indicated that creativity was enhanced as an outcome.

Bredderman (1983) conducted a meta-analysis of 57 studies that included 900 classrooms of science programs in elementary through high school. He reported the outcomes of all the studies with respect to increases in scores for science processes, science content, affective outcomes, creativity, intelligence, language, and mathematics. Although this meta-analysis documented gains in creativity, as well as in other areas, an examination of the details of Bredderman's study revealed that none of the five studies

that were done on kindergarten children attempted to measure gains in creativity. The gains in creativity were reported at other grade levels. Gains in creativity were noted by two studies on sixth grade students, two studies on fifth grade students, and one study on second grade students.

Loehle (1990) maintained that creativity can be enhanced and trained and is not determined by heredity or birthright. He, too, noted the impact that schools can have by fostering intrinsic motivation in students. He emphasized that teachers should place a focus on innovation and problem solving, rather than on learning the right answers. He added that problem finding and problem solving, as well as free time to think and incubate, were important aspects of science and creative efforts.

Glass (1993) also promoted the idea of exploration and discovery, and of science being presented as a journey through wonder in order to foster intrinsic motivation in creative students. However, he called for teachers to identify gifted students in order to provide them with enhanced opportunities in the classroom.

Montessori (1989) recognized the creative potential in all humans and also viewed science and nature as being the key to unlocking imagination, curiosity, and motivation in young children. She stated,

If the idea of the universe be presented to the child in the right way, it will do more for him than just arouse his interest, for it will create in him admiration and wonder, a feeling loftier than any interest and more satisfying. The child's mind will then no longer wander, but becomes fixed and can work. The knowledge he then acquires is organised [sic] and systematic; his intelligence becomes whole and complete because of the vision of the whole that has been presented to him, and his interest spreads to all, for all are linked and have their place in the universe on which his mind is centred [sic]....A greater curiosity arises, which can never be satiated; so will last through a lifetime. (p. 6)

Science, in Montessori's view, was a key to children's motivation, curiosity, intelligence, and self-actualization (Montessori, 1989), all of which contribute to creativity.

Maslow (1971) mockingly referred to science "as a technique whereby noncreative people can create" (p. 58). This type of creativity was what he referred to as "secondary creativity" (p. 80), which is born from hard work, persistence, and conscious effort.

Holt (1989) listed numerous benefits of science for young children. Her list included "Self-Concept Development....Cognitive Development....Development of Communication Skills....Strengthening of Emotional Security....Social Development" (pp. 7-10). These benefits have a strong connection to creativity. Theorists who surveyed the process-oriented view of creativity noted the importance of cognitive processes and the communication of their work as major parts (Feldhusen & Goh, 1995; Guilford, 1967; Torrance, 1963). Confidence and independence are among traits that have been listed of creative people (Davis, 1983). Gordon (1961) and Harrington (1990) have emphasized cooperative and social aspects of creativity.

Jensen (1998) believed that the "best way to grow a better brain is through challenging problem solving....It makes sense to encourage youngsters to do any problem-solving activity; the more real-life, the better. Also good are science experiments or building projects" (p. 36). Science can facilitate problem solving.

This all leads one to believe that a connection exists between science and creativity. Creativity has certainly impacted the field of science. Can science impact creativity?

### The Importance of Early Childhood

Many theorists who dealt with the exploration of creativity have recognized the importance of childhood experiences in unlocking creative potential. These experiences can be a determining factor in the emergence and growth of creative energies. Caine and Caine (1991) and Sousa (2001), like Piaget (1970) and Montessori (1967a, 1967b, 1989), emphasized the importance of early childhood and the importance of critical periods and sensitivities during these early years.

Montessori (1989) realized that if children are not awakened to imaginative exploits and are not motivated to explore and investigate, then their potential may be lost forever. The kindergarten-aged child requires certain elements in order to reach his/her fullest potential. She stated,

there is an unusual demand on the part of the child to know the reasons of things. Knowledge can best be given where there is an eagerness to learn, so this is a period when the seed of everything can be sown, the child's mind being like a fertile field, ready to receive what will germinate into culture. But if neglected during this period, or frustrated in its vital needs, the mind of the child becomes artificially dulled, henceforth to resist imparted knowledge. Interest will no longer be there if the seed is sown too late, but at six years of age all items of culture are received enthusiastically, and later these seeds will expand and grow. (p. 3)

Maslow (1971) recognized not only the inherent creativity in young children, believing that childlikeness was a characteristic of healthy and self-actualized people. Maslow further stated that "primary creativeness" (p. 80) is found in all healthy children.

It was primary creativeness that was born from the unconscious and that Maslow believed to be common and universal. Children's creativity remained undefinable in terms of a product, but existent, nonetheless. Maslow (1971) also noted that having a childlike view of the world, one that was "independent of control, taboos, discipline, inhibitions, delays, planning, calculations of possibility or impossibility" (p. 85), facilitated one's creativity.

Holt (1989) noted the tremendous amount of curiosity, motivation, and joy that children derive from exploring and discovering their natural world. Their inclination toward activity and involvement with their experiences lends itself to an immersion into the world of science. Holt also noted early childhood as being a time when not only the process of critical reflection, which is a useful tool in creativity, but also an active and unfaltering interest in understanding the world emerges.

Gardner and Wolf (1994) acknowledged the importance of early childhood activities and experiences as impacting creativity. They stated that "childhood creativity is not equivalent to the creativity of the master but it is difficult to envisage the possibility of adult creativity without the experience of childhood" (p. 66).

Gardner (1999) related that early childhood is an extremely important part of fostering creativity in light of recent brain research. He indicated that brain research foretells a "use it or lose it" immediacy, and that early experiences impact brain formation because of the brain's plasticity. Early childhood is a crucial time, in Gardner's view, for children to develop thinking and problem-solving skills, create objects, and are active participants who enjoy these processes. Sousa (2001) also related

that neuroplasticity “is exceptionally rapid in the early years” (p. 3). Jensen (1998) stated that the “brain learns fastest and easiest during the early school years” (p. 32) and promoted an immediacy in fostering its growth during these formative years, as did Caine and Caine (1991). Fishkin and Johnson (1998) have “proposed the phrase, germinal creativity...to describe children’s budding creative potential” (p. 2) and related that germinal creativity is dependent “on numerous factors such as their developing skills, the response requirements of a task, and their interest in the task at a given time” (p. 2). The need to address creativity, problem solving, meaningful learning, and providing an enriching environment for children at an early age is evident.

#### Early Childhood, Science, and Creativity

Gould, Weeks, and Evans (2003) developed a science program for early learners, Science Starts Early, which was administered to children who were identified as gifted. This program helped to spark the children’s interest and was a successful means of teaching science to young learners. The natural curiosity of young learners was a contributing factor to its success. Science and young children seem to make an interesting and fruitful combination. It is this interest that leads to understanding in the field of science (Barinaga, 1990). Perhaps it can lead to an increase in creativity, as well.

Jacobson (2002) met with great success when she used a science curriculum with young children in order to enhance their literacy and language skills; science was integrated into the entire curriculum. Not only were science, literacy, and language skills improved, but also, the children’s observation skills and their ability to ask educated questions improved.

In an interview, Katz commented on the natural inclination of young children to be scientists, in that they tend to “make sense of their experience” (Anonymous, 2001, p. 1). An interactive approach by teachers with children this age satisfies children’s need to investigate, observe, and question.

Another benefit of science with young children noted by Sprung (1998) was the formation of attitudes in children toward science and learning that can motivate and recruit lifelong learners in the field of science, as well as school in general. Science in the early years can be a means to develop self-actualizers who, in Maslow’s (1971) view, may be the same as creative people.

It is important to note that the field of early education can be pivotal in developing creativity in people. Arieti (1976) stated, “early experiences can play a determining role in stimulating and directing the individual toward a certain kind of activity” (p 28-29). Gardner (1989) concurred, “in many ways the young schoolchild is closer to the mind (and the sensibility) of the artist than the same child will be a few years later” (p. 72). He further stated that between the ages of 2 to 6, “Artistry and creativity in general are unleashed—or blocked” (Gardner, 1991, p. 82). It is at this early age that one has hopes of enhancing children’s creative potential.

The National Research Council (1996) produced the *National Science Standards*, which revealed the importance placed on skills and behaviors conducive to creativity. It is important to discuss these standards in order to substantiate their relationship to creativity and problem solving.

TEACHING STANDARD A:

Teachers of science plan an inquiry-based science program for their students....

TEACHING STANDARD B:

Teachers of science guide and facilitate learning....

TEACHING STANDARD C:

Teachers of science engage in an ongoing assessment of their teaching and of student learning....

TEACHING STANDARD D:

Teachers of science design and manage learning environments that provide students with the time, space, and resources needed for learning science....

TEACHING STANDARD E:

Teachers of science develop communities of science learners that reflect the intellectual rigor of scientific inquiry and the attitudes and social values conducive to science learning....

TEACHING STANDARD F:

Teachers of science actively participate in the ongoing planning and development of the school science program. (pp. 30-51)

Key aspects of these standards are supportive of teachers' efforts to develop creativity in children. The key word in Standard A, *inquiry*, was defined as "a set of interrelated processes by which scientists and students pose questions about the natural world and phenomena;...students acquire knowledge and develop rich understanding of concepts, principles, models, and theories" (National Research Council, 1996, p. 214). Questioning and understanding are stressed, not memory and recall.

Standard B noted the role of teachers as being facilitators, not lecturers or authority figures. The focus is on the learner.

Standard C required ongoing assessment. This assessment was not a multiple choice, end-of-the-year exploit. It was ongoing and entailed multiple forms of assessment and student observations. This assessment method reflected a teaching method that does not require memorization and recall, but rather, a process of engaging the student.

Standard D stressed the importance of the teacher preparing the environment to suit the learner. Time constraints were curtailed in deference to the exploits of the learner.

Standard E recognized the importance of diversity, cooperation, collaboration, and communication. All these are indispensable in the process of creativity, especially the study of synectics.

Standard F required flexibility and change as part of the learning and teaching process. These standards reflected the value placed on skills, behaviors, and methods needed as teachers help students become more creative.

#### Implications for Education

Davis' (1983) list of traits, compiled from his own research and the research of others, indicated that independence, enthusiasm, curiosity, energy, humor, playfulness, and so on are traits to be nurtured if creativity is to flourish. Learning settings should allow these important features to flourish rather than stifle them.

America's educational system, generally speaking, calls for a different type of student. This student is compliant and follows rules, is able to sit through lectures and teacher-directed textbook activities, obeys authority and looks to authority for guidance and answers, and is a passive learner (Chomsky, 2000). Playfulness, humor, energy, and spontaneity are qualities reserved for the playground and after-school activities.

The curriculum and teaching methodologies in traditional school settings are, in many cases, lecture-oriented (Wolfe, 2001), lack meaning and context (Jensen, 1998) and assess children with tests that do not foster independent thinking, problem solving

(except to calculate correct answers), and independence. "A typical classroom narrows our thinking strategies and answer options" (Jensen, 1998, p. 16). Most assessments value correct answers that only a certain percentage of students are expected to be able to remember or regurgitate. Gardner (1989) stated that "test taking assesses chiefly linguistic and logical intelligence, with some bonus points for speed, flexibility, and superficiality" (p. 29) and that these tests "often fail to pick up the most important human capacities and attributes; that they favor the glib and conventional rather than the profound or the creative" (p. 30). Jensen (1998) had an even stronger aversion to standardized tests, stating that "to get the right answer violates the law of adaptiveness in a developing brain" (p. 16).

Yet, creativity theorists who were process-oriented emphasized the need for children to learn how to think, problem solve, generate new and many answers, as well as to ponder, daydream, and imagine (Arieti, 1976; Davis, 1983; Feldhusen & Goh, 1995; Feldman, Csikszentmihalyi, & Gardner, 1994; Torrance, 1963). All of these functions seemingly do not serve the purpose of an educational system that is on a timetable, that focuses on the results of standardized tests, and whose goal is for children to accumulate facts, rather than acquire understanding and meaning.

Product-oriented theorists viewed products as being an indicator of creativity if experts or the majority of people deem them to be creative (Albert & Runco, 1990; Feldhusen & Goh, 1995; Gordon, 1961; Harrington, 1990). What product is valued in schools? Is it the right answer, high grades and standardized test scores, or acceptance

into institutions of higher learning? What kind of creativity can emerge from such products?

Cognitive processes that allow exploration, divergent thinking, and thinking that is “out of the box” must be fostered if one values the views of cognitive-oriented and process-oriented theorists such as Arieti (1976), Gardner (1999), Guilford (1967), and Torrance (1963); however, settings that promote these features and thinking skills are not part of the mainstream educational system (Beyer, 1984; Oakes, 1985). Perhaps this study can be a demonstration for teachers of the value of these factors in fostering students’ creativity. Feldhusen and Goh (1995) stated, “if the skills and strategies used in creative activities can be defined, then it should be possible to develop curricular models for use in the classroom” (p. 241).

Montessori (1967a, 1967b, 1974, 1989) firmly believed in the potential of all people and especially in the cultivation of children’s potential. Her means was via a prepared environment that would also facilitate children in reaching their fullest potential. Children, in her view, were self-directed learners guided by an inner need to do their own work, in their own time, in their own way, and by their own hands. Driven by their own internal motivation, children cultivated order, concentration, coordination, and independence by means of a prepared environment. The whole child prospers under these conditions and grows socially, emotionally, physically, cognitively, and spiritually.

Gardner (1989) proposed that schools should not attempt to mold children, but rather, provide support for their creative endeavors. This flowed from the belief that “The child in his own creative genius should be allowed to flower” (p. 278). Although

Gardner recognized American society as encouraging creativity, he did note that “America’s schools are not its most innovative institutions” (p. 280).

Gardner (1989) noted the seemingly conflicting perspectives between stressing basic skills and fostering creativity in America’s schools. American schools have historically wrestled with the issue of the traditional type of school versus one based on children’s construction of their knowledge via experiences (Ackerman, 2003).

Motivational issues are also a concern in educational systems in the United States (Caine & Caine, 1991; Healy, 1987). These issues are closely related to creativity.

Educators need to be sensitive to what current research indicates with respect to how students learn. Caine and Caine’s (1991) explanation of taxon memory (used in rote memory exercises) and locale memory (used in the process of seeking understanding and making connections) underlie the conflict between rote and banking methods of teaching and experiential teaching. Learning that uses the locale memory system is incapacitated by perceived threats, which may include extrinsic motivators, authoritarian teachers, tests, and peer pressure in school settings. Creativity is stifled and snuffed when what Caine and Caine (1991) termed “downshifting” occurs.

Caine and Caine’s (1991) principles of brain-based learning have implications for the cultivation of creativity in learners. These principles include addressing all aspects of the brain and utilizing various methods such as Gardner’s (1989) multiple intelligences. The systemic view of the learner as one who possesses cognitive, spiritual, physical, social, and emotional aspects, all subject to their own developmental timelines, requires that educators must also take a systemic perspective of their students. Caine and Caine

(1991) also recognized the importance of meaningful educational experiences, rather than a traditional mode of dissected bits of knowledge requiring memory for tests and lacking context. Patterns, the use of metaphors and analogies, and the integration of what is learned are conducive not only to how the brain works, but also to creativity, as well. This patterning and integration also deals with seeing parts and wholes, as well as contexts, and having the ability to analyze and synthesize. Addressing emotions in learning also impacts learning, creativity, and motivation for further learning experiences. Educators must keep in mind the dangers of downshifting and the benefits of creating environments in which children can have a relaxed and alert state of mind.

Theorists who possessed a systemic perspective of creativity viewed the interaction of agents and elements in the system as they gave rise to creativity (Albert, 1990; Arieti, 1976; Csikszentmihalyi, 1990; Helson, 1990; Hennessey & Amabile, 1987). Synectics supported a diversity of members who used techniques such as metaphors and analogies to unlock creativity (Gordon, 1961). Does America's educational system support interaction or individual achievement? Do teachers foster diversity or tracking? Do metaphors and analogies have a place in institutions that reward only one right answer?

Many theorists have recognized the importance and influence of environment and culture on creative exploits (Albert, 1990; Arieti, 1976; Csikszentmihalyi, 1990; Helson, 1990; Hennessey & Amabile, 1987). Milgram's (1990) structure of giftedness included categories and levels, as well as settings and environments. Arieti's (1976) recognition of the importance of environmental influence culminated in the vision of the

“Creativogenic Society” (p. 313), which is a society that provides environmental conditions that favor creativity, and recognizes the importance of environmental influences on the release of creative potential. Does one of the cornerstones of society, the educational system, reflect a creativogenic society, or one that hinders creativity instead? A perusal of these perspectives of creativity and what they require with respect to the educational system proves to be dismal. However, with new research on the brain, multiple intelligences, and creativity, a new direction is open to the educational system.

Albert (1990) suggested several ways of cultivating creativity in the classroom, which included assisting children in experiencing “larger emotions—anger, joy, love, passion” (p. 29); involving the children in learning and making learning an active experience; opting for discovery and experiential learning by the children rather than disclosure of facts by the teacher; encouraging reflexivity; and engaging the children in the quest for knowledge by making it a cooperative effort involving the teacher and the students.

Synectics (Gordon, 1961), current research on the brain (Caine & Caine, 1991; Healy, 1987; Jensen, 1998; Sousa, 2001; Wolfe, 2001), and multiple intelligences (Gardner, 1991) support the techniques of utilizing metaphorical thinking, integrating learning experiences, seeking patterns in experiences, and providing an experiential, constructive approach to learning. All these techniques are conducive to fostering creativity in the learner.

Caine and Caine’s (1991) model of brain-based learning offers educators alternative methodologies to use in the classroom. These include an integrated

curriculum, thematic teaching, thematic orchestration, cooperative learning, innovative uses of traditional methods, and freedom and control. All of these methodologies not only facilitate brain-based learning, but also creativity.

The integrated curriculum and thematic teaching and orchestration all contribute to utilizing the brain's ability to make connections and patterns in understanding, analyzing, and synthesizing. Sousa (2001) explained the value of integrating curriculum by recognizing its value to aid "students to make connections between subject areas by integrating the curriculum" (p. 49). He said that this method "increases meaning and retention, especially when students recognize a future use for new learning" (p. 49). Cooperative learning is at the heart of synectics and brain-based learning. Cooperative learning fosters collaboration and communication, and it increases the power and potential of only one mind to the power and potential of many minds working together.

Innovative teaching methods, as opposed to traditional methods, can facilitate creativity in the classroom. If a teacher can be innovative and model creativity in his/her teaching, students may follow suit. For example, instead of circling verbs in a workbook, children can pantomime a verb for other students to guess. Not only can novel methods and new approaches be a means of making learning more meaningful and inviting active participation and involvement, innovations can contribute to a playful and humorous classroom atmosphere that can be highly motivating and engage the student in movement and activity that facilitate meaningful learning (Jensen, 1998; Montessori, 1964, 1967a, 1967b; Sousa, 2001).

Caine and Caine's (1991) concept of freedom and control is similar to the tenet of "discipline founded upon liberty" (Montessori, 1964, p. 86) in a Montessori classroom, and in society, as well. Children should be allowed to choose activities that interest them, and they, in turn, have the responsibility to use the activity properly and to care for the materials, the environment, themselves, and others. Learning in such a setting is meaningful because students select what they want to work with, and they are intrinsically motivated to do so.

Caine and Caine (1991) took a holistic view of the learner by recognizing that the learner's entire physiology is involved in the learning process, and that learning is affected by emotions, psychological states, and the environment, as well as by the physiology of the learner and that marvelous organ known as the brain. Caine and Caine (1991) recognized the importance of patterns and connections. They recognized that the search for meaning is innate in all people. Past experiences and knowledge are built upon, connected, and rewired to produce new meanings and understandings. This type of true learning is not accomplished by memorizing facts and lectures, as traditionally done in schools. This type of learning is synthesized by the learner via experiences, connections, and interactions, and sometimes with a spark of creativity.

Montessori's (1989) approach concurred with Caine and Caine's (1991) brain-based learning by indicating the need for the respect and cultivation of imagination and hands-on experience in the learning process. This she saw as being possible by using the scientific wonders of the universe as the focal point of curriculum for young children

(Montessori, 1989). All these elements in an educational setting, along with the teacher, must nurture the learner's entire being.

Maslow (1971) viewed education as nurturing the child toward his or her lifetime goal of self-actualization. Education should promote the growth of learners who are comfortable with change and improvisation. This is the creative type of person needed in a world of technological advances in which knowledge is becoming obsolete at an unbelievable pace. Maslow stated that this world needs

a new kind of human being who can divorce himself from his past, who feels strong and courageous and trusting enough to trust himself in the present situation, to handle the problem well in an improvising way, without previous preparation, if need be... We must become more interested in the creative process, the creative attitude, the creative person, rather than in the creative product alone. (p. 95)

Gardner (1999) also recognized that the future of society required problem-finders and synthesizers. He saw the need in educational institutions for creativity and higher cognitive functions other than just memorization and drill. Feldhusen and Goh (1995) stressed that creativity in thinking "probably can be accessed through training programs that focus on cognitive skills and methods, personality factors, motivation, cognitive styles, and metacognitive skills" (p. 244). Education can be the key.

Beyer (1984) noted several important problems in the issue of developing thinking skills in students that might prove enlightening as to why educators have been lacking in improving thinking skills, problem solving, inquiry, and critical thinking. These included confusion as to which thinking skills should be addressed, lack of definition and understanding on the part of teachers as to what these skills are and how to

teach them, inability of teachers to follow through on instructional methods conducive to the cultivation of these skills, and assessments that promote memorization rather than understanding.

These problems indicated two important parts of the educational system that need to be addressed in order for any transformation to occur—the teacher and teacher education. The needs of the learner, the environment, and the teacher and teacher training must be addressed. Teachers, in turn, are influenced by other parts of the system, society, and administration. However, according to systems theory, small changes can lead to dramatic effects with unpredictable outcomes (Lewin, 1992). Small changes induced by a few teachers can make a difference. This is the value of teacher action research.

Gardner's (1991) theory of multiple intelligences can be addressed by using innovative teaching methods and teachers who recognize different learning styles, awaken interest and motivation, use patterns, and make connections to the learner. These eight intelligences included "language, logical-mathematical analysis, spatial representation, musical thinking, the use of the body to solve problems or to make things, an understanding of other individuals, ... an understanding of ourselves" (p. 12), and a naturalist intelligence (Gardner, 1999). Gardner (1991) questioned what should be taught in the educational system. Should schools strive to produce adults who perform according to specifications, should schools strive to have learners who possess vast amounts of information, or should schools strive "for the attainment of rich

understanding of the concepts and principles underlying bodies of knowledge" (p. 116-117)?

It is obvious which of the three would be more apt to unleash the potential for creativity in the learner. It is also evident which of the three would be more valuable in a world where information and knowledge grow and become obsolete at an exponential rate. There is no real need for children to memorize mountains of information that can be pulled up at the push of a button, but there is a need for children to be able to apply and comprehend the information.

Gardner (1991) also noted the connection between what should be taught and how children should be taught. The options include "mimetic" education and the "transformative" approach (p. 119). The first is teacher-dominated, based on regurgitation of facts, and represents traditional modes of education. It includes rote memorization and repetition of what is taught. In the latter approach, the teacher is a facilitator and prepares the environment in such a way as to "encourage the student to work out his own ideas, test them in various ways, and further his own understanding" (p. 119), a process similar to the creative process. In fact, Gardner (1991) stated that the difference between the two is

an emphasis on basic skills and an emphasis on creativity...[and] an opportunity for individuals to invent knowledge on their own to a significant extent, to transform what has been encountered in the past, and perhaps eventually to contribute new ideas and concepts to the collective wisdom. (pp. 119-120)

Gardner (1991) advocated the integration of two methods that address how children can learn and understand in a meaningful and creative way. These methods are

similar to an apprenticeship and a children's museum. The understanding gained in an apprenticeship is contextualized and is effective because it is facilitated by a master providing tried and true knowledge and methods built on generations of experience and is a relationship that fosters cooperation. Learning in this scenario is experiential and motivating. Meanings, reasons, and relationships are revealed in the experience. Performance is connected to the experience and one's understanding.

The experiential and interactive aspects of children's museums, along with their "potential to engage students" (Gardner, 1991, p. 202), provide an invitation to the learner and pique the learner's interest and motivation. Gardner suggested that the "evocativeness and open-endedness of the children's museum need to be wedded to the structure, rigor, and disciplines of an apprenticeship" (p. 203).

A transformative approach provides the means to help children attain genuine understanding. Gardner (1991) defined this approach as involving "sets of performances—carrying out analyses, making fine judgments, undertaking syntheses, and creating products that embody principles or concepts central to a discipline" (p. 186). This transformative approach is, in essence, similar to the creative process, as described by Feldhusen and Goh (1995) and Davis (1983).

Montessori's (1964) method of education addressed the important aspects of a methodology that addresses creativity and what is now known about the human brain (Caine & Caine, 1991). Montessori's basic premise was to educate the whole child spiritually, mentally, socially, physically, and cognitively. The child was recognized as a magnificent system that required respect and the freedom to construct learning at his or

her own pace and in his or her own way. In her method, she recognized key aspects of creativity, motivation, and imagination, which included a hands-on, integrated learning environment, freedom and responsibility, independence, an ownership of one's learning experience, and an environment based on the value of nurturing intrinsic rather than extrinsic motivation.

Much in the same vein as Csikszentmihalyi (1990), Helsen (1990), Hennessey and Amabile (1987), and others, Montessori (1964, 1967a, 1967b) recognized the influence of the environment on the learner. The environment, the teacher, and the child were parts of a triad that formed the basis of her method. It was the teacher's role not to input knowledge into her charges, but rather, to prepare the environment for them to use in their quest for knowledge and understanding. This environment should be inviting, aesthetically pleasing, and child-like. Emphasizing the importance of the child independently creating his or her own learning experiences, the materials should be self-correcting and in good order. It was the teacher's role to provide materials that interested the child and challenged him/her, as well as to follow the lead of the child.

Montessori (1967a) recognized the value of intrinsic motivation and the drawbacks of extrinsic motivation. Children worked because it was in their nature. Time limits and a syllabus-driven curriculum were of no use. She also viewed imagination as the key to learning and knowledge, as well as the key to motivation. Montessori (1989) explained,

The secret of good teaching is to regard the child's intelligence as a fertile field in which seeds may be sown, to grow under the heat of flaming imagination. Our aim therefore is not merely to make the child understand, and still less to force

him to memorize, but so to touch his imagination as to enthuse him to his inmost core...Educationists in general agree that imagination is important, but they would have it cultivated separate from intelligence, just as they would separate the latter from the activity of the hand. (p. 11)

Montessori viewed the wonder of the universe as being the key to unlocking a child's imagination.

However, education today falls short, and, in fact, may be a detriment to creativity in the classroom. Teachers in traditional classrooms demand that children obey them and adopt a passive learning style (Chomsky, 2000; Healy, 1990; Gross, 1999; Maiorana, 1992; Wiles & Bondi, 1998). Information and knowledge are de-contextualized. "America now has an inferior standard of learning in our public schools" (Gross, 1999, p. 12). Yet, the demand for standards and competency is reflected by the technological world (Glass, 1993). Oakes (1985) remarked that educational settings that do foster these higher-level skills are generally reserved for the culturally advantaged. Critical thinking skills cannot flourish in an environment devoid of critical thinking, communication, and dialogue. Friere (1970) stated that "only dialogue, which requires critical thinking, is also capable of generating critical thinking" (p. 92). Traditional classroom settings are not noted for dialogic opportunities. Perkins (1992) concurred by stating that understanding and thinking are shortfalls in American society.

Examination of the early childhood center in Hawaii and its philosophy, methods, and curriculum indicated that the techniques that were conducive to nurturing creativity were evident in the classroom, but were they enough? Were issues that the teachers were not aware of present? Perhaps the teachers were overlooking a motivational force, a

natural wonder, a connection, or a key to curiosity and imagination. Perhaps science was the inspiration needed to unlock imagination, exploration, curiosity, and critical thinking in the children at the early learning center. The natural interest the children had displayed in the past in the subject of science seemed to indicate that science might be the key to unlocking children's creativity.

### Summary

This chapter contained various theories of creativity, including theories that examined the person and his or her traits (Albert, 1990; Becker, 1995; Davis, 1983; Gedo, 1990; Maslow, 1971; Simonton, 1990), process-oriented theories (Arieti, 1976; Guilford, 1967; Feldhusen & Goh, 1995; Torrance, 1963), theories that focused on the importance of the product (Albert & Runco, 1990; Besemer & O'Quin, 1999; Eysenck, 1994; Gordon, 1961; Harrington, 1990), and theories that focused on the systemic nature of creativity (Albert & Runco, 1990; Arieti, 1976; Csikszentmihalyi, 1990; Gordon, 1961; Helson, 1990; Hennessey & Amabile, 1987). Other factors contributing to creativity such as motivation (Albert, 1990; Amabile, 1990; Csikszentmihalyi, 1990; Davis, 1983; Gardner, 1991; Hennessey & Amabile, 1987; Maiorana, 1992), intelligence (Arieti, 1976; Davis, 1983; Hennessey & Amabile, 1987; Milgram, 1990), and heredity (Becker, 1995) were also discussed. Current research on the brain (Caine & Caine, 1991; Healy, 1987; Jensen, 1998; Sousa, 2001; Wolfe, 2001) and multiple intelligences (Gardner, 1991) and how they applied to creativity were also examined.

The literature review revealed a connection between science and creativity (Chandler, 1999; Innamorato, 1998; Jacob, 2001; Tyler-Wood, Mortenson, Putney, &

Cass, 2000; Spicker, 1996). The processes involved in the study of science (Simon, 2001), as well as the benefits of the study of science, were identified. Studies linking science and creativity were reviewed (Amabile, 2001; Bredderman, 1983; Glass, 1993; Loehle, 1990; Ryan, 2000), especially science exploration during early childhood (Holt, 1989; Montessori, 1989). This review of science, creativity, current research, and early childhood led to the implications for education arising from these topics.

These implications impacted the curriculum, methodology, and educational environment of this particular study. The next chapter will present the methodology of this study, along with a review of the culture of inquiry. The qualitative nature of this study and a description of the research method will be detailed. This will include a description of the setting, the participants, the intervention, and the analysis of the data.

## CHAPTER THREE: METHODOLOGY

There is no such thing as a *neutral* educational process. Education either functions as an instrument that is used to facilitate the integration of the younger generation into the logic of the present system and bring about conformity to it, *or* it becomes "the practice of freedom," the means by which men and women deal critically and creatively with reality and discover how to participate in the transformation of their world. (Friere, 1970, p. 34)

### Introduction

This chapter begins with a restatement of the research questions and an introduction to the culture of inquiry used in this study, including action research and collaborative action research. This study entailed the use of teacher action research and involved the collaboration, observations, and reflections from the four kindergarten teachers at an early learning center, the site of the study, as well as student, parent, and teacher interviews or surveys. The goal of the teachers who engaged in this study was to improve and to enhance the science curriculum, as well as the methodologies used at the center, and to facilitate creativity and problem solving in the kindergarten students. This study was a way to determine if the creativity-focused science curriculum did increase creativity and problem solving in the students who experienced it.

The purpose of this study was also to provide insight and understanding regarding the viability of enhancing creativity at an early age by using a science curriculum. The teachers involved reflected on the importance of the process, the participants in the process, and the curriculum in their observations. Sharing of the understanding and results achieved in this study could prove valuable not only to the members of this faculty, but also to other teachers, as well. Another purpose of this study was to

contribute understanding to the field of education, and, as with action research in general, to improve the situation (Altrichter, Posch, & Somekh, 1993; Sagor, 1992) at the early learning center. This improvement affected the curriculum, the methodology used by the teachers, and the learning environment at the early learning center.

This chapter includes a description of the setting, participants, procedures, intervention, and methods of data collection used in this study. These sources of data included the Torrance's *Thinking Creatively in Action and Movement* (Torrance, 1981) test scores given at the beginning and end of the study to the kindergarten participants, as well as participating student, parent, and teacher surveys and interviews, and observations and reflections from the kindergarten teachers. A section on data analysis follows. This chapter ends with a summary of the methodology of this study.

#### Restatement of the Research Questions

The research questions for this study were

- Will the scores on Torrance's *Thinking Creatively in Action and Movement* (1981) for the kindergarten children who are exposed to a revised science program increase during a 5-month period more than the kindergartners who are exposed to the regular science program?
- Will the parents of kindergarten children in the group receiving the new science program relate an increase in their child's interest in science or creativity or observe any other benefits that may be attributed to the new science curriculum, as opposed to the parents of children who are experiencing the regular combined cosmic/science program?

- Will kindergarten children who participated in the revised science program notice an increase in their own creativity or ability to generate new ideas, more than students who participate in the regular science program?
- Will the teachers involved in the study observe any differences in the creativity of their students that may be attributed to the different science curricula or methods?

### Culture of Inquiry

This study involved the collection of qualitative data and the use of a quantitative instrument, using an action research design. Mills (2003) defined action research as “any systemic inquiry conducted by teacher researchers, principals, school counselors, or other stakeholders in the teaching/learning environment to gather information about how their particular schools operate, how they teach, and how well their students learn” (p. 5). The four teachers in this study were involved in a process of systemic reflection on their methods, curriculum, and practices in an effort to improve on them, and they implemented changes based on their findings. These teachers used qualitative data, such as observations, interviews, surveys, and feedback to improve their practices at the early learning center. The results from the quantitative instrument were not conclusive, but merely suggestive and aided in the triangulation of the study results. Triangulation, or “using multiple sources of data” (Mills, 2003, p. 52) contributed to the study’s credibility and attaining a “comprehensive perspective” (Calhoun, 1994, p. 59) The inclusion of data from parents, teachers, and students added “greater complexity to our collective inquiry;

however, it is a complexity that yields a clearer understanding of the learner and the learning environment" (Calhoun, 1994, p. 61).

Johnson (2002) stated, "Qualitative research...uses systemic observations to reach understanding. Researchers take the world as they find it instead of trying to manipulate conditions to isolate variables" (p. 7). The systemic nature of a classroom environment, which includes dynamics of relationships, histories, participants, and environment, makes the isolation of variables too complex to undertake. Qualitative methods lend themselves to such a setting. "Action researchers acknowledge and embrace these complications rather than trying to control them" (Mills, 2003, p. 3). This study, however, utilized a quantitative research instrument to supplement the observations, interviews, and surveys.

Unlike traditional positivists whose role was that of an objective outside observer, "action researchers, on the other hand, look at what *they themselves* are or should be doing" (Sagor, 1992, p. 7). This process creates a learning experience for the researchers. This process also results in changes that the researchers implement, as well as changes in the researchers' behavior and person. It "has the potential to be a powerful agent of educational change" (Mills, 2003, p. 4). This change affects the teachers, as well, by engaging them in problem solving, professional development, and "lifelong learning experiences" (Calhoun, 1994).

Although the number of steps involved in action research may vary between researchers, they basically involve finding a starting point or topic (Altrichter, Posch, & Somekh, 1993; Ziegler, 2001), selecting a research question (Sousa, 2001, p. 10),

formulating a problem (Cox & Craig, 1997; Johnson, 2002; Keith, 2001; Sagor, 1992; Ziegler, 2001), or identifying an area of focus (Mills, 2003). The collection of data and its analysis in conjunction with action strategies and its implementation is another step in the process (Altrichter, Posch, & Somekh, 1993; Cox & Craig, 1997; Johnson, 2002; Keith, 2001; Mills, 2003; Sagor, 1992; Sousa, 2001; Ziegler, 2001). Finally, an evaluation and reporting of the study with possible modifications and further action as a result should ensue (Altrichter, Posch, & Somekh, 1993; Cox & Craig, 1997; Johnson, 2002; Sagor, 1992; Sousa, 2001). A review of literature and current research dealing with the topic is also an important component of the action research process (Calhoun, 1994; Cox & Craig, 1997; Keith, 2001)

Reason's (1994) four phases of co-operative inquiry are almost identical to the steps listed above. These phases include agreeing on the topic of inquiry, implementing the action and observing the results and behaviors, "full immersion" (p. 326) into the experience, and reevaluating the hypotheses to formulate improved courses of action. This full immersion is what I hoped would occur in the course of the study.

The importance of understanding something via action research is augmented by the role of dialogue, reflection, and action in the process to reach awareness (Altrichter, Posch, & Somekh, 1993; Reason, 1994). This awareness benefits not only the researcher, but also should benefit its participants. Reason (1994) considered the "cycling and recycling between action and reflection" (p. 327) as an effective antidote for the threats to the validity of such a study.

Action research is a rigorous process that involves the practice of reflexivity.

Altrichter, Posch, and Somekh (1993) explained,

The results of reflection are continuously transformed into practice, and practice continuously throws up reasons for reflection and development of these practical theories. The term for this characteristic feature of action research is *reflexivity*. Through constant movement between action and reflection... weaknesses in the practical theories are gradually detected and useful action strategies are explored and extended. Through reflexivity, the reflective practitioner's action gains quality and the research process is rigorously tested. (p. 208)

Altheide and Johnson (1994) commented further, stating, "One meaning of *reflexivity* is that the scientific observer is part and parcel of the setting, context, and culture he or she is trying to understand and represent" (p. 486). Ziegler (2001) concurred by stating, "This reciprocal process, in which practice and research inform each other, leads to new knowledge and increasingly effective action" (p. 3).

Researchers have raised the issue of the implications of teacher action research on inequalities, school structures and practices, and social consciousness (Cochran-Smith & Lytle, 1990; Hollingsworth & Sockett, 1994; Zeichner, 1993). This study did not address the notable inequalities of socioeconomic status, race, or gender, but rather, the inequalities in opportunities that should be provided to young children to reach their potential in a way that is respectful of their person as experiential, autonomous learners, rather than being molded into passive vessels being filled with facts and pertinent information. The oppression of the traditional model of education was being addressed.

Teacher action research can also have powerful implications for the researchers involved in a study such as this one, wherein teachers can experience reflective practice, professional development, autonomy, empowerment, personal renewal, and the

development of community and collegiality (Zeichner, 1993). Mills (2003) suggested that "one of the critical factors leading to teacher burnout is the isolation of the profession" (p. 145). Collegiality and cooperative reflexivity has proven to be an antidote to this isolation in our case. Sousa (2001) also recognized benefits of action research for its teacher participants as including valuable feedback on practices and teacher effectiveness, and the integration of research into one's profession. Auger and Wideman (2000) summarized the benefits of action research by stating,

Action research provided a powerful means for improving professional practice by enhancing participants' sense of autonomy. It provided a framework for integrating and synthesizing information....Participants developed an enhanced ability to observe children with a greater sense of acuity. Collecting data by various means drew their attention to the child's learning as a necessary central focus....Action research also provided collegial support for professional growth by setting up a venue for shared investigation of common concerns and a heightened sense of collegial communication. (pp. 121-122)

McCarthy and Riner (1996) recognized the value of the process of action research, its systemic nature, and its potential for improving educational settings. They stated,

Any systemic attempt to derive data to illuminate and guide decision making, regardless of the number of flaws, is infinitely superior to a process utilizing inherent bias, covert assumptions, and fragmented perceptions. While unsystematic, opinion-based models currently dominate school decisionmaking, simply changing from a consensus of bias to a systemic attempt to test assumptions is the most fundamental improvement in school governance that can be made. (p. 227)

Through the systemic process of action and reflection, and being aware of biases and assumptions, teachers, as action researchers, can garner understanding and explanations, and employ changes indicated by their findings. It is my hope that the faculty involved in

this study found this to be true. I hoped to not only impact our method, practices, and curriculum, but also looked to this experience as a source of professional and personal growth for the staff involved.

*Collaborative Action Research: The Participating Teachers*

Sagor (1992) defined collaborative action researchers as a group of “practitioners who have common interests and work together to investigate issues related to those interests” (p. 10). Due to the fact that the teachers of the kindergarten/preschool division of the early learning center practice team teaching and collaborate on matters of curriculum and methods, and because all are experienced in the practice of observing, this study was a collaborative action research project. All four teachers in the division had input and participated in developing the curriculum and action planning, as well as being “active participant observers” (Mills, 2003, p. 54). Both the kindergarten teacher who does science for the other classroom and I delivered the science lessons to our own students. All four teachers were active in evaluating the science program for their respective classrooms. Members were asked to keep field notes consisting of observations, descriptions, anecdotes, and reflections. Having multiple professional perspectives lent to the credibility of the study.

The multiple realities perceived by a cooperative group must be subject to “critical subjectivity” (Reason, 1994, p. 327) to contribute to the validity of the group’s findings. Because the researchers were participants, each with histories, biases, and perspectives, they had to be “*aware of* that perspective and of its bias, and *articulate* it in [their] communications” (p. 327).

With this in mind, observations of the other teachers who were involved in the study were a valuable asset as part of the data collected. It was an additional means of gathering data and different perspectives, as well as a way of fostering collaboration, cooperation, autonomy, and empowerment. The dialogue and reflections on our practices impacted not only the teachers' behavior, but also the teachers themselves. Wolfe (2001) summed up our situation in this study when she stated, "Although we are not scientists or researchers, we do work in the laboratory called the classroom, and we have a tremendous amount of knowledge and understanding of the teaching/learning process" (p. viii).

The kindergarten/preschool division staff of the early learning center consisted of four teachers, including the assistant director. Teachers in this division each had a mixed group of preschoolers and kindergartners. Each teacher in this division was responsible for the students in his or her group and their assessments. The team collaborated on a regular basis to discuss any difficulties, concerns, and/or strategies that might have been valuable. Observation of the students was an integral part of the assessment process. Teachers delivered group lessons to all the children in their respective classrooms. Each of the two classrooms that were involved contained two groups of children, both mixed in ages ranging from 3 to 6 years of age. Each teacher had a class group that was mixed in age. Individual and small group lessons were shared with the teacher's own particular group of mixed-aged children. The children separated into preschool and kindergarten groupings for their curriculum lessons, regardless of who was that particular child's teacher. Each teacher was responsible for the delivery of particular curriculum lessons

for the entire group of kindergartners in the classroom. For example, one teacher taught phonics and literature to all the kindergartners in the classroom, and the other teacher covered math and science/cosmic studies. In this respect, the children were familiar with both of the teachers in each of the classrooms.

Although the formulation of the revised science curriculum fell under my duties, and I instigated the move to revise it, the revision grew from dialogue among the teachers. The sharing of concerns, strategies, ideas, methods, materials, and activities is commonplace between the kindergarten/preschool division teachers. The kindergarten/preschool division teachers share common activities, curriculum, materials, and scheduling as opposed to the toddler division teachers or the young preschool division teachers. All of the kindergarten/preschool division teachers were involved in the process of collaborative action research for this study. Sagor (1992) outlined this process as including, "Problem formulation...Data collection...data analysis...Reporting of results...Action planning" (p. 10).

The kindergarten/preschool division teachers contributed to the formulation of the problem and the research questions. These kindergarten/preschool teachers contributed their observations, assessments, evaluations, and anecdotes as part of their field notes and data collection. They also were asked to be active in dialogue and reflections concerning the implementation of the updated science curriculum and its effect on the children, as well as on themselves. The four teachers had input on how the results of the study were reported and on further action planning as a result of the findings.

The kindergarten/preschool teachers consider the process of curriculum development to be an ongoing one in all areas. The curriculum is evaluated and revised on a yearly basis. The faculty members responsible for the 3- to 6-year-old children consider the curriculum to be flexible and subject to the interests and needs of the children. If the children display a high degree of interest in a certain topic, all staff consult with each other and are free to alter the curriculum and the schedule to allot more time to the area of interest.

With this in mind, the teachers explored the dilemma regarding the apparent weakness in problem-solving skills among the former students of the early learning center. This led to discussions regarding creativity and the relationship that problem solving apparently had with theories of creativity (Davis, 1983; Feldhusen & Goh, 1995; Feldman, Csikszentmihalyi, & Gardner, 1994; Torrance, 1963). The complexity and systemic nature of creativity defies simple cause-and-effect explanations or theories. To attempt a study regarding the facilitation, revelation, or growth of creativity, one must realize that the results may not be definitive. Rather, the results will merely point educators in a direction to take toward nurturing this elusive quality.

The goal of this study was to contribute understanding and explanations regarding what will be experienced in the course of this study to the field of education, especially early childhood education, with respect to creativity, and "to enhance the lives of students and teachers through positive educational change" (Mills, 2003, p. 132). We also sought to understand and improve the learning experience at the center with the hopes of providing a model for early childhood educators. The intent of this study was to enhance

the science curriculum at the early learning center with the goal of unlocking creative potential in the children. The upper-division teachers, including myself, looked to science as a source of inspiration, curiosity, and wonder, as well as a means of integrating the curriculum, making connections, and fostering mechanisms such as metaphorical thinking, critical and analytical thinking, collaboration, problem solving, and, ultimately, creativity. We also looked to this subject area as a way of promoting motivation, a key aspect of creativity, in our students.

Qualitative research is the key to understanding when engaging in a study in a natural setting (Guba & Lincoln, 1994). The issue in this study of a classroom and its participants was the attempt to understand and to achieve a sense of “knowing” what one perceives to be taking place. In this case, what one perceived was contextual and was subject to change and growth, much like life itself. Life is action and a process. Those who presume to study life in an effort to understand must do so via praxis. Qualitative researchers recognize that the “world and human beings do not exist apart from each other, they exist in constant interaction” (Friere, 1970, p. 50). Denzin and Lincoln (1994) explained that qualitative research paradigms “work against and alongside (and some within) the positivist and postpositivist models. They all work within relativist ontologies (multiple constructed realities), interpretive epistemologies (the knower and known interact and shape one another), and interpretive, naturalistic methods” (p. 13).

### The Setting

The setting was an early learning center in Honolulu, Hawaii, which we shall refer to as the ELC for the intents and purposes of this study in order to retain

confidentiality. The student population numbered 160 from the ages of 2 to 7. The ELC is a Catholic, non-profit, private school located in a prominent suburban area of the island and has been accredited by the Western Association of Schools and Colleges (WASC), the National Association for the Education of Young Children (NAEYC), and the National Catholic Educational Association (NCEA). The center is licensed by the Hawaii Department of Education and the Department of Human Services in Hawaii.

The center is affiliated with the American Montessori Society and follows the Montessori philosophy of education, which includes several key points. One major point is that teachers in a Montessori center address the systemic nature of the children, including their whole being: social, spiritual, emotional, physical, and cognitive. Montessori's (1964, 1967a, 1967b, 1974, 1989) philosophy indicated that children construct their knowledge and themselves experientially by interacting with the environment, the materials, and others in the environment. Children in the environment are respected as individuals, and the aim of education is to assist them in reaching their fullest potential. Teachers believe that they have the capacity to absorb and to learn via experience and interaction, especially between the ages of 3 through 6.

The environment provides freedom of choice with responsibility on the part of the learner (Montessori, 1964, 1967a, 1967b). Children are recognized as being capable of self-direction and choice. Most of the materials are self-correcting or have a control of error to foster children's independence in their pursuits. A control of error is some characteristic of the activity that will indicate to the child that something has not been done correctly. For instance, if a child does not have enough items to count in order to

finish his or her activity in a counting activity, the child will know that some mistake has been made, and he or she needs to check his/her work. Children are able to check and to correct their work independently.

### The Participants

The cosmic/science curriculum was designed for the kindergarten children. Because interest is keen and active in the sciences within the kindergarten age group, and because the cosmic/science lessons were intended for the kindergartners (Montessori, 1989), this age group was selected.

In order to have an adequate sample of kindergartners, the kindergartners from the two upper-division classrooms were selected for the study. In keeping with the Montessori philosophy, the kindergartners were members of a mixed-age grouping of 3 to 6 years old in each classroom (Montessori, 1967a, 1967b). Twenty-four kindergartners, 12 from each classroom, were permitted by their parents to participate in this study. Eight boys and four girls were in the creativity-focused group classroom, and nine boys and three girls were in the regular group classroom. They all were between the ages of 4 to 6.

The parents of the kindergartners were also asked to participate by contributing their input via a written survey. In hopes of garnering richer insight into parental perceptions of their children, four of the twenty-four sets of parents were randomly selected to participate in answering the same survey questions, but in an oral interview format instead.

The kindergarten teachers in both the creativity-focused classroom and the regular classroom participated by keeping a log of their observations and reflections during the course of the study. All kindergarten teachers, except me, participated in an interview at the end of the study.

In order to determine if the hypothesis of this study was valid, one classroom group, the "regular" group, received our regular science curriculum, with two lesson periods per week being allotted for the combination of science and cosmic curriculum for a period of 20 weeks. The other classroom group, the "creativity-focused group," was exposed to the new curriculum, along with a change in schedule dedicating two lesson periods per week specifically only to science. The creativity-focused group received their social studies lesson during a separate period assigned for cosmic studies at a separate time, once every 2 weeks. The length of lessons varied with each teacher and the topic, but, generally speaking, lessons usually lasted for 15 to 20 minutes each for both groups.

#### Procedures

Much like what Denzin and Lincoln (1994) termed a "bricoleur" (p. 2), qualitative investigators utilize multiple methods. As described further in this chapter, this study included observations of the students in both classroom groups by the teachers, interviews with the students, surveys and interviews with the parents and teachers of the participating children from both classrooms, and the administration of Torrance's (1981) Thinking Creatively in Action and Movement (TCAM) test, both with the creativity-focused group and the regular group. The TCAM, as explained later in this chapter, was

administered at the beginning of and conclusion of the study. T-tests were performed to determine if there were any differences in scores between the regular group and the creativity-focused group. Dialogue, reflection, and action among the teachers between the months of November and May were ongoing. Interviews and surveys were administered at the conclusion of the study. These sources of data provided by the participating parents, children, and teachers are detailed later in this chapter. These sources of data were examined for themes that arose during the course of this study.

### *The Intervention*

The intervention included the use of a creativity-focused science curriculum and increasing the amount of time allotted to the science curriculum. First, the science curriculum was revised by applying what we had learned about the brain (Caine & Caine, 1991), multiple intelligences (Gardner, 1991), and theories of creativity (Amabile, 1990; Arieti, 1976; Csikszentmihalyi, 1990, 1994; Davis, 1983; Feldman, Csikszentmihalyi, & Gardner, 1994; Gardner, 1989; Gedo, 1990; Harrington, 1990; Helson, 1990; Hennessey & Amabile, 1987; Maslow, 1971; Torrance, 1981) to our curriculum. This creativity-focused science curriculum was used only with one classroom group, named the “creativity-focused group” for the purpose of this study, and was implemented near the beginning of the school year in November 2003. Then, two of nine weekly kindergarten lessons (phonics, math, and literature were also scheduled twice a week, and religion was a weekly lesson) were allotted for science-only lessons for the creativity-focused classroom group. The geographical and cultural lessons that are also an integral part of the Montessori Cosmic curriculum was delivered in an extra bi-weekly lesson added for

the creativity-focused group only. The creativity-focused classroom allocated one extra lesson period per week on Fridays for the Montessori Cosmic curriculum, keeping two lesson periods for science alone. Teachers for the other classroom group, which shall be named "regular" for the purpose of this study, continued to use the same two lesson periods for a combination of cosmic and science lessons with no extra Friday time slot. The creativity-focused group averaged an extra 60 to 80 minutes per month for science lessons. The science teachers for each of the two classrooms used the curriculum designated for their particular classroom.

### *The Curriculum*

Two upper-division teachers, who are teachers of the mixed classrooms of preschoolers and kindergarteners, implemented the creativity-focused science curriculum in one of the two classrooms hoping to facilitate creativity and problem solving in the children. The other two teachers used the regular science curriculum in their classroom. There were many similarities in both classrooms. Caine and Caine's (1991) model of brain-based learning revealed the importance of problem solving, inquiry, patterns, and demonstrations in the delivery of lessons. If teachers align their teaching methods with the model of brain-based learning, an environment of relaxed alertness (Caine & Caine, 1991) rather than an authoritarian or threatening atmosphere will result. Learning that utilizes the locale memory system and is meaningful and is the result of using this approach.

Both classrooms followed a brain-based learning approach. Extrinsic rewards were not used, but rather, intrinsic motivation was fostered. Integrating the science

curriculum into other subject areas contributed to a holistic perspective and a brain-based approach. The language, literature, mathematics, family living, art, and all other areas in the classroom reflected the theme that was being used in the science curriculum for both groups in the study. The science curriculum for both groups reflected characteristics of an integrated curriculum, a holistic approach, a non-threatening atmosphere, and a focus on problem-solving, inquiry, and patterns.

The issues regarding motivation, a non-threatening atmosphere, meaningful learning, and integration of the science curriculum were addressed 2 years ago in 2001 when the four kindergarten teachers developed the cosmic/science curriculum that the regular group used. The curriculum that was revised for this study continues to address these issues and newly recognized ones, as well.

Both groups experienced a science curriculum that was integrated with other curriculum areas, in keeping with the principles of brain-based learning (Caine & Caine, 1991). Both groups are also members of classrooms that do not promote extrinsic rewards for their work, in keeping with the Montessori philosophy (Montessori, 1964). Gardner's (1991) revelations about multiple intelligences were implemented in both groups by using an array of activities.

This creativity-focused science curriculum differed from the regular one in several ways. The two teachers in the creativity-focused classroom were cognizant of the brain-based learning approach and were determined to continuously address these points in their classroom work during the course of the study. Songs, literature, cooperative and individual efforts, kinesthetic activities, and spatial and logical-mathematical connections

were utilized when possible. Healy's (1987) emphasis on play, discovery, and exploration provided a guideline for lesson delivery. More experiments and developmentally appropriate methods that facilitated inquiry were used in partnership with the children to reveal to them the wonders of nature and how things work. This emphasis on discovery and experiments did take up a large amount of classroom time. Instead of being overly concerned with academics and devoting the majority of time to language and math skills, the teachers in the creativity-focused classroom made science and creativity a priority as far as time was concerned.

The major revision of the curriculum for the creativity-focused group included an emphasis on inquiry, problem solving, and critical thinking, along with the conscious use of metaphors and patterns in the curriculum. Utilizing an array of art media, including three-dimensional media, in the children's science journal and lesson follow-up work, hopefully facilitated a stronger connection to artistic and creative endeavors. A conscious effort was made to include poetry, stories, movement, and music to creativity-focused group activities. Different creative pursuits, projects, and an emphasis on problem solving was a distinguishing characteristic of the creativity-focused group. More time for pursuits in science was being provided to the children in the creativity-focused group.

An excellent resource for developing both the regular curriculum and the creativity-focused science curriculum, as well as for integrating curriculum materials was "Curriculum for the Cosmic Plan of Education and Environmental Studies" by Sister C.

Trudeau (1984). This resource has since been published in Hawaii. A sample lesson plan used in this study is provided in Appendix D.

Another difference between the two classrooms was that teachers in the creativity-focused group used analogies and promoted opportunities for students to think “out of the box.” Both teachers of the creativity-focused group collaborated on the processes involved in creativity and were determined to include analogies and metaphorical thinking in their delivery of lessons. Person-oriented theories of activity (Davis, 1983; Maslow, 1971) rendered a guideline for qualities to nurture in the children, such as independence, curiosity, risk-taking, and exploratory endeavors. Process-oriented theories of creativity led teachers in the creativity-focused classroom to emphasize problem finding, problem solving, divergent thinking, and critical thinking. Rather than looking for the right answer, the children explored alternative ideas, and, in the process, deduced what made these ideas viable or impossible. The teachers in the creativity-focused room became more aware and determined not to look for one right answer, but to entertain many possibilities. Instead of just answering questions, the creativity-focused teachers tried to have the children come up with possibilities and answers.

This study was designed on the premise that environmental conditions and other elements of the child’s system can influence creative potential (Albert & Runco, 1990; Arieti, 1976; Gordon, 1961; Helson, 1990; Hennessey & Amabile, 1987). The systemic view of creativity (Arieti, 1976) was reflected by the emphasis on promoting the children’s creativity by making changes in the environment, curriculum, and methods.

The changes that were made by the teachers in the creativity-focused classroom included placing an extra emphasis on a brain-based learning approach; re-prioritizing classroom time and experiences to devote the majority of time to creative pursuits, projects, discovery, experimentation, and science; incorporating problem-solving processes, such as analogies and metaphorical thinking, as part of teaching daily methods; and modeling acceptance of many possibilities, instead of just one correct answer. This study was also based on Maslow (1971) and Hennessey and Amabile's (1987) belief that everyone possesses creative potential, and that environmental conditions impact creativity.

Writing the yearly science curriculum schedule and lesson plans were my responsibility. The *National Science Education Standards* (1996) produced by the National Research Council, as well as the Diocesan standards from the Catholic school department were my guidelines. I designed the science journals for both groups in order to document the children's work in science, as we do for all other curriculum areas. The journals are simple and allow for a great deal of creativity. Only the title of the lesson is printed on the journal page. The children were free to give their impression of what they learned during the lesson. Students in the creativity-focused group, however, supplemented their science journals with special projects in order to use various art media and materials that could not be contained in a journal. The teachers participating in this study had concurred, from past experience, that journals were a valuable tool for assessing student understanding in this curriculum area.

The curriculum was implemented near the beginning of the school year in November 2003, and it ended in May 2004. The kindergarten/preschool division teachers met in the summer of 2003 to finalize the revised yearly science curriculum schedule. It was agreed that two teachers in the creativity-focused classroom would implement the new curriculum and the other two teachers would use the previous year's curriculum in the regular classroom. Although the lesson plans were the same for both groups, the creativity- focused classroom did more as far as projects were concerned, and went more into depth on science topics. It was agreed that the creativity-focused classroom would dedicate an extra time slot every other Friday for Montessori's Cosmic curriculum and use two time periods per week for science alone. An initial seminar among participating teachers was held to review the goals, strategies, and data collection procedures involved in the study. Meetings were held on an as-needed basis during the course of the study to afford the opportunity for the participating teachers to dialogue, reflect, revise, and share data. The two teachers in the creativity-focused classroom agreed to devote more time to projects and experiments and to change their methods to promote discovery, metaphorical thinking, creative pursuits, and to entertain the possibility of more than just one correct answer to problems.

#### *The Thinking Creatively in Action and Movement Test*

The Thinking Creatively in Action and Movement Test (TCAM; Torrance, 1981) is appropriate for children from age 3 to 8 and allows for both verbal and physical responses. In the TCAM, children's movements and verbal responses are scored on

fluency, originality, and imagination. The results of the TCAM are interpretive, rather than statistically definitive, due to the small number of students in the sample.

Reliability tests on Torrance's TCAM (1981) yielded "an overall test-retest reliability coefficient of .84" (p. 7) using a sample population of 20. Torrance (1981) conceded that although the test-retest reliability of the TCAM has been satisfactory when all four measures are used in the test, the validity studies, though positive so far, are still ongoing and are not definitive. Torrance (1981) stated that "although tests of direct validity of the TCAM are difficult to invent, there is a considerable accumulation of indirect validity evidence" (p. 11). Validity studies that were done utilized a small number of participants ranging from 16 to 34 in number; however, this instrument only supplements the other data that were collected in this study.

Torrance (1981) stated that

the most direct validity study of *Thinking Creatively in Action and Movement* thus far completed is by Reisman, Pellegrini, Paguio, Floyd, and Torrance (1980). In this study, scores derived from TCAM are correlated with traditional Piaget measures having one correct answer (convergent problem solving), a modified Piaget set of measures eliciting a variety of alternative solutions (divergent problem solving), and a mathematics readiness test also permitting a variety of solutions or methods of obtaining correct answers. (p. 7)

The study, which was done on 34 preschool children, showed that the TCAM scores did "correlate positively and significantly with the *Modified Piaget Tests* and the *Mathematics Readiness Test*" (Torrance, 1981, p. 7). Reviews regarding the TCAM as an assessment tool conducted by the Center for Creative Learning rated the TCAM as "good" both in reliability and validity.

The intent of the TCAM is not to determine *who* is creative, but to determine if the children in the creativity-focused group grew in their ability to think with more fluency, originality, and imagination more than the children in the regular group. A growth in these three areas should suggest a growth in creativity.

The other three teachers have approved the selection of the TCAM. Since the setting was an early learning center, this instrument, as well as observations of students and interviews with them, seemed appropriate for the study. Input from the teachers and the children's parents were also examined. The triangulation of the results contributed to the validity of findings.

#### *The Parent Survey and Interview*

The parent survey (see Appendix A) was administered at the end of the study to contribute yet another perspective and to garner additional information on the children outside of the school setting. Ten parents from each of the two groups were asked to respond to a written survey. Two parents from each group were randomly selected to answer the same survey questions, but in an oral interview. The interviews were done with the hopes of gathering more comprehensive and richer responses. The questions were the same for both the parent survey and the parent interview. These parent surveys and interviews provided a means of finding out if any changes in the creativity-focused science curriculum promoted creativity in other areas of the child's life. These surveys and interviews provided the parents with an opportunity to share their observations with the teachers. This collaboration between parents and teachers hopefully promoted a partnership in the child's education.

### *Interviews with the Children*

Interviews with the children (see Appendix B) were conducted at the end of the year, as well. All 12 children in each group were interviewed. Journals from both groups provided additional data for use in the study. The creativity-focused group also had work samples from different projects that they did in lieu of journal work.

### *Data from the Teachers*

True to the nature of qualitative research, this study relied on the strength of multiple sources of data (Cochran-Smith & Lytle, 1990; Denzin & Lincoln, 1994, 2003). There were four kindergarten teachers involved in this study, two from the creativity-focused classroom and two from the regular one. Teachers also contributed their views in the form of a staff interview (see Appendix C) conducted at the end of the study. Interviews were conducted by me with the two teachers from the regular classroom, and the other teacher besides myself in the creativity-focused classroom.

Teachers' observations were categorized to see if any patterns arose that were related to this study. The teachers recorded their observations and reflections during the course of this study in a research log that had been provided to each of them. "Pausing to analyze and reflect during action research is essential" (Mills, 2003, p. 103) to the process. The teachers contributed field data that included classroom observations and anecdotes. The teachers' observations and anecdotes were recorded with care and detail. Any observations or anecdotes that they felt pertinent to this study were written in a log kept by each teacher involved in the study. The four teachers, including myself, had an initial meeting to discuss and clarify data collection procedures. All of these sources of

data were expected to provide an emic perspective (Vidich & Lyman, 2003) of the research study. Comparisons were then made using interviews and the research logs to see if any differences existed between the two participating groups of teachers.

The four kindergarten/preschool division teachers, including myself, participated in the collection of data and had input into the coding process along the way. Personal reflections regarding the quality of the study and its impact were sought by giving the teachers a draft of the findings. They contributed their input to the final draft for any revisions, clarifications, interpretations, and deletions. My responsibilities included coordinating data collection: observations, interviews, research logs, the administration of the TCAM at the beginning and end of the school year, and writing up the results of the study. I also coordinated procuring consent from parents and children in the study, planning the science curriculum schedule for the year, and developing the science lesson plans. The final report, in the form of my dissertation, was also my responsibility.

### *Quality of the Study*

It is important to note considerations regarding the reliability and validity of a qualitative study, such as this one. Much of the learning experience in school, systemically speaking, is not reflected in achievement test scores or other quantitative measures. Yet, test scores are a primary indicator of learning used today (Katzman & Hodas, 1995; Perkins, 1992; Winters, 2003). Program evaluations and the success of privatization of schools depend on their increasing testing scores (Winters, 2003). As with these cases, a distinction must be made on the purpose of what is being examined. This study incorporated the TCAM and several qualitative data sources to examine the

effects of the new science curriculum on the creativity of the students. The TCAM results, though they may not be statistically significant, are interpreted along with the other data to provide the basis of an interpretive study.

The results of this study cannot be reflected in "scores," but rather, the voicing of experiences, interpretations, and understanding attained in the course of this study. "Qualitative research uses narrative, descriptive approaches to data collection to understand the way things are and what it means from the perspectives of the research participants" (Mills, 2003, p. 4). Validity and quality issues in a qualitative study such as this one are supplanted by concerns for trustworthiness and authenticity (Denzin & Lincoln, 1994). Guba and Lincoln (1994) explained these two concerns by stating that trustworthiness encompassed "credibility," "transferability," "dependability," and "confirmability" (p. 114), and authenticity encompassed the "criteria of fairness, ontological authenticity (enlarges personal constructions), educative authenticity (leads to improved understandings of constructions of others), catalytic authenticity (stimulates to action), and tactical authenticity (empowers action)" (p. 114).

Mills (2003) explained the components of trustworthiness:

The **credibility** of the study refers to the researcher's ability to take into account all of the complexities that present themselves in a study and to deal with patterns that are not easily explained....**transferability** refers to qualitative researchers' beliefs that everything in the study is context bound and that the goal of their work is not to develop "truth" statements that can be generalized to larger groups of people....**dependability** refers to the stability of the data....**confirmability** of the data, [is] the neutrality or objectivity of the data. (pp. 78-80)

These issues were addressed primarily by detailed and verified data collection

procedures, triangulation, reflexivity, and devoting a prolonged amount of time at the site of the study (Mills, 2003).

The quality of this research study was not dependent on reliability in replication or statistical margins of error. The quality of this study was held to Guba and Lincoln's criteria of trustworthiness and authenticity, and was also held to the four criteria noted by Altrichter, Posch, and Somekh (1993):

- to develop and to improve practice through research in the interests of all those concerned;
- to develop the knowledge and practical understanding of those involved in the research process;
- to develop the professional knowledge of teachers as a whole;
- to develop and to improve education as a discipline. (p. 74)

The issue of reliability in this qualitative study was addressed using Johnson's (2002) suggestion: "Reliability is the degree to which a study or experiment can be repeated with similar results....The closest we come to repetition is noticing recurring items, themes, or patterns that emerge from our data" (p. 73). This was attempted via coding and inductive analysis of the data.

In this qualitative study, the terms "such as *credibility*, *transferability*, *dependability*, and *confirmability* replace the usual positivist criteria of internal and external validity, reliability, and objectivity" (Denzin & Lincoln, 2003, p. 35). Herein exists a different type of research that is not dependent on causality, a linear view, and the

manipulation of conditions and variables. It is a systemic experience grounded in the context of the study and its participants and their entire being.

This study addressed validity by seeking alternative perspectives and multiple sources of data, as suggested by Altrichter, Posch, and Somekh (1993) and Mills (2003). The study addressed reliability issues by seeking patterns in the data and close scrutiny of the data and interpretations. In essence, measures were taken to insure that this study was credible, dependable, and fair, and had addressed the issue of “ontological and educative authenticity” (Lincoln & Guba, 2003, p. 278).

Ethical concerns regarding the study were addressed in an application to the Institutional Review Board of the Fielding Graduate Institute to conduct this study at the early learning center. Parental informed consent forms (see Appendix E), student assent forms (see Appendix F), and staff consent forms (see Appendix G) were signed by participants who were willing to participate in this study. Confidentiality was maintained through the use of pseudonyms.

#### Data Analysis

The scores on the pre-TCAM test and post-TCAM test were compared to see if any changes occurred during the course of the year. Contrasts were done between the students in the regular group and the creativity-focused group to see if any differences occurred as a result of the differences in curriculum, which included subject matter, time allocation, and follow-up activities. The Statistical Package for the Social Sciences (SPSS), Version 12.0, was used to analyze the data from the TCAM. T-tests were

performed to determine any differences in growth between the regular and creativity-focused groups.

Four activities that allow children to demonstrate creative thinking were used in the TCAM. The responses to these activities are then scored on measures indicating fluency, originality, and imagination using tables provided with the test. Standard scores that are dependent on the age of the child are then computed. The statistical data derived from these standard scores are presented in a table containing the number of students in the population, the mean scores, standard deviations, probabilities, and t-scores. These results are presented in chapter 4.

The teachers' observations and anecdotes from their logs were categorized and coded using two methods in the process, the deductive method and the inductive method. Altrichter, Posch, and Somekh (1993) said,

According to the *deductive* method, categories are chosen from the researcher's theoretical knowledge and the data is then searched for relevant passages: in this case the development of categories is independent of the data. According to the *inductive* method, categories are chosen during and after scrutinising [sic] the data: in this case the categories are "derived" from the data. In action research, it is probably useful to use a mixture of both methods, capitalising [sic] on what you already know but remaining open to the surprises the data can contain. (p. 124)

The field data were coded and summarized by the preschool/kindergarten teachers using methods described by Altrichter, Posch, and Somekh (1993) and Sagor (1992).

The data were examined, and important information was highlighted. These highlighted passages were then re-read and categorized according to content. These passages were cross-indexed by marking each passage, noting its place in a category on a data matrix (Sagor, 1992), and noting the passage and source of data on the data matrix. This matrix

contained the different sources of data in a row under their respective headings. The column headings denoted the categories and themes that were being researched, as well as those that arose. The researchers collaborated on defining each category for the sake of clarity and understanding. All teacher researchers were expected to contribute to the reading, categorization, and selection of the data, as well as aide in the conclusions and interpretations of the study. The issue of representation was addressed in this manner. The children's work samples in the form of journals or projects were also categorized and documented using photographs of their work, when possible.

The data from the children's interviews, parent surveys and interviews, and teachers' interviews were placed in table form. The teachers were then given the tables and asked for their interpretations of the data addressing the issue of reliability. The issue of reliability in this qualitative study followed Johnson's (2002) suggestion that patterns in the data will lend to reliability.

The parent responses to the same survey and interview questions were listed and scrutinized for themes revealed in the data. These responses were examined for references to increase in their child's interest and motivation and the manner in which this increase was related. The answers themselves were examined for indications that the science curriculum was a factor in their child's interest. The children's responses to interview questions were similarly examined. The qualities of their responses, as well as the responses themselves were analyzed.

Coding of the data revealed patterns. Perusal of the data, which included observations, surveys, interviews, work samples, and TCAM results by the teachers,

aided in the identification of themes and patterns in the data. All four teachers participated in the collection and interpretation of the data.

### Summary

This study was a query into the effects of a revised science curriculum on the creativity of kindergarten students at an early learning center. It used a collaborative action research approach (Sagor, 1992). It relied on both quantitative and qualitative measures of data collection, which include the administration of Torrance's TCAM (Torrance, 1981), teachers' observations of the participating children, interviews of teachers involved in the study, as well as surveys and interviews of parents of the children who participated, interviews of the children in the study, and samples of these children's work in the form of journals for the regular group, and journals and projects for the creativity-focused group.

Two groups of children, one the regular group, and the other, the creativity-focused group, experienced two different science programs. The data collected during the course of this study were coded and summarized (Altrichter, Posch & Somekh, 1993; Sagor, 1992). The teachers collaborating in this study then had input into the presentation of the data, the interpretations of the data, and the conclusions of this study. Concerns regarding the quality of the study were addressed by using multiple means of gathering data, multiple perspectives, having all teachers contribute their views, and being conscious of biases and ethical considerations.

## CHAPTER FOUR: RESULTS

The quality of these early years is crucial. If, in early life, children have the opportunity to discover much about their world and to do so in a comfortable, exploring way, they will accumulate invaluable 'capital of creativity,' on which they can draw on later in life. (Gardner, 1993, p. 31)

This chapter begins with the results of the TCAM (Torrance, 1981) pretest and posttest for the children who participated in this study. The results of the parent surveys and interviews are then presented, followed by the results of the children's interviews. Finally, the data from the participating teachers are presented.

### TCAM Testing Results

Due to the small sample size, a paired samples t-test was used to discern any changes in pre-TCAM scores and post-TCAM scores for the two groups. Table 1 includes the results for the regular group and the creativity-focused group on the Thinking Creatively in Action and Movement (TCAM) Instrument (Torrance, 1981). The lack of statistical significance between groups found on the pretests indicated that the two groups were comparable at the beginning of the study. Significant differences existed between the regular group and the creativity-focused group for the posttests of Fluency, Imagination, and Originality. These results can be interpreted as indicating that the creativity-focused group did experience an increase in creativity when one considers these results along with the other data that were collected.

Due to the small number of girls, a total of seven in the study, a t-test could not be conducted using gender as a variable. This also applied to ethnicity. Ethnicities in this sample were so diverse, not only in the sample, but in the children themselves, that a t-

test could not be utilized. Twelve students came from two or more ethnic backgrounds. Besides the issue of mixed ethnicity within individual students themselves, the student population in the sample was so varied that the maximum number of children in an ethnic group numbered four in a group. This sample size was too small for comparison using a t-test based on ethnicity.

Table 1

*T-tests for Regular Group and Creativity-Focused Group on the Thinking Creatively in Action and Movement (TCAM) Instrument*

Test	Regular Group (N=12)		Creativity-Focused Group (N=12)		<i>t</i>	<i>p</i>
	M	SD	M	SD		
Fluency						
Pretest	80.17	11.31	93.50	20.62	1.96	.062
Posttest	92.67	25.10	131.75	34.14	3.20	.004**
Imagination						
Pretest	75.33	25.79	92.58	17.30	1.92	.067
Posttest	88.67	24.79	119.75	31.36	2.69	.013*
Originality						
Pretest	84.42	18.93	92.25	13.52	1.17	.256
Posttest	86.00	20.73	102.75	8.79	2.58	.021*

*Note.* \* $p \leq .05$ ; \*\* $p \leq .01$ .

#### Parent Survey and Interview Data

The answers to the parent surveys and interviews are presented in the following tables. The questions asked in the surveys and interviews are presented in Appendix A.

The tables are separated according to the groups to which the parents' children belonged. Tables that include student numbers 1 through 12 reflect responses from parents of children belonging to the creativity-focused group. Tables that include student numbers 13 through 24 reflect responses from parents of children belonging to the regular group.

All parents were asked to complete the survey, except for 4 of the 24 parents. These four parents were randomly selected to answer the same questions in an interview. Two parents were selected from the creativity-focused group, and two parents were selected from the regular group. The responses to the parent interview questions are included in the tables with the parent survey responses. Only the answers to interview questions are listed, not comments regarding things that did not pertain to this study. The parent interviews included some personal responses and anecdotes about the students' families that did not pertain to the questions. However, these were not presented in the tables. Interviewed parents are parent numbered 1, 5, 16, and 22 in the tables. Only one of the parent surveys was not returned and is designated as missing. These tables were examined with respect to the curriculum area named, indications of heightened interest, and if any examples of topics covered in science were given. It was assumed if parents knew specific topics or could give examples of interest in a scientific area, this would indicate that the child related this information to the parent out of interest.

The responses from parents of children who belonged to the creativity-focused group to question 1, "Please relate any increased interests in any curriculum areas that your child has related to you during the course of this past year," showed that six parents

named science and six named math as an area of increased interest. Three parents named art. The responses of parents from the regular group revealed that six children showed an increased interest in reading, four parents named math, three named computer, two named science and art, and one said there was no increased interest that was noticed.

If a parent noted more interest or used words such as “enthusiasm” or “profound,” this remark was tallied as indicating more interest. The creativity-focused group parents made nine remarks indicating increased interest in a curriculum area and seven regular group parents noted such remarks. Four of the nine parents in the creativity-focused group related this increase to science. Two of the seven parents in the regular group related this increase to science.

Six parents from the creativity-focused group related a specific example or topic that was covered in the school curriculum, and all six of these cited were science topics. One parent from the regular group was able to relate an example of a curriculum topic, and this was related to math.

The parent responses for the children in the creativity-focused group to question 1, “Please relate any increased interests in any curriculum areas that your child has indicated to you during the course of this past year. Include any stories or incidents involving your child that may relate to this question,” are presented in Table 2, and the responses from the parents whose children belonged to the regular group are in Table 3.

Table 2

*Parent Responses of Children in the Creativity-Focused Group to Question 1: “Please relate any increased interests in any curriculum areas that your child has indicated to you during the course of this past year. Include any stories or incidents involving your child that may relate to this question.”*

---

Student No.	Response
1	Most interested in science for some reason. He likes experimenting.
2	He shared his new profound knowledge of camouflage and water currents.
3	He likes to practice writing letters. He opens books and thumbs through them more. He’s expressed wanting to tell time and what time of the day it is. When doing artwork, he covers the entire page with color. Noticed he talks about science more and enjoys activities throughout the year including cleaning up the earth, different layers, and atmospheres. “We traced our body on paper and drew in our throat and heart. It was fun.”
4	He loves to listen to storytelling and books being read to him. He likes and tries to read books.
5	She likes the planets and dinosaurs and tells us who she plays with.
6	He enjoys show-n-tell and speaking in front of class. He shows interest in words, such as those on billboards and street signs.
7	She has told us that she wants to be a scientist when she grows up. She asks to set up and do experiments (collecting, sorting, and graphing). We enjoy her enthusiasm.
8	His interest increased in reading books, drawing (art), and sports activities.
9	He has an increased interest in the solar system and dinosaurs. He created stories of dinosaurs using himself and his brother as an example. He was the strong and big dinosaur, while his two brothers were the other smaller types.
10	Our child has become interested in reading and learning to read. On half days, she usually wanted to buy toys. Now, she is more interested in books and reading.
11	My daughter has had and continues to demonstrate a new interest in reading, writing, and art.
12	He has an increased interest in reading—especially since he learned his letter sounds and sight words. He enjoys reading signs and tries to read children’s books during our rides.

---

Table 3

*Parent Responses of Children in the Regular Group to Question 1: “Please relate any increased interests in any curriculum areas that your child has indicated to you during the course of this past year. Include any stories or incidents involving your child that may relate to this question.*

---

Student No.	Response
13	She is excited about computer class and reading.
14	Missing. Did not return the survey.
15	As he ages and matures, his interests continue to evolve. He enjoys counting money and telling time, things he really didn't pay much attention to last year.
16	Drawing, singing, and reading. She has a lot of interest in drawing.
17	Reading. There was a block, but it got easier and math is easier for him.
18	He seems more interested in reading, and is proud of his accomplishments. A definite increase in both his ability and interest in computers.
19	He seems to have developed an interest in science. He's been borrowing science-related books from the library and says that he wants to become a scientist.
20	None
21	Art, math, and reading. He really takes pride in his artwork and enjoys music.
22	She has a strong interest in language, especially non-fiction science. She progressed quickly in kindergarten.
23	He was always interested in the computer, not just the games, but its applications, e-mails, etc.
24	He is interested in computers. He really likes listening to stories at night.

---

The responses to question 2, “What are your impressions of your child's creativity,” from parents whose children belonged to the creativity-focused group are listed in Table 4, and the responses from parents whose children belonged to the regular group are in Table 5. As shown in the two tables, the responses to question 2 were similar in their content, but different in tone. Although parents of children in both groups

related that their children displayed creativity in various ways, the group of parents whose children were in the creativity-focused group were more emphatic, using words such as "amazed," "tremendously," "loves," and "strong." There were eight instances of emphatic terms used by parents of children in the creativity-focused group to describe their child's creativity, compared to five emphatic responses from regular group parents. These five responses included three "very creative" responses, one "pretty creative" response, and one "loves to" response. Responses from parents of children in the regular group did not appear to be as strong.

Examples of a type of creativity exhibited by their child that were noted by parents were also coded in terms of creativity displayed as imagining, problem solving, performing, and creating something. Creativity-focused group parents noted nine examples of creating something, seven examples of creativity as performance, one example of problem solving as creativity, and one of creativity as imagination. Parents from the regular group cited seven examples of creating something, three examples of creativity as problem solving that were noticed, two of creativity as imagination, and one of creativity as performance.

Table 4

*Parent Responses of Children in the Creativity-Focused Group to Question 2: “What are your impressions of your child’s creativity?”*

Student No.	Response
1	He’s good at problem solving...uses imagination...creates role plays with what he knows or what he has done.
2	He’s amazed us with animated faces and loves to perform anything. He composes his own songs and choreographs movements. He’s been extremely creative when it comes to cutting paper and taping it...colors designs.
3	Loves to do anything with creating with his hands and talking, drawing. Verbally talks about his projects,...learned to read.
4	Seems to have more interest in drawing pictures and coloring.
5	She loves music, singing, arts, crafts, and tape and glue. She always liked it. She likes puppet shows and wants to do things together.
6	His artistic skills have improved...He likes to sing songs he learned in school. Sometimes he’ll perform, playing the ukulele as he sings.
7	She is very expressive. She draws, sings, composes poetry and stories. Her work has become more focused and complete.
8	My child is now willing and wanting to play the piano on his own.
9	His creativity has grown tremendously. He draws, and then puts a story behind what he draws. He then gathers all his stories and creates books. His speech has improved along with his storytelling. With this better confidence, it has actually helped in other areas, especially sports.
10	Very creative. She is a very good story-maker. Loves to dance, draw, sing, and make more stories.
11	She has a strong attraction to conceptual art. This includes detailed art, usually drawing and other mediums.
12	He has an interest in artwork using various materials and media.

Table 5

*Parent Responses of Children in the Regular Group to Question 2: “What are your impressions of your child’s creativity?”*

Student No.	Response
13	She is very creative and just keeps getting better all the time.
14	Missing. Did not return the survey.
15	He is a very creative child. He can take an item, such as a toy, and pretend it’s something completely other than what it really is. He also enjoys seeing objects in clouds.
16	She makes up her own songs and dance, very creative ... makes up stories.
17	He’s pretty creative, but not confident. Problem solves, like tipping the basketball net if he can’t reach. He likes to draw. As for imagination, he doesn’t make up a lot of things.
18	He appears to have become more verbal in recounting small adventures and perception of events. More mature in his drawings, etc.
19	His clay sculptures and drawings have become more realistic.
20	Creativity is good. She loves to draw and asks what if we were...and what if it was questions.
21	I feel his imagination through storytelling has developed. He seems to be more interested in having stories read to him.
22	He does think “out of the box.” He’s into science. “What happens if we do this” ... and science experiments. He’d rather have puzzles, maps, and mazes than action figures. Likes to figure things out.
23	He likes to make books without words, like comic books. His drawings are very colorful.
24	He has creativity with painting and has ideas for making toys.

The parent responses for question 3, “What feedback has your child conveyed to you regarding his/her science experiences in school this past year,” are presented in Table 6 for the parents of children in the creativity-focused group, and in Table 7 for the parents of children in the regular group.

Parent responses to question 3 revealed that all children in the creativity-focused group had talked about aspects of their science experiences with their parents, with most of them giving details of the curriculum. The children's interest, motivation, and curiosity were reflected in the parent responses. The answers from creativity-focused group parents were more detailed and explicative. Eight out of twelve responses from this group of parents gave examples of what had been studied in science. Six of the regular group parents gave an example of what had been learned in science by their child; however, these answers were shorter and less detailed. Four parents from the creativity-focused group noted their child's joy or experience of having fun in learning. Four parents from the creativity-focused group also noted their child's interest or curiosity in this area, as well. None of the regular group parents mentioned their child's joy in learning in science, although one parent did note an increase in curiosity. Parent responses from the regular group revealed that three had not received science-related feedback from their children, and two received minimal feedback from their children.

Table 6

*Parent Responses of Children in the Creativity-Focused Group to Question 3: “What feedback has your child conveyed to you regarding his/her science experiences this past year?”*

---

Student No.	Response
1	Experiments and problem solving.
2	Water, water currents, and animals that camouflage themselves.
3	Enjoyed them! Loves creating with his hands and enjoyed projects, such as tracing himself, making islands, dinosaurs, the earth...he made me go to the store and get plaster and clay to make more dinosaurs at home.
4	Fun to learn, do, and watch.
5	She talks about the planets. Which are the farthest, and biggest, and dinosaurs. Uses bigger words than previously and uses the calculator.
6	He brings home animal and insect books. He discussed animals, planets, hurricanes and tornadoes. He constantly mentions the things he’s learned from you.
7	She is curious and concerned about her environment, a good combination.
8	My child enjoyed all of the science experiences this past school year. My child has learned the enjoyment of growing and raising flowers and plants on his own.
9	He truly enjoyed learning about the earth, the formation of the earth, and the plates of the earth. He is more inquisitive of the islands and how they were formed, and shows tremendous interest when he actually sees the lava flows on the Big Island.
10	She has become very curious about many things and is always excited to learn new words.
11	I have witnessed her evolve from having minimal interest to an in-depth interest in earth science.
12	I’ve been very impressed with what he’s learned about the human body—specifically the cardiovascular system (how it functions), and the class’ studies of the planets and environments.

---

Table 7

*Parent Responses of Children in the Regular Group to Question 3: “What feedback has your child conveyed to you about his/her science experiences in school this past year?”*

---

Student No.	Response
13	A little bit about the stars and the moon.
14	Missing. Did not return the survey.
15	He hasn't commented specifically...now he insists on keeping his "creations," sometimes for weeks.
16	She would talk about what she learned and the topics. For example, the heart is not really heart-shaped.
17	No.
18	Not too much, to be honest.
19	He hasn't mentioned anything in particular.
20	She talks about volcanoes and the different islands.
21	He seems to be very interested in ocean animals.
22	He'll talk randomly about the clouds or sun and try to take it further.
23	He uses words like "black hole" or "lava" that are related to experiments from class.
24	Only a little.

---

Parent responses to question 4, "Do you think our science curriculum has been beneficial to your child," for the creativity-focused group are presented in Table 8, and parent responses for the regular group are presented in Table 9. The parent responses to question 4 revealed that the parents of children in the creativity-focused group were more expressive in their responses and evidently felt strongly that science was indeed beneficial. The creativity-focused group parents used adjectives, such as "amazed," "excellent," "absolutely," "very impressed," and "definitely." One parent from the regular group described the science curriculum as being "very beneficial," and one

responded with the word “definitely.” Five parents from the creativity-focused group also mentioned their child’s enjoyment or interest in science, whereas, only one parent from the regular group mentioned this. Two parents from the creativity-focused group also noted an increase in motivational aspects, saying that their child wanted to learn more or had a positive attitude toward science. One parent from the regular group stated that their child loved science. Parents of children in the regular group gave more generic and general responses to the question. All parents in both groups felt that science was beneficial.

Table 8

*Parent Responses of Children in the Creativity-Focused Group to Question 4: “Do you think our science curriculum has been beneficial to your child?”*

---

Student No.	Response
1	Yes, very pleased at the level they are learning. In our days, if you could write your name, you were ahead. I’m amazed at the things he comprehends: seasons, planets—and he wants to learn more! He remembers facts and his experiences. He is amazing.
2	He asks the question, “Is this science?” at home.
3	Excellent! He has learned a lot this year, and it is evident when he comes home and talks about what he did/learned that day...He has an excitement in his voice, so I know he not only learned a lesson, but enjoyed it, also! What better way to teach than having a child remember his lessons and enjoy what he is doing?
4	Yes, science is an important subject in school and can also be difficult to learn. If the kids enjoy what is being taught, it could be conducive to their learning and be beneficial to them in the future.
5	Yes, she really likes it, so she’s coming for summer school.
6	His education progressed, and he enjoyed his classes.
7	Absolutely! I am grateful for the exposure she has had in the classroom.
8	Yes, the enhanced science curriculum has been very beneficial to my child. My child’s fascination for science has increased due to the science curriculum. Please continue the science curriculum.
9	Yes, definitely. Explore more with hands-on science during the year.
10	Yes, because my child wants to learn and ties it to new things she learns in science. It keeps her interest and comes back as something she then wants to spell.
11	Having been a science teacher, I encouraged her to participate in hands-on science. I would submit that many of the class science projects she had this year are responsible for her positive attitude and desire to visit the aquarium and the zoo.
12	Yes, I have been very impressed with the science curriculum and believe it is beneficial. As I said, I am impressed with the studies of the human body, the environment, and the planets. Keep up the good work!

---

Table 9

*Parent Responses of Children in the Regular Group to Question 4: “Do you think our science curriculum has been beneficial to your child?”*

---

Student No.	Response
13	I am very pleased with the early learning center.
14	Missing. Did not return the survey.
15	Any increase in science can only be beneficial.
16	Yes, she shows a lot of interest in animals and flowers.
17	I think it would be, but he’s more into social things.
18	I believe that any enhancement in the curriculum would be a benefit, even if the results are not always obvious.
19	Yes.
20	I’m sure it’s better to expose them. I notice she asks a lot more questions now.
21	Yes.
22	Yes, for him. He loves any science. He loves it, and it keeps him interested. The more hands-on, the more interested he is.
23	Yes, definitely. I think it pulls the child to have interest in everything around him.
24	The science curriculum has been beneficial to my child. I wish to take him to the park and ocean and tell him more.

---

#### Children’s Interview Data

The data garnered from the children during the course of their interviews were very similar between the creativity-focused group and the regular group. The questions asked in this interview can be found in Appendix B.

The responses for question 1, “Which journal did you enjoy doing the most,” from the children in the creativity-focused group are presented in Table 10, and the children’s responses from the regular group are presented in Table 11. Approximately one-half of the children from both groups selected their science journal as their favorite

journal. The journal that children refer to as “I Am Special” was the religion journal where the children drew pictures that related to themes covered in religion lessons, such as “My Family” and “Ways I Can Help.”

Table 10

*Creativity-Focused Group Children’s Responses to Question 1: “Look at all your journals. Which journal did you enjoy doing the most? Tell me about it.”*

---

Student No.	Response
1	The “I Am Special” (religion) journal. It’s about other people and yourself.
2	The red (science) one, especially the volcanoes.
3	The “I Am Special.” It’s fun and easy.
4	Science. It has better things like volcanoes and it was fun to do.
5	The “I Am Special.” It’s helpful.
6	Science. It has volcanoes.
7	Science. It has more interesting things like our solar system.
8	Yellow (literature). It has stories.
9	Science and math. When scientists do experiments, they have to know how to measure.
10	Science. I like to do science every day, and even reading.
11	“I Am Special” because I like praying to God.
12	Science, “I Am Special,” and literature. I learned about the rainforest and helping Mom.

---

Table 11

*Regular Group Children's responses to Question 1: "Look at all your journals. Which journal did you enjoy doing the most? Tell me about it."*

---

Student No.	Response
13	Yellow (literature). The story was in it.
14	Science.
15	Literature. We do our own story. I like our story one.
16	Literature. It's stories.
17	Literature, because it has my story in it.
18	Literature, because we wrote a story.
19	Science. You don't have to write words.
20	Red (science) and yellow (literature). I like learning science and following instructions and I like literature because we got to do our own storybook. It has eleven pages.
21	Science. I like it because it's so fun.
22	Science. It had a lot of stuff and it was fun, like making things.
23	Science. I forget already.
24	"I Am Special." You get to draw.

---

The responses from the children in the creativity-focused group to the second item in the interview, "Tell me about the lessons you like the best," can be found in Table 12, and the responses from the children in the regular group can be found in Table 13. Six children from the creativity-focused group selected science as their favorite lesson, and four children from the regular group selected science as their favorite lesson. Five children from the creativity-focused group and four children from the regular group selected math as their favorite lesson. Two children from each group selected literature as one of their favorite lessons. Two children from the regular group selected phonics

and reading as their favorite lesson. One child had more than one favorite, so both selections were counted.

Table 12

*Creativity-Focused Group Children's Responses to Item 2: "Tell me about the lesson you liked the best."*

---

Student No.	Response
1	Math and science. Math is about studying stuff and science is interesting.
2	Science because it taught me great things like saving the oceans.
3	Literature. We got to read books and then you get to draw your favorite picture.
4	Math. It has better things. It's nice.
5	Science. It's what scientists do. We did things like the "Big Bang."
6	Math. We learn stuff.
7	Science. It helps me learn a lot about the solar system. I liked it because some of the things are real life.
8	Math, because it's so hard.
9	Science. Science is great. You learn a lot. You can do science projects.
10	The numbers. I like to do it everyday and learn a lot. I like to find out what comes after each number. I like to count and read a lot.
11	Literature. I liked doing the story.
12	Science and scientists. My friends and I are scientists.

---

Table 13

*Regular Group Children's Responses to Item 2: "Tell me about the lesson you liked the best."*

---

Student No.	Response
13	Literature because you get to draw pictures and write words.
14	Reading, because I learn how to read.
15	Math.
16	Literature.
17	Math. I like the homework that we do, like writing and drawing pictures.
18	Math. You get to do pluses, equals, and minuses.
19	Science. I like to make sharks.
20	Adding and subtracting. It's fun to do.
21	Science.
22	Language and learning sounds.
23	Science. It's about cool stuff like the black hole.
24	Science.

---

Children's responses to question 3, "What kind of new and different ideas have you had as a kindergartner," for the creativity-focused group are presented in Table 14, and children's responses for the regular group are presented in Table 15.

The most obvious difference between the two groups emerged in their answers to the third question of the interview. All except one of the children in the creativity-focused group referred to their ability to make or create new things. The responses from the regular group included one child who stated that his drawings were new and different, one child that said that he could make books, and two children related that they thought of new and different things. Five out of the twelve in the regular group related that they had no new and different ideas. Three said they forgot if they did or not. Six children

from the creativity-focused group gave an example of something from the field of science as something that they could make, and one child from the regular group gave a similar response.

Table 14

*Creativity-Focused Group Children's Responses to Question 3: "What kind of new and different ideas have you had as a kindergartner."*

---

Student No.	Response
1	I make different things, like spaceships, instruments, and rattles.
2	I make things, like castles out of clay.
3	At home, I like to do arts and crafts. I went into my mom's boxes and made a car.
4	Yes, I can do things at school, like play and make friends.
5	I can make things, like crafts. You can make anything out of tape, scissors, and glue.
6	I can make birthday cakes, make apple juice with apples, make stars with papers, make shoes, build homes with rocks, and make trains.
7	I make islands. I can make new stories and put puzzles together.
8	I can make a safe place, like a cave. I make stories. I can make a pencil and a car.
9	You can make cool stuff, like a bird house. You can put some paper on sticks to make things better. I have a good idea how to make something. It'll be a paper plate airplane. I just think about these ideas.
10	Reading. I never read. I like to make castles. I like to decorate and draw well, and I like to play.
11	I can make flowers and dishes out of paper. You can make houses out of paper.
12	I have new ideas about making a volcano. The volcano could explode.

---

Table 15

*Regular Group Children's Responses to Question 3: "What kind of new and different ideas have you had as a kindergartner."*

---

Student No.	Response
13	None.
14	None.
15	I like drawing. I draw apples sometimes.
16	None.
17	Not really. I forget my ideas.
18	No new ideas. I can kind of make different things, like how to make a book.
19	Yes, I think different things.
20	I have a lot of good ideas, like swimming, and times. Ten times ten equals one hundred. That's all I know.
21	No.
22	I forgot them all.
23	Yes, I don't know what.
24	No.

---

The children's responses to question 4, "How do you feel about science? Tell me about your feelings and things that you like or do not like about it," are presented in Table 16, and children's responses for the regular group are presented in Table 17. All of the children related that they enjoyed their experience during science lessons, except for one child in the regular group. Seven children from the creativity-focused group volunteered examples of something they remembered from science. One child from the regular group gave such an example.

Table 16

*Creativity-Focused Group Children's Responses to Question 4: "How do you feel about science? Tell me about your feelings and things that you like or do not like about it."*

---

Student No.	Response
1	I like it being hard and learning about dinosaur bones, people, and magic.
2	I like it. I don't like reading.
3	Yes, I like it. We get to learn stuff. I learn about volcanoes and the earth.
4	I like science. I like it and it's fun to do.
5	I do like it. It's scientific, and I like to make surprises.
6	I like it because I can color new stuff like whales. We learn new stuff, like how dinosaurs are born and turtles, too! I like to learn about hot and cold and how to make popcorn.
7	I feel great about it because science is fun.
8	I like it because I like to draw ducks and volcanoes.
9	I like reading about it. There is so much to learn about. I have a science question. What do you think about if you were a scientist and were making a project to discover something? What would you make? I need to do a science project so I can get more ideas.
10	I like science. I think about things, experience the moon, or something in experiments.
11	Good. I like learning about flowers.
12	I like it when they find dinosaur bones and when scientists use cool computers, but I don't like when the volcanoes explode and scientists go there.

---

Table 17

*Regular Group Children's Responses to Question 4: "How do you feel about science? Tell me about your feelings and things that you like or do not like about it."*

---

Student No.	Response
13	Yes, I like it. You get to know about everything.
14	I like it. I like drawing plants. I like making islands and Africa.
15	I like it. You get to learn and draw.
16	I like it a little bit because I learn a lot of new stuff.
17	I like it because you get to draw sports pictures sometimes.
18	I don't like it. I don't know much about science.
19	Happy. I like it. It's fine.
20	I feel happy about it because it's fun.
21	I like it. It teaches you stuff, like if you want to be a doctor.
22	It's hard. I like it because it's fun to do. I like making the stuff.
23	I like it. It's cool.
24	I like it.

---

#### Teacher's Data

Data from the teachers were gathered in two ways. A staff interview (see Appendix C) was conducted at the end of the study, and each teacher kept a research log during the course of the study.

#### *Staff Interviews*

The teachers' responses to the first question on the staff survey are presented in Table 18. Teachers number 1 and 2 were with the regular group, and teacher number 3 was with the creativity-focused group. The teachers preferred not to be tape recorded during their interviews. The essence of their responses is reported here. Summaries of

their replies are presented. I did not interview myself in this study; therefore, only the other three teachers' responses are listed.

The responses from the teachers in the regular group related creativity to the children's products and materials that were available in the classroom. The teacher in the creativity-focused group related creativity to the observed behavior of the children rather than to what the children produced with available materials. Both classrooms have the same availability of funds for materials, and the teachers usually purchase the same materials for use in both rooms.

In the second part of this first question, teachers were asked if they noticed any differences, in terms of creativity, between the two groups of children. Both teachers in the regular group were not able to observe the children in the creativity-focused group due to staffing constraints. The teacher of the creativity-focused group did notice a difference between the students in each group and remarked that it could possibly be attributed to the creativity-focused group's access to different art media. This teacher had observed that the regular group appeared to "lag behind slightly."

Table 18

*Teacher Responses to Question 1: “How do you think the science curriculum in your room has impacted the creativity in your students this past year? What kinds of changes have you noticed in the children from the other group, if any?”*

Teacher No.	Response
1 Regular Group	<p>The hands-on material in the classroom offered the children room for creativity.</p> <p>Unable to compare the students from both classes.</p>
2 Regular Group	<p>They were more creative with the materials. It’s unknown if this is connected to science. Due to budget constraints, we had limited hands-on materials. If money was available for better materials, they would use science activities more and for a longer length of time.</p> <p>Unable to compare the students from both classes due to staffing constraints.</p>
3 Creativity- Focused Group	<p>They looked at situations differently, and their vocabulary was enriched. They displayed problem solving when working, related things to their own life experiences and to the things they made.</p> <p>The regular group lagged behind a bit. They didn’t have a lot of different media to work with.</p>

Table 19 lists the responses from the teachers to question 2, “What other elements do you think contributed to this outcome?” Only teacher 3 noted other elements.

Table 19

*Teacher Responses to Question 2: “What other elements do you think contributed to this outcome?”*

---

Teacher No.	Response
1 Regular Group	None.
2 Regular Group	None.
3 Creativity- focused Group	The variety of media made their thinking and drawing more well-rounded. I started seeing it more in computer class.

---

As shown in Table 20, the teachers' responses to question 3 revealed that all three teachers felt that the study was a benefit to both the teachers and to their children.

Teachers 1 and 2, who were both from the regular group, were teacher-oriented in the benefits they detailed, saying that the study aided in the development of the curriculum, in communication, and in getting new ideas for lessons and materials. The teacher from the creativity-focused group responded from both the teacher's perspective, and also the children's perspective. She noted that children were thinking about the process of projects they were undertaking, communicating, and displaying divergent thinking in their work. She also noted that she began to see things more from the children's

perspective and began to let them show her and discover, rather than telling them and teaching them. She found herself getting ideas from the other teachers, as well as from the children. The regular group's teachers keyed in on the curriculum, materials, and methods, and how these could be enhanced to benefit the children, whereas the creativity-focused group's teacher focused on the children and their ability to drive the curriculum with their thinking and interests. All teachers did note that communication and reflection were benefits they experienced during the course of the study.

Table 20

*Teacher Responses to Question 3: “What do you feel the benefits of this study have been on the children’s creativity in the regular group, the creativity-focused group, our environment, methods, and curriculum, and our interaction as a staff?”*

Teacher No.	Response
1 Regular Group	It helped to develop the curriculum rather than following the same routine. I could walk into the other classroom and get ideas. I’ve always asked what you’re doing, so I don’t know if it’s because of the study, but we communicated and shared ideas to enhance each lesson.
2 Regular Group	The results will allow teachers to understand better, and to provide materials to extend the knowledge of children. This classroom didn’t have unique and interesting materials available, such as the art cabinet and aquarium. Free access to the art cabinet provided the children with a variety of materials generating interest and conversation. It benefited our interaction as a staff by sharing knowledge, having the teachers collaborate more, and to help understand the interests of the children from a fresh perspective.
3 Creativity- Focused Group	It enhanced it for me. The children sat and thought about the process first, rather than just jumping in. I saw children doing it, thinking out of the box. I found that this was a more fun way of teaching and learning, and I found myself telling the children to show me, rather than me just telling them things. When we bounce things off each other, we come up with better ideas, and we took the children’s lead, too.

The teacher responses to question 4 are presented in Table 21. All teachers gave recommendations for further study that pertained to what could be done in the classroom to improve it. Only the teacher who was from the creativity-focused room indicated that her aim was to “have an explosion of children driving” the curriculum.

Table 21

*Teacher Responses to Question 4: “What recommendations would you have for further study in this area as a result of your experiences?”*

---

Teacher No.	Response
1 Regular Group	<p>Search for grant money for in-depth study for other opportunities for children to learn.</p> <p>Find more topics of interest in science.</p> <p>Find ways of purchasing materials for children to use.</p> <p>Find opportunities for excursions to areas for further study, such as places to hike, beaches, movies, places to explore, gardens, airports, boat docks, museums.</p> <p>Study ways to provide more hands-on experiences.</p>
2 Regular Group	<p>Try combining the classes when doing lessons to increase interaction among the children.</p> <p>Find ways to develop a more interactive approach rather than lecture formats.</p>
3 Creativity- Focused Group	<p>We could see how much more we could integrate the curriculum to have an explosion of children driving our curriculum.</p>

---

It is evident that the study generated interest in improving the curriculum and methods and resulted in reflection on the part of the teachers. These responses do not refer so much to areas for further study, but rather, they refer to areas that they felt should be addressed by the teaching team in the future. These areas included expanding the science curriculum; providing more hands-on, interactive, and real-life experiences; improving teaching methods; and integrating the curriculum further.

*The Teachers' Research Logs*

It should be noted that the material in this section comes mainly from my research log. Although all teachers who were involved in this study met regularly and were cognizant of the need to keep entries in the log, time constraints and the work itself resulted in a small number of actual written entries in the logs. Therefore, much of the data in this section came from my log.

Several themes emerged when the four teachers' logs were compiled. These themes included "going one step further," verbalization of thinking skills, emergence of cooperative endeavors, creating things from materials, and applying similes and metaphors to lessons. Parental feedback to the teachers also contributed to the data that teachers collected in their logs or related in their interviews.

*Going One Step Further*

The observations noted as "going one step further" was a label that the four teachers gave to incidents where children displayed divergent thinking or enhanced activities or assignments beyond the normal routine. Teachers from both groups noticed various incidents where the children were observed taking that extra step.

*The Regular Group*

Instances in the regular group included some examples from various phonics lessons. In one lesson, the children were to draw a window "pane" and label their drawing with this silent final "e" word. One of the children asked if she could go ahead and draw the house around the pane. In another phonics lesson that dealt with the digraph "sh," a child opted to draw a container ship. This ship had a man on deck

kicking a container in the air. The "extra" part is how the child depicted the motion of force in that the man's foot pointed in the same direction that the container was being kicked. This same language teacher from the regular children's group wrote further:

Children are beginning to be so innovative in their ideas and their usage of hands-on materials. In lesson presentations of sounds "ch," "wh," "th," and "sh," the children were asked to draw words and pictures with the above digraphs. They extended the instructions by having chicks play soccer, sheep grazing in fields with a wolf nearby, cheeks of Santa Claus, wheels on a bus going around.

The other teacher from the regular group also noticed the children going beyond what the instructions specified. When asked to draw a treasure chest on a ship, one child drew the chest, which was connected by a chain, hanging under the ship to keep it hidden.

In another lesson, the children in the regular group were drawing their favorite picture from the story, "Where the Wild Things Are" (Sendak, 1963). This picture not only depicted that favorite page but included the water, small rowboat, and tree growth very similar to what had been covered in a previous science lesson.

The children in the regular group also began to enhance their computer drawings. Instead of just drawing three Christmas trees, the picture became three Christmas trees with stockings, chimneys, and other decorations of the season. One child's creation of a lion using Kid Pix computer program stamps was elongated by stamping extra mid-sections. This, he explained, was to make the lion longer so more people could fit under it for the lion dance, a cultural celebration in Hawaii.

Teachers in both groups also noticed that various tangram activities in the classroom, which had never been favorites of the children in the past years, were

constantly being used. The children in the regular group were creating their own designs, and in some instances, they began incorporating their floor mats into their designs.

### *The Creativity-Focused Group*

When compared with what was logged by the teachers in the creativity-focused group, some important differences between the groups emerged. The children in the creativity-focused group began to see the whole form of images that they wanted to draw or create. This attention to form carried over to their work with manipulatives and blocks, and they began to use some manipulatives three-dimensionally. They created the overall form, and then added details to their work. Children in the creativity-focused group became more aware of various art media and became concerned with which media would best fit their work. They also began to add the dimension of action and imagination to their products by using them in different ways.

In one instance, teachers from the creativity-focused group related that the children were drawing insects in their science journals. They searched the books that were available in the classroom for pictures of insects, said that they could draw insects by looking at their forms, and proceeded to do so. In the same vein, when the children began drawing castles, they carried the theme over into their work with manipulatives and began constructing castles using various designs and forms. They began to see forms in their pictures, in books, and when working with three-dimensional items.

When the children in this creativity-focused group were given the opportunity to work with pastels in their science journal, they began to ask if they could use their choice

of media when working with their other journals. Rather than their pictures changing in details as the regular group's pictures did, the creativity-focused group began to look at the overall scheme of their tasks—forms and use of different media.

The creativity-focused group also displayed another imaginative aspect of their drawings. In one instance, they were drawing cars on mini chalkboards. When they finished their drawings, they began “driving” them around the room, adding the element of action to their works.

This concept of “going one step further” also surfaced when they were at their science table working with the fingerprinting activity. They began by stamping their fingerprints on paper and observing the various swirls and curls in each fingerprint. Then, they began writing their names using their fingerprints. When the teachers viewed their fingerprint creations, they had created animals by adding details onto their fingerprints. They later began making patterns using fingerprints of different colors.

The children in the creativity-focused group were also making their own creations with tangram activities, but the teachers in the creativity-focused classroom noticed that the miniature wooden tangrams were their favorite. This wooden tangram set allowed them to build three-dimensional designs. The other tangram sets were too thin to build three-dimensionally. Besides various three dimensional designs, creativity-focused children began constructing creations that connected to their work in other areas, which included vehicles and fortresses using the wooden tangrams.

Evidence of creative exploits was also seen in the use of hands-on materials in various areas of the creativity-focused classroom. A map activity was brought to life by

sounds of transportation vehicles used in the activity. The culture corner's tea ceremony activity was now accompanied by yoga exercises. It appeared as if they had creatively added their own touches of realism and knowledge to the materials that were available.

### *The Verbalization of Thinking Processes*

Teachers in the creativity-focused classroom also noticed that the children verbalized their thinking processes as they worked on their creations, and this thinking was integrated into other curriculum areas by the children. This verbalization was not documented by teachers in the regular group. For example, two children connected what they learned in science with their religion lesson. When drawing life-sized self-portraits of their circulatory system, two children were having a conversation about their bodies and how God had made them. They remarked how people knew how to breathe without anyone teaching them how to, and that the circulatory system was so intricate. They concluded that they must have been created by God because of the complexity of the human body, and that only God would have been able to create them.

In another instance, a child from the creativity-focused group was sharing how she had constructed a butterfly house using art materials. The class discussion that ensued was an exercise in problem solving and the feasibility of solutions. When looking at what she had done, this child, J, saw that her house needed air holes because all living things needed air. She also stated that she needed a place to drop in food because all living things needed food. She said that she could just open it up and drop in the food and seal it up again, but went on to question what she would do the next time her

butterfly needed food. Then, she questioned how she would keep an ample water supply. Next, surprisingly, the children questioned if the butterfly would be happy in the house or if it would be happier if it were free to fly about. J quickly added that she could put two butterflies in the jar instead of only one, but then added that this might not be enough because butterflies really needed to fly. Another child, N, then told her that maybe she should make it a mouse house instead of a butterfly house because mice liked to live in his house. He then told her to use chocolate eggs to lure them into her house because that's how his mother trapped them in her mousetraps. Then, someone suggested geckos because everyone's house has geckos in it. N quickly added that feeding the geckos wouldn't be a problem because they love to eat bugs, and his little brother loved to catch bugs and would surely be able to supply the food.

There were numerous displays of this type of problem solving among the children in the creativity-focused class during the course of the study. In some instances, the connection to the science topic was clearly evident. For example, during a discussion that occurred when completing a castle made with blocks, the children began discussing the knights hiding in the castle and how they could use magnets to draw them out because of the armor that they wore.

#### *Emergence of Cooperative Endeavors*

Another theme that arose in the research logs was the emergence of cooperative endeavors among the children in both groups. The regular group was producing murals on the chalkboard and whiteboard on a regular basis. This cooperative effort resulted in many instances of communication of their works, ideas, and problem solving as part of

the process. The children in the regular group began experimenting with the different lines, designs, and effects that could be made by using the chalk in different ways.

The creativity-focused group also experienced this same type of cooperation while creating murals in the same manner. In addition, they extended it to art projects and craft creations. The activities that were taking place in the group became group activities. The children became involved with each other by working together, or by working on their own products while sharing ideas. This leads to the next theme that arose in the course of this study, the spurt in creating things from art supplies.

### *Creative Products*

The works that the children created during the course of this study revealed imaginative exploits in both groups. However, differences in the children's products and activities that were associated with these products were evident.

The regular group's teachers were experiencing instances of children making things with tape and paper. In one instance, the children began to make telescopes of various designs. This came about when one child made an eye patch from paper, and then another child decided to make a telescope for his eye, instead. Soon, many children were designing telescopes.

Another example involved children making badges and taping them to their shirts. The children from the regular group produced badges of many designs that incorporated everything from their names to eagles and flags.

The children in the creativity-focused group also produced items from materials available in the classroom. However, during the course of the study, they were given

access to their own art closet that was stocked with various arts and crafts materials because their demand for these items became part of the daily routine. The teachers in the creativity-focused room decided to give the children free access to the art closet, rather than being constantly called upon to get art supplies for the children. These products of their creativity also reflected cooperation. For instance, one child constructed a jet plane that was equipped with helicopter rotors so it could fly as a jet or a helicopter. Another child decided to make a large airplane with a landing strip on its back that could act as a landing strip for smaller planes while in flight. This led to various aircraft being produced, but it didn't stop there. The children went on to figure out ways to hang it in the air above a table for a better effect. Soon, the table was beneath a miniature aircraft museum.

The children in the creativity-focused groups also experienced a telescope creation episode after a science lesson; however, they went on to fashion medieval hats to go along with their telescopes and began having a parade, then proceeded to go about looking for treasure.

The children in this same group also began making musical instruments. Paper cups became maracas when filled with broken toothpicks and decorated with tissue paper. One child made his own imaginary popsicle out of art materials and acted as if he had spilled some on his shirt. These were examples of creations and constructions done on their own. However, they carried over this creativity into not only their science lesson projects, but also their other projects as well.

When fashioning biomes, the creativity-focused group's creativity and individuality also surfaced. Biomes were presented as geographical areas in different parts of the world in which certain types of ecological populations existed. The children studied biomes such as the savannah, forests, tundra, deserts, oceans, and rainforests. One child's desert biome was constructed on poster board laced with sand. The animal occupants of this particular biome ranged from meerkats lounging on snakes coiled up as recliners to hyenas with feathers on their backs to depict how hyenas raised their back hairs in the wild. This group's snake creations were action-packed and not just rolled pieces of modeling dough, as the teachers had seen in the past. These snakes had raised heads and slithering bodies, and were of different types and sizes.

While creating Easter eggs with modeling dough, the creativity-focused group children began to experiment with re-mixing the dough after touching them with markers to get various colors, rather than just making the eggs out of modeling dough and coloring them with markers. Nests accompanied the eggs, and students drew geometric designs on them. In addition, they decided that Easter masks would be fun to make, rather than reserving masks for Halloween.

The activity that changed the dynamics of the creativity-focused classroom was the appearance of the "puppet show." One day, one of the children in this group brought in two simple white socks with faces drawn on them and asked to perform a puppet show. After procuring their teacher's permission, she, along with the help of her friends, arranged the desk chairs to resemble a theater seating. She then proceeded with a show with a constant flux of onlookers. Though the faces on these two socks remained the

same, somehow, their character and roles changed throughout the show. The next day, she again asked for permission to give a puppet show, and after that, the show became a daily event when time permitted. By the end of the year, she not only had theater seating and puppet performances, but she had children who acted as musicians playing plastic tubs and imaginary instruments, dancers, a fire dancer, and a concession stand, complete with counter help. Because this activity had grown to such proportions, the teachers in the creativity-focused group had to designate a time in the afternoon, right before dismissal, for these performances so as not to disrupt the regular work and lesson routine.

#### *The Rise of Similes and Metaphors*

One theme was noted as emerging only in the creativity-focused room, and that was the rise of similes and metaphors in the children's thinking. Examples of class discussions that revealed this type of thinking included one discussion on the circulatory system. When viewing a picture of the human body's circulatory system and organs, one child remarked how the rib cage was like a turtle's shell, while another child said it was like a butterfly. During a discussion about the properties of a particular object, the children listed the properties of an object, saying that it was smooth, spiky, pink, and white. One of them suddenly exclaimed that it was a castle, a princess' castle. Another child chimed in saying, "You're right. It does look like a castle!"

A lesson on the planets of the solar system turned into an exercise in metaphorical thinking. When viewing the first planet, one child remarked that it was a baked potato

and looked like one, too. Mars, then, became a red ball, and Venus became an egg yolk.

### *Other Observations*

The two teachers in the creativity-focused group made some additional observations of their children that were not observed by the teachers in the regular group. These teachers in the creativity-focused room observed that all of the children were extremely interested in science videos, such as Geo Kids. These videos never had kept the children's interest very long in prior years, but when the creativity-focused group's teachers decided to dust one off and show it to the children on video day, they were mesmerized and thoroughly enjoyed these types of videos. The creativity-focused group's teachers also noticed that when they were joined by children from the regular classroom, the science video was turned off and replaced with an animated one because the children from the regular group had lost interest and began talking and playing.

The teachers in the creativity-focused room also noticed that the kindergarten children stayed in their desk areas for longer periods of time, sometimes the whole morning work period. This desk area was their workspace for projects, as well as lessons. There were a few instances when they asked if they could choose to forego recess time and keep working. The two creativity-focused group's teachers also noticed that children began purchasing and bringing in nature books to share, rather than only storybooks. The children in the creativity-focused room who were early arrivals in the morning started to come into the room immediately and begin working on classroom activities, rather than staying out on the patio area and playing with Legos or coloring and

cutting. Another key observation made by the two teachers in the creativity-focused room was that the children who were experiencing difficulty in reading and mathematics were the ones who immersed themselves in projects and science activities. Their work in these areas was innovative, and their focus, interest, and concentration grew.

The issue of the affect that ethnicity, social class, and gender of the participants had on the results was not evident in observations, as well as in the surveys or interviews. The small number of girls in the study and the fact that the majority of the children were of mixed ethnic and socio-economic backgrounds made it difficult to discern any differences due to these variables. No patterns involving these variables emerged during the course of this study.

#### *Parental Feedback to Teachers*

Teachers in the creativity-focused room also began receiving unsolicited feedback on the science curriculum from parents quite regularly. For instance, one parent came in and said that her son always came home with announcements as to what Mrs. Gomes was doing in science today. Another parent, who was considering holding her child back another year in kindergarten just to afford him another year to grow and develop, had previously requested that if he did return, he should be placed in the regular classroom, just for a change. She approached her son's teacher toward the end of the year and said that she had changed her mind. Her son enjoyed science in our class so much that she decided he should stay in the same room because he would never get bored. Another child brought in a box full of craft items because her mother wanted to contribute to our art closet after seeing some of the children's creations. One of the assistants suggested

that the teachers design our summer school program around a science theme because she heard several parents talking about how great the science curriculum was in the creativity-focused room. In my 20 years of teaching at this early learning center, I have never experienced this type and frequency of feedback on a particular curriculum area. The comments on the content of the curriculum area and the creations that the children produced were promising.

### Summary

The results from all aspects of this study, including the TCAM pretests and posttests, parent surveys and interviews, children's interviews, and the data collected from the teachers indicated differences between the children in the creativity-focused group and the regular group. The TCAM scores showed a significant increase in the creativity scores in all areas for the children in the creativity-focused group, and no such increase for the regular group. The results from the parent interviews and surveys indicated that parents of children in the creativity-focused group were stronger in tone and emphasis regarding their child's creativity, and they were more aware of their child's science experiences in school and of some instances of heightened interest and motivation. The responses from parents in the creativity-focused group also gave more examples of subjects being covered in science that their child had related to them. Many of the parents from the creativity-focused group also noted joy or fun that their child had in their science experiences. The children's interviews also revealed that all but one child in the creativity-focused group felt that they had new or different ideas, compared to four

children in the regular group. The data from the teachers documented differences in their children's behavior in several areas.

## CHAPTER FIVE: DISCUSSION

Life is a cosmic agent. How shall this truth be presented to children so as to strike their imagination? (Montessori, 1989, p. 20)

This chapter begins with an overview of the findings of this study. This is followed by a discussion of the findings, recommendations for the site of the study, recommendations for practice, recommendations for further research, and a summary.

### Overview of the Findings

The results of the TCAM tests showed that children in the creativity-focused group did experience a significant increase in their posttest scores compared to the students in the regular group who did not. The parent interviews and surveys showed that more parents from the creativity-focused group related an increase in their child's interest in science, as well as talking about their child's creativity in more emphatic terms. The parents of the children in the creativity-focused group also related that they had received more feedback from their children regarding their science experiences, when compared with the regular group. This was documented by their ability to give specific examples of what their child had learned. This feedback revealed greater interest, curiosity, and motivation on the part of the children in the creativity-focused group. Interest, curiosity, and intrinsic motivation have a beneficial impact on creativity (Albert, 1990; Amabile, 1990; Helson, 1990; Hennessey & Amabile, 1987), as well as on meaningful learning (Caine & Caine, 1991; Jensen, 1998; Sousa, 2001; Wolfe, 2001). Parents of the creativity-focused group remarked about the joy or fun their child had experienced while studying science. The parents of the creativity-focused group also displayed a more

intense affirmation that science was indeed beneficial to their child, whereas the parents of children in the regular group were more generic in their feelings regarding the benefits of a science curriculum. Creativity-focused group parents also cited more ways that their child displayed their creativity than parents in the regular group.

The children's responses to the interview questions were similar in the regular group and the creativity-focused group in all but one of the questions. The answers to the third interview question indicated that all but one of the children in the creativity-focused group felt that they had new ideas for "making things," whereas four of the children in the regular group answered in this manner, however did not offer much detail about what they could do. The children in the creativity-focused group recognized their ability to generate new ideas for making things. This difference may have been due to the creativity-focused science curriculum, as well as other contributing factors that included free access to art supplies and teachers' attitudes that fostered imagination and divergent thinking. Half of the children from the creativity-focused groups revealed that the things that they could make or create were related to the science curriculum, whereas one child from the regular group reported this connection.

Teachers in both groups observed increases in their children's creativity during the course of the year. Interviews with teachers revealed that the teachers in the regular group connected creativity with the availability and the use of curriculum materials used to supplement the curriculum, whereas the teachers from the creativity-focused group were connecting creativity to the children's display of problem solving and divergent thinking in their behaviors, as well as their use of materials. The children in the

creativity-focused classroom displayed some creative qualities (Healy, 1987) that included an "intense absorption in activities" (p. 315), new combinations in their products, and asking discerning questions.

Several themes emerged in the teachers' observations that were documented in the research logs. These included "going one step further," the emergence of cooperative endeavors, creative products, and the verbalization of thinking processes. Key differences between observations made of the regular group and of the creativity-focused group included the element of action that the creativity-focused group children added to their work in the form of a parade, puppet shows, or driving chalkboards around the classroom, and the verbalization of their thinking processes. Problem solving and metaphorical thinking were observed by teachers in the creativity-focused group. Metaphorical thinking is conducive to creativity (Albert, 1990; Gordon, 1961), and problem solving is an integral part of the creative process (Arieti, 1976; Csikszentmihalyi, 1990; Feldman, Csikszentmihalyi, & Gardner, 1994; Isaksen & Treffinger, 1985; Milgram, 1990). Creativity-focused children were interested in what types of media to use and the forms in objects that they wanted to depict, rather than in details of their pictures, as the regular group's children were. This holistic perspective and the ability to see wholes, as well as parts, is an important component of brain-based learning (Caine & Caine, 1991) and contribute to the creative process. The creativity-focused group children's work with materials became three-dimensional. Using materials in new and different ways can indicate creativity (Healy, 1987). Teachers received parental feedback and support for the creativity-focused science curriculum.

Connections to what was being explored in the science curriculum became evident in the creativity-focused group's conversations, behaviors, and products.

The teachers in the creativity-focused classroom were becoming centered on the children driving the curriculum with their interests and discoveries, rather than maintaining a focus on the curriculum and materials. Discovery and interest contribute to independence and inner direction, and does foster creativity (Davis, 1983; Montessori, 1964). The materials, curriculum, and methods were becoming a means rather than an end for the teachers in the creativity-focused room. It is true that all of the teachers sought to improve their materials, curriculum, and methods; however, the teachers in the creativity-focused room began to look at the children and their behaviors more than the materials and works that they produced.

### Discussion

This section includes a discussion of the findings, which consist of the TCAM scores, parents' responses, children's responses, teachers' responses and observations. The teachers' observations contain observations of creative processes, children's products, and other factors.

### *Findings*

The results of this study suggested differences between the children in the two groups at the conclusion of the school year. Differences between the groups were found in the TCAM scores, parent surveys and interviews, children's interviews, and the data from the teachers.

### *The TCAM Scores*

The TCAM scores did show a significant increase for the students in the creativity-focused group in all three areas: fluency, imagination, and originality. The increase in TCAM scores for the children in the creativity-focused group was boosted, in part, by their fluency scores. It was these fluency scores that reflected the children's use of what they had learned in science during the course of the year. The children drew heavily on members of the animal kingdom for their responses. The professional problem-solving group, known as the Synectics group, derived their ideas from biology when using analogy mechanisms (Gordon, 1961).

Fluency of ideas was listed as one of the "three most important characteristics of divergent thinking" (Arieti, 1976, p. 17). Feldhusen and Goh (1995) noted that fluency was one of the "three best measures available to assess creative potential" (p. 240). Isaksen and Treffinger (1985) noted the connection between creativity and "think[ing] of many possibilities" (p. 13), as did Fishkin and Johnson (1998).

### *Parent Responses*

The parent responses to question 1 indicated that six children from the creativity-focused group, compared with two children from the regular group, related an increased interest in science. Nine parents from the creativity-focused group compared to seven parents from the regular group also noted some level of increase in a curriculum area observed by them in their child. Four of the nine parents in the creativity-focused group related their child's increase in interest to the science curriculum specifically, compared to two of the seven parents in the regular group. Six parents from the creativity-focused

group were also able to cite examples from their child's science experiences while answering this question. One parent from the regular group cited an example of their child's increased interest in the math area.

The parent responses to question 2 revealed that all parents thought that their children displayed creativity; however, nine parents from the creativity group told about things their child made or created. Seven parents from the creativity-focused group also related creativity displayed by means of some type of performance, one spoke of imagination, and one spoke of creativity exhibited through problem solving. Seven parents from the regular group noted creativity in their child being displayed through things they created, three parents noted creativity being displayed through some type of performance, two said their children displayed creativity through the use of imagination, and one through problem solving. The strong use of emphatic tones from parents in the creativity-focused group as compared to the regular group parents indicated that their child made a stronger impression on them with respect to displaying creativity. Although all parents felt that their children were creative, the parents of the creativity-focused group were more detailed in their responses regarding their child's creativity.

The detailed knowledge of what their child was doing in science and their child's enjoyment and interest in this curriculum area that was related by the parents in their responses to question 1, carried over to questions 3 and 4: "What feedback has your child conveyed to you about his/her science experiences in school this past year?" and "Do you think our enhanced science curriculum has been beneficial to your child?" It was through the parents' tone of response and the details they gave regarding their child's curricular

exploits in science that the children in the creativity-focused group appeared to benefit more from the science program in terms of increased interest and motivation.

The responses of the creativity-focused group parents to question 3, "What feedback has your child conveyed to you regarding his/her science experiences in school this past year?" revealed that eight of twelve parents could cite examples from the science curriculum, and these examples were detailed. Six parents from the regular group did cite examples from science, but these examples were shorter and less detailed. Four parents from the creativity-focused group noted joy or fun in their child's learning experience, as well as four parents commenting on their child's curiosity or interest. No parents from the regular group related their child's joy in learning, although one regular parent noted an increase in curiosity.

Parental responses to question 4, "Do you think our enhanced science curriculum has been beneficial to your child?", also reflected a difference between the two groups' responses with respect to length of response and the tone of the response. Five parents from the creativity-focused group related enjoyment on their child's part, compared to one parent from the regular group. Two parents from the creativity-focused group noted the motivational influence that science had on their child, whereas, one parent from the regular group stated that their child "loved science." Parents from the creativity-focused group used adjectives such as "amazed," "excellent," "absolutely," "very impressed," and "definitely." The strongest remarks from the regular group's parents were "very beneficial," and "definitely."

This increase in motivation and interest is conducive to creativity (Albert, 1990; Amabile, 1990; Hennessey & Amabile, 1987; Montessori, 1964), as well as brain-based learning (Caine & Caine, 1991). In studies of creativity, intrinsic motivation has been deemed as the driving force behind creativity (Albert, 1990; Amabile, 1990; Helson, 1990; Hennessey & Amabile, 1987). The important role that emotions play on brain function, learning processes, and on memory has been documented (Healy, 1987; Jensen, 1998; Wolfe, 2001). Emotions, such as joy in learning and having fun while learning, were evident in creativity-group parent responses regarding their children to a greater degree than regular group parents. These emotions and an increase in interest have a link to Davis' (1983) list of creative traits, such as being energetic, curious, spontaneous, and playful. Jensen (1998) noted the importance of making learning experiences meaningful and gaining children's attention. If children are interested, then they will be attentive and look for meaning. Creativity-group parents cited various and detailed examples of their child's science experiences and connected science into their child's interest, motivation, and creativity more so than parents from the regular group.

#### *Summary of Findings from Parent Responses*

The parent responses to question 1 revealed that more creativity-focused group parents than regular-group parents noted a heightened increase in science and were specific by citing examples from the science curriculum. The parent responses to question 2 indicated that creativity-focused parents were more emphatic in describing their child's creativity and cited a variety of ways that their child exhibited creativity. Creativity-focused group parent responses to question 3 noted more detailed examples of

what their child had covered in science. Creativity-focused group parents also noted joy and curiosity in this curriculum area on their child's part. Creativity-focused group parents were also more emphatic and detailed about the benefits of the science curriculum for their children. These responses indicated a connection between science and their child's curriculum interests, creative exploits, and intrinsic motivation.

### *Children's Responses*

The children's responses to their interview questions indicated that they all enjoyed science, except for one child in the regular group. Science has been shown to spark interest in young children (Gould, Weeks, & Evans, 2003), and interest is crucial to fostering intrinsic motivation and meaningful learning (Caine & Caine, 1991). The overwhelming response received from the creativity-focused group that they had new and different ideas about making things points to their opinion that they were creative. Davis (1983) listed awareness of one's creativity as a trait of creative people. Creativity in the children belonging to the creativity-focused group was also confirmed by parent responses and by teachers' observations.

Children from the creativity-focused group also referred to science in citing examples to questions 3 and 4 more than the regular group. Six creativity-focused group students said they could make or create something related to a science topic compared to one student in the regular group. Seven creativity-focused students, compared to one student from the regular group, gave examples from science when answering question 4 that related to how they felt about science.

*Summary of Children's Responses*

It was in the children's responses to the interview questions that a strong link between their feelings about science and their views regarding their creativity became evident. Creativity-focused group students cited more examples related to science in their responses. Not only did all but one of the twelve creativity-focused group students feel that they could make or do something creative, but also more creativity-focused group students also felt that they could make or create something that was related to science than regular students. Clearly there was a connection between what they perceived as their creative ability and science.

*Teachers' Observations of Creativity Traits*

The data that were collected by various means pointed to an increase in creativity in the creativity-focused group children when viewing the data from a person-oriented perspective, as well as a process-oriented perspective. If one focuses on the personal traits of creative people, the creativity-focused group children's behavior indicated that they were aware of their own creativity, independent, high in energy, spontaneous, reflective, and had artistic interests. These were all creative traits that Davis (1983) listed. Healy's (1987) list of qualities of creative students also matched qualities that were observed in the creativity-focused group's children. These included "intense absorption in activities....an unusual ability to see patterns or relationships....an ability to combine things or ideas in new ways....seeing things in new or different ways....insightful observations or questions....[and] an interest in new ideas" (pp. 315-316). Metaphorical thinking (Albert, 1990) and spontaneity (Arieti, 1976), which were

also listed as creative traits, were also observed in children who belonged to the creativity-focused group.

*Summary of Teachers' Observations of Creativity Traits*

Observations of children from the creativity-focused group displaying metaphorical thinking were made by the teachers in their classroom. These teachers also noted that the children displayed some traits of creative people as listed by Davis (1983) and Healy (1987). No such observations were made by teachers in the regular classroom.

*Teachers' Observations of the Creative Process*

The children in the creativity-focused group also displayed metaphorical thinking, another synectics mechanism (Gordon, 1961) and a key ingredient in brain-based learning (Caine & Caine, 1991). Albert (1990) cited metaphorical thinking as a trait of creative people. Sousa (2001) stated that "[m]etaphors, analogies, and similes are useful devices for promoting abstract transfer" (p. 148), and that "transfer is one process that allows this amazing inventiveness to unfold. . . . Transfer is the core of problem solving, creative thinking, and all other higher mental processes, inventions, and artistic products" (p. 136).

The children's verbalizations of problem-solving strategies also documented another important facet of creativity. Creativity theorists who were process-oriented noted the importance of problem solving in the process (Feldman, Csikszentmihalyi, & Gardner, 1994; Gordon, 1961; Isaksen & Treffinger, 1985; Torrance, 1963). These verbalizations were tied to a topic that was being studied in science.

An increase in problem solving and fluency of ideas, which are integral parts of the creative process (Arieti, 1976; Feldman, Csikszentmihalyi, & Gardner, 1994; Isaksen & Treffinger, 1985; Torrance, 1963), was observed in the creativity-focused group. Imagination, which was displayed in the works and performances of the children in the creativity-focused group, is a necessary ingredient in the process of creativity (Arieti, 1976), as well as science and art (Jacob, 2001).

#### *Summary of Teachers' Observations of the Creative Process*

Creativity-focused group teachers noted three key behaviors in the children that reflected important aspects of the creative process. These three behaviors included metaphorical thinking, verbalization of problem-solving processes, and an increase in their fluency of ideas.

#### *Teachers' Observations of Creative Products*

The children in the creativity-focused group were demonstrating their ability to create things, as well as to perform and to imagine. The children in the creativity-focused group were observed by teachers involved in the study as being more action-oriented with their work and using classroom materials that were traditionally used in a two-dimensional form, in a three-dimensional manner. This active involvement and divergent use of materials pointed to qualities of creative students that Healy (1987) suggested, including having a different perspective of things, having an "intense absorption in activities" (p. 315), and making new combinations.

The creativity-focused group also displayed a concern for overall form and use of various media in their artwork. Caine and Caine (1991) stated that the "brain processes

parts and wholes simultaneously" (p. 91), and that seeing parts and wholes enhances meaning and learning. This ability to see form would also be beneficial in drawing analogies and in "making the strange familiar" (Gordon, 1961, p. 33), both of which are mechanisms used in synectics (Gordon, 1961).

#### *Summary of Teachers' Observations of Creative Products*

The creativity-focused children displayed a use of imagination and added an element of action to their products. Their works also showed their ability to create things by looking at the overall form of what they wished to create, then adding detailed parts to the product. These observations were tied to creative processes.

#### *Other Factors*

Although connecting this increase in creativity demonstrated by the children in the creativity-focused group to their science experience in the classroom cannot be confirmed, it is highly likely that there is a connection between this heightened creativity and science when one takes into consideration that the teachers in the creativity-focused room hadn't experienced the behaviors exhibited by the children in their classroom in previous years, and that the behaviors that were observed during the course of the study were not observed in the same children in the 3 months before the study. Bredderman (1983) also noted gains in creativity when studying the effects of activity-based science curriculum programs on older elementary school children.

The personalities and methods of the teachers in the creativity-focused classroom appeared to affect the children in the classroom; however, the changes noted in the

children occurred during the course of the study, from January to May, not at the beginning of the school year, from September through December.

Several findings cast questions on whether or not the creativity of the children in the creativity-focused group was enhanced by the science curriculum. The fact that almost all of the children stated that they enjoyed the science curriculum, and that similar responses from children in both groups were received when asked what their favorite journal was, may indicate that science was not a key factor in their responses. However, the fact that the creativity-focused group felt that they had new ideas and the ability to make new things, whereas the regular group did not, does suggest that the creativity of students in the creativity-focused group, or their confidence in their creativity, did increase. Davis (1983) suggested that awareness of one's creativity and self-confidence were common traits in creative people. The works that the children produced and their topics of investigations were related to science topics in most cases.

Amabile and Gitomer's (1984) study demonstrated the beneficial impact of choice in task materials on student creativity. True, it could be that increased access to art materials, along with the focus of the teachers on the children's creativity, could have been responsible for these results; however, the conversations and products of the children that were observed, in addition to parental feedback, would lead one to believe that there was indeed a connection to their science experience. The children in the creativity-focused group did share their science experiences with their families.

The fact that the creativity-focused group had free access to their own art closet impacted both the amount and quality of art work that they produced. It is possible that

the interest and motivation to create with these materials could have impacted their behavior. Amabile and Gitomer (1984) also noted the effect that choice in materials had on both intrinsic motivation and creativity in one of their studies by stating,

Both the creativity results and the intrinsic interest result support the intrinsic motivation hypothesis of creativity. The extrinsic constraint of denied choice with task materials led to lower levels of creativity than the allowance of free choice, even controlling for the number and type of material used. (p. 213)

The regular group displayed creativity and interest when working with paper and tape. This leads to the question, would their products have been more creative if they had been able to have access to their own art supply, as the creativity-focused group did? The regular group also did not have access to the same classroom materials that the creativity-focused group did. The materials were similar, yet different in some aspects. Would the regular group's work have taken on a three-dimensional perspective if they had used the same materials? These are key questions that might have impacted the results; however, beyond the three-dimensional and elaborate craft projects, the creativity-focused group used problem-solving strategies, as well as a level of metaphorical thinking. The problem solving and metaphorical thinking were strongly linked to science. The creativity-focused group also used their products in active imaginary play, and they were willing to forego recess in order to stay on task.

The creativity-focused group's works appeared to be demonstrations and extensions of what they had been learning in science. Their work with curriculum materials and projects reflected a great deal of thought, creativity, and problem solving, as well as a strong connection to the science curriculum. The creativity-focused group's

fluency scores on the TCAM were boosted by drawing on members of the animal kingdom, which were presented and explored in science. This practice of drawing on biology for generating creative ideas was also used by the Synectics group (Gordon, 1961). Parent responses indicated a great deal of interest in science by the children in the creativity-focused group.

Aside from having free access to their own art supplies and a creativity-focused science curriculum, the fact that the teachers in the creativity-focused group were more conscious of promoting problem solving (Arieti, 1976; Davis, 1983, Feldhusen & Goh, 1995; Torrance, 1963), discovery (Gordon, 1961), independence (Davis, 1983), and other conditions conducive to creativity may also have had an impact on the results. The teachers in the creativity-focused group also provided one extra lesson time of 15 to 20 minutes per week for science, as well as giving science projects a priority during the day instead of the math or language areas. The teachers in the regular group spent most of the free part of the day on math and language activities. It was the combination of all the elements that apparently provided a classroom environment that was indeed conducive to the creativity of the children in the group.

It is also possible that some of the observations and responses might be due to the Hawthorne effect (Mayo, 1933). The behaviors and attitudes exhibited by those involved in the study may be due to the fact that they realized that they were involved in a study, and this, in turn, might have affected the behavior of the participants, the dynamics of the group interaction, and its effects, as well. Diaper (1990) suggested that if equal attention is given to both groups, this effect can be offset. Teachers in both groups were

enthusiastic about the study, and this, in turn, may have generated attention focused on the children. The teachers themselves and their observations and responses may have also been affected in this manner. It would be impossible to determine in this setting if the attention in both cases was indeed "equal." In action research, it is recognized that interactions of those involved in the study and their awareness of the study could contribute to complications. It is also a certainty that the situations and group dynamics between the children themselves, and the teachers and the children, were not the same in both classrooms. However, "[a]ction researchers acknowledge and embrace these complications rather than trying to control them" (Mills, 2003, p. 3).

It should also be noted that since I was in the creativity-focused classroom and was deeply involved in the study and the research, my presence and participation may have affected the other teacher in the creativity-focused room. Although all teachers met formally and informally to talk about this study, the two teachers in the creativity-focused room discussed the study to a greater extent. It is possible that this situation could have affected the key participants, the children.

Systemic views of creativity hold that creativity is not found in the person, process, or product alone, but is affected by many factors, including the person, process, product, the environment, and the interaction of these factors (Albert & Runco, 1990; Arieti, 1976; Gedo, 1990; Hennessey & Amabile, 1987). The fact that there may have been many contributing factors to the outcome of this study is to be expected when examining a complex ability such as creativity, over a period of 5 months.

The extra lesson time of 15 to 20 minutes spent on science each week by the teachers in the creativity-focused room was a consideration. It must be noted that this increase in time was part of the creativity-focused curriculum. Devoting more time to science every week was a conscious decision by the teachers in the creativity-focused group in order to make science a priority, rather than spending that extra time on individual math or language lessons as the teachers in the regular classroom did.

This close connection to the science curriculum in the products and performances of the creativity-focused group, along with notable increases in characteristics and activities that are indicators of and conducive to creativity led me to conclude that this creativity-focused science curriculum did enhance the creativity of the children in the creativity-focused group.

#### *Summary of Other Factors*

This section addressed the issues involved in this study. These included discerning if increases noted in creativity were due to the science curriculum, or if these increases were due to other factors such as students having a choice of art media or the Hawthorne effect (Mayo, 1933). These were valid considerations; however, the creativity-focused group children's products, responses to interview questions, and their parents' responses displayed a connection to science. This connection to science was also evidenced in the subject matter they used when displaying problems-solving strategies, metaphorical thinking, and imagination.

## Practical Applications

Many factors were crucial in enhancing the science curriculum for this study. These included providing meaningful learning experiences, opportunities for hands-on, experiential learning, critical thinking and problem-solving activities, and an environment that fostered cooperation. Including these elements in an educational setting, while providing basic knowledge and skills, has been the subject of controversy about the best type of instruction for students (Bobbitt, 1997; Gardner, 1989; Gross, 1999). This conflict between emphasizing basic skills and knowledge in a traditional classroom setting versus promoting freedom, independence, and creativity was explored by Gardner (1989, 1991) in terms of mimetic and transformative education. Gross (1999) vehemently supported the traditional mode of education against new “fads” in education.

This debate over a traditional and basic skills approach versus a transformative approach that emphasizes higher order thinking skills has been tied to socio-economic status by Oakes (1985), who noted the connection between socio-economic status and student placement in a tracking system. Oakes stated that parents’ socio-economic status plays an important role in determining the quality and type of education that a child receives in the educational system. The practice of tracking imposes basic skills and memorization approaches to teaching on those of lower socio-economic status, while promoting higher-order thinking for those who are economically privileged. Further study might reveal the connection between the two approaches to creativity, as well as the impact of parents’ socio-economic standing and/or ethnicity on the fostering of creative potential in children.

This study supported Amabile (2001) and Loehle's (1990) conviction that creativity has more to do with intrinsic motivation and fostering problem solving in students rather than test scores and heredity, and that enhanced programs should be available to all students, not only those who are deemed as gifted (Amabile, 2001).

A traditional school environment that requires students to be passive rather than active learners has been shown to quell intrinsic motivation on the part of the learner (Gardner, 1991; Healy, 1987; Maiorana, 1992). Experiential learning, an emphasis on discovery, and a contextual, hands-on approach are necessary ingredients in promoting intrinsic motivation and meaningful learning experiences (Gardner, 1991; Healy, 1987; Jensen, 1998; Montessori, 1964, 1967; Sousa, 2001; Wolfe, 2001).

The teachers involved in this study firmly believed in providing hands-on, experiential, and meaningful learning experiences for the students. Our philosophy included recognizing all facets of the learner, and promoting the children's cooperation and independence. We have been involved in seminars on the topic of brain-based learning and are committed to its principles. All of these elements are evident in our philosophy, methods, and environment, and were incorporated into this study.

Montessori (1989) viewed science and cultural studies as a means of heightening imagination, motivation, and creativity in children. Innamorato (1998) stated that imagination and creativity provided a sound foundation for enhancing scientific skills. This study supported both their views in that not only the children's imagination, motivation, and creativity were impacted, but also their skills in problem solving and metaphorical thinking became evident.

Bredderman's (1983) meta-analysis documented gains in creativity in elementary schools due to activity-based science programs, but did not include data for gains in creativity for kindergartners. The study at this early learning center does substantiate his views at the kindergarten level.

The Montessori method (Montessori, 1964) is an indispensable ingredient in our school environment. The Montessori training that all the staff received has been the foundation of our methods, materials, philosophy, and environment. The commitment to continuously scrutinize and to change in order to improve our methods and curriculum has led to annual revisions of our curriculum. This creativity-focused science program is not merely the product of a year's effort or involvement in a research study, but is the constantly evolving product of teachers in action.

As with most teachers, when encountering new and interesting ideas that might be implemented, the question of how to do so arises. Our efforts included online searches, as well as a search for books that offered hands-on exercises that would promote science exploration and inquiry. The staff became experts at simplifying activities, and we always kept in mind that our aim was to expose the children to new scientific experiences in a fun and interesting manner, not to instill definitions and have them memorize facts. Celebrations, cooking experiences that related to the subject matter, and integrated activities became mainstays in our curriculum.

#### Conclusions about Action Research

This action research study itself was valuable to all of the teachers involved, not only because it provided them with an exercise in researching and scrutinizing their

methods, but also because all teachers felt that it provided opportunities for collaboration, dialogue, and reflection as a working group of professionals. These practices contributed to a greater understanding for the teachers involved and were a benefit of action research (Altrichter, Posch, & Somekh, 1993; Reason, 1994). It has prompted us to reflect on our philosophy and goals, as well as our methods, and has had implications for our school environment. Other researchers (Cochran-Smith & Lytle, 1990; Hollingsworth & Socket, 1994; Zeichner, 1993) have also noted these effects as a result of action research. The teachers involved in our study have begun to question their priorities. Should they focus on basic skills needed by kindergartners or allot more time for discovery and creativity? Are we, as teachers, addressing the needs of the children, or are we focused on developing the skills that they will need to be successful in academic areas in the school system and the skills that parents expect them to develop in kindergarten? What can we, as teachers, do to promote the problem-solving skills and creativity of the children? This study has initiated changes in our curriculum and methods for our summer program, as well as the coming school year. It has also prompted teachers to reflect on their motives, attitudes, and expectations of the children.

The faculty involved in this study related beneficial implications of this study in several areas that have been documented by other researchers. These included an improvement in our methods and school environment (Altrichter, Posch & Somekh, 1993; McCarthy & Riner, 1996; Sagor, 1992; Sousa, 2002), heightened collegiality (McCarthy & Riner, 1996; Mills, 2003; Sagor, 1992; Ziegler, 2001), reflection (Altrichter, Posch, & Somekh, 1993; Johnson, 2002; Mills, 2003; Sagor, 1992; Sousa,

2001; Ziegler, 2001), and professional development (Altrichter, Posch, & Somekh, 1993; Johnson, 2002; Mills, 2003; Sagor, 1992; Sousa, 2001; Zeigler, 2001).

The focus on our science curriculum involved a deep investigation into Montessori's (1989) cosmic curriculum and resulted in a deeper understanding of her philosophy behind it. Previously, the teachers had viewed the cosmic curriculum as being primarily a study of cultures with a focus on global citizenship, but through this study, they have evolved into an understanding that Montessori's Cosmic curriculum was, indeed, one that focused on the sciences with an emphasis on the systemic nature of creation and the interdependence of all living things, past and present (Duffy & Duffy, 2002; Montessori, 1989).

#### Recommendations for the Early Learning Center

As a result of this study, the teachers in both classrooms have decided to use their new understanding of Montessori's Cosmic curriculum to design and implement a science/cosmic program that has been further enhanced to focus on creativity. Montessori's Cosmic curriculum is an integrated combination of science, history, and social and cultural studies that seeks to promote a "unitary vision of the world" (Duffy & Duffy, 2002, p. 7), and to foster reverence for life and this planet (Duffy & Duffy, 2002; Montessori, 1989; Trudeau, 1984). This revised curriculum will follow her design, philosophy, and cultural aspects even more closely, and will include an emphasis on creativity. The following recommendations for the Early Learning Center arose as a result of this study:

- Provide the kindergarten students with a choice in art materials for projects and journal work.
- Promote creativity, discovery, problem solving, and critical thinking skills to a greater degree.
- Continue to enhance, integrate, and supplement the science/cosmic curriculum and gain a richer understanding of Montessori's Cosmic curriculum.
- Make the Montessori Cosmic curriculum the core curriculum area and integrate the other curriculum areas more fully with it.

These steps should lead the staff toward not only cultivating the development of the whole child, but also cultivating the child's creativity as well.

#### Recommendations for Practice

Several key areas need to be addressed if creativity is to be fostered in a classroom setting. These include providing an environment that is safe (Caine & Caine, 1991) and where learning is active, experiential, and hands-on (Gardner, 1991; Healy, 1987; Jensen, 1998; Montessori, 1964, 1967; Sousa, 2001; Wolfe, 2001). Cooperation among students should be promoted (Albert, 1990; Caine & Caine, 1991; Gordon, 1961; Holt, 1989; Lind, 1997), and diversity should be respected and valued (Gordon, 1961). Learning should be meaningful to the learner (Albert, 1990; Caine & Caine, 1991; Healy, 1987; Jensen, 1998; Sousa, 2001; Wolfe, 2001) and contextual (Caine & Caine, 1991; Healy, 1987). Healy (1987) defined "contextualized instruction" as instruction whereby

“teachers try to relate all learning to something that is personally meaningful to the child” (p. 305).

Integration of the curriculum and core concepts promotes brain-based learning and meaning in a school setting (Caine & Caine, 1991; Jensen, 1998; Sousa, 2001). Science plays an important role in integration (Jacobson, 2002) and also promotes problem solving (Jensen, 1998), intrinsic motivation (Glass, 1993; Montessori, 1989), and curiosity (Montessori, 1989), as well as cognitive skills and children’s self-concept (Holt, 1989).

Environmental influences have a great impact on creativity (Csikszentmihalyi, 1990; Helson, 1990; Hennessey & Amabile, 1987). Schools, which are a mainstay in the lives of children today, do impact student motivation (Caine & Caine, 1991; Healy, 1987; Loehle, 1990). Considering the considerable role that schools have, not only on time spent in the institution, but also on all aspects of the learner, it is imperative that educators address all of these areas if they hope to foster creative, healthy, students who are able to think, problem solve, and create in today’s world, regardless of grade level.

Although a Montessori classroom environment ideally includes these elements of safety, active and experiential learning opportunities, respect for diversity, facilitation of cooperation, meaningful and contextual learning situations, and an integration of the curriculum due to the philosophy of the Montessori method, these same elements may also be found in other learning centers that are not Montessori centers. Teachers need to provide all these ingredients in their school setting and methodology for all students, regardless of aptitude, socio-economic background, ethnicity, philosophy, or age. A

systemic view of children as learners is imperative (Caine & Caine, 1991; Montessori, 1964, 1967, 1989). All students have creative potential (Amabile, 1990; Loehle, 1990; Maslow, 1971; Montessori, 1989), and it is the responsibility of all schools and educators to foster the potential of all students in the classroom.

Although the teachers were not aware of it, Montessori's Cosmic curriculum is the perfect vehicle for attempting to use science to foster creativity in young children. Further investigation of this Cosmic curriculum at the conclusion of this study revealed that Montessori's Cosmic curriculum was not confined to studies of other cultures and geography. This Cosmic curriculum designed by Montessori provides a rich context for integrating science into the study of other cultures, history, geography, and the sciences, including life science, physical science, and earth science. It provides an integrated and systemic view of all these subjects and a spiritual aspect, as well. The ultimate goal of the Montessori Cosmic curriculum is to aid children in understanding their role in contributing to life on earth. This Cosmic curriculum was designed to begin at the kindergarten level and proceed through the elementary grades.

It is also critical to address these issues in a child's early and formative years. Early experiences impact not only the formation of the brain (Caine & Caine, 1991; Montessori, 1964, 1967, 1989; Jensen, 1998; Wolfe, 2001), but also attitudes toward life, and one's creativity (Gardner, 1999; Maslow, 1971), as well.

#### Recommendations for Further Study

Due to the existence of so many variables in an action research study such as this one, further study could be done on the enhancement of curriculum areas other than

science to determine if it is the subject matter that plays a major role in enhancing creativity. Can other curriculum areas be utilized to enhance creativity in young children? Does one curriculum area have more impact than others?

Additional research could also be conducted on the effect that socio-economic background and ethnicity may have on the quality and methods of early learning center environments to which one has access. This access, in turn, affects not only the curriculum young children are exposed to in these settings, but also on their creative potential, as well.

In a classroom consisting of mixed ages such as ours, further study might be done, beginning with preschoolers and extending through their kindergarten years, to see if there is a window of time that is more opportune than another for the cultivation of creativity, and if "creative plasticity" does exist in young children.

#### Summary

The results of this study indicated that the creativity-focused science curriculum played a role in enhancing the creativity of the children in the creativity-focused group. The children in this group showed a significant increase between their pre- and post-TCAM scores. The parent surveys also indicated that the parents of the children in the creativity-focused group were more aware of what their children were doing in science, and they suggested that the teachers had imparted a feeling of motivation and interest in their children.

The children's interviews revealed that most of the children in the creativity-focused group felt that they had new and different ideas about how to "make things."

Adding the element of action, making their work three-dimensional, and using collaborative problem solving and metaphorical thinking were only observed in the creativity-focused group. The creativity-focused group also related their science experiences to their work, products, discussions, and behavior.

Although all of the teachers felt that their students displayed creativity, differences reported between the teachers in the two groups were in the type and quality of behaviors that were observed in their respective classrooms. The teachers involved in this study became intent on improving the classroom environment and their methods of teaching. The teachers in the regular group were focused on improving the materials, methods, and curriculum, whereas the teachers in the creativity-focused group focused on the children, and their interests and behaviors. The study impacted the teachers from the two rooms differently in this way. The study impacted all of the teachers' collegiality, dialogue, and reflective practices. It also has caused us to seek greater understanding of the Montessori Cosmic curriculum and prepare to implement a more complete and enriching one this coming year. This research project has fostered a concern for children's creativity and how to enhance it in our classroom environment. In our environment, where we seek to address all aspects of the child—physical, cognitive, emotional, social, and spiritual—a concern for the children's creative spirit has blossomed.

## References

- Ackerman, D. (2003). Synthesize traditional and progressive education for today's students. *The Education Digest*, 68(7), 4-12.
- Albert, R. (1990). Identity, experiences, and career choice among the exceptionally gifted and eminent. In M. Runco & R. Albert (Eds.), *Theories of creativity* (pp. 13-34). Newbury Park, CA: Sage.
- Albert, R., & Runco, M. (1990). Observations, conclusions, and gaps. In M. Runco & R. Albert (Eds.), *Theories of creativity* (pp. 255-269). Newbury Park, CA: Sage.
- Altheide, D., & Johnson, J. (1994). Criteria for assessing interpretive validity in qualitative research. In M. Denzin & Y. Lincoln (Eds.), *Handbook of qualitative research* (pp. 485-499). Thousand Oaks, CA: Sage.
- Altrichter, H., Posch, P., & Somekh, B. (1993). *Teachers investigate their work: An introduction to the methods of action research*. New York: Routledge.
- Amabile, T., (1990). Within you, without you: The social psychology of creativity, and beyond. In M. Runco & R. Albert (Eds.), *Theories of creativity* (pp. 61-89). Newbury Park, CA: Sage.
- Amabile, T. (2001). Beyond talent: John Irving and the passionate craft of creativity. *American Psychologist*, 56(4), 333-336.
- Amabile, T. & Gitomer, J. (1984). Children's artistic creativity: Effects of choice in task materials. *Psychology Bulletin*, 10(2), 209-215.
- Anonymous. (2001). Lillian G. Katz, Ph.D.: Children as young scientists. *Scholastic Early Childhood Today*, 15(6), 47.

- Arieti, S. (1976). *Creativity: The magic synthesis*. New York: BasicBooks.
- Auger, W., & Wideman, R. (2000). Using action research to open the door to life-long professional learning [Electronic version]. *Education, 121*(1), 120-128.
- Barinaga, M. (1990). Bottom-up revolution in science teaching. *Science, 249*(1972), 978-979.
- Becker, M. (1995). Nineteenth-century foundations of creativity research. *Creativity Research Journal, 8*(3), 219-228.
- Besemer, S., & O'Quin, K. (1999). Confirming the three-factor product analysis matrix model in an American sample. *Creativity Research Journal, 12*(4), 287-296.
- Beyer, B. (1984). Improving thinking skills--Defining the problem. *Phi Delta Kappan, 66*(7), 489-490.
- Black, S. (1998). How do your children grow? In M. Reed (Ed.), *Into teachers' hands: Creating classroom success* (pp. 128-131). Peterborough, NH: Society for Developmental Education.
- Bobbitt, F. (1997). Scientific method in curriculum-making. In D. Flinders & S. Thornton (Eds.), *The curriculum studies reader* (pp. 9-16). New York: Routledge.
- Bredderman, T. (1983). Effects of activity-based elementary science on student outcomes: A quantitative synthesis. *Review of Educational Research, 53*(4), 499-518.
- Caine, R. N., & Caine, G. (1991). *Making connections: Teaching and the human brain*. New York: Addison-Wesley.

- Calhoun, E. (1994). *How to use action research in the self-renewing school*.  
Alexandria, VA: Association for Supervision and Curriculum Development.
- Chalufour, I., & Worth, K. (2003). *Discovering nature with young children*. St. Paul,  
MN: Redleaf Press.
- Chandler, R. (1999). Creative parallel spaces in science and art: Knowledge in the  
information age. *Journal of Arts Management, Law, and Society*, 29(3), 163-177.
- Chomsky, N. (2000). *Chomsky on miseducation*. Lanham, MD: Rowan & Littlefield.
- CTB/McGraw-Hill. (1997). *Terra Nova*. Monterey, CA: CTB/McGraw-Hill.
- Cochran-Smith, M., & Lytle, S. (1990). Research in teaching and teacher research: The  
issues that divide. *Educational Researcher*, 19(2), 2-11.
- Cox, A., & Craig, D. (1997). Action research: Teachers studying teaching and learning in  
their own classrooms. *The Science Teacher*, 64(6), 50-53.
- Csikszentmihalyi, M. (1990). The domain of creativity. In M. Runco & R. Albert (Eds.),  
*Theories of creativity* (pp. 190-211). Newbury Park, CA: Sage.
- Csikszentmihalyi, M. (1994). The domain of creativity. In D. Feldman, M.  
Csikszentmihalyi, & H. Gardner (Eds.), *Changing the world: A framework for the  
study of creativity* (pp. 135-158). Westport, CT: Praeger.
- Darling-Hammond, L. (2001). Educating teachers for California's future [Electronic  
version]. *Teacher Education Quarterly*, 28(1), 9-56.
- Davis, G. (1983). *Creativity is forever*. Dubuque, IA: Kendall/Hunt.

- Denzin, N., & Lincoln, Y. (1994). Introduction: Entering the field of qualitative research. In N. Denzin & Y. Lincoln (Eds.), *Handbook of qualitative research* (pp. 1-18). Thousand Oaks, CA: Sage.
- Denzin, N., & Lincoln, Y. (2003). Introduction: The discipline and practice of qualitative research. In N. Denzin & Y. Lincoln (Eds.), *The landscape of qualitative research* (pp. 1-46). Thousand Oaks, CA: Sage.
- Diaper, G. (1990). The Hawthorne Effect: A fresh examination [Electronic version]. *Educational Studies*, 16(3), 261-268.
- Duffy, M., & Duffy, D. (2002). *Children of the universe: Cosmic education in the Montessori elementary classroom*. Hollidayssburg, PA: Parent Child Press.
- EPES Testing Service. (2003). *Skills list and sample items for practice test, Mathematics, Grade 1*. EPES Testing Service. Retrieved August 30, 2003, from <http://www.epes.com/terra/tnmath4.pdf> [2003]
- Epstein, R. (1990). Generativity theory and creativity. In M. Runco & R. Albert (Eds.), *Theories of creativity* (pp. 116-139). Newbury Park, CA: Sage.
- Eysenck, H. (1994). The measurement of creativity. In M. Boden (Ed.), *Dimensions of creativity* (pp. 199-234). Cambridge, MA: The MIT Press.
- Feldhusen, J., & Goh, B. (1995). Assessing and accessing creativity: An integrative review of theory, research, and development. *Creativity Research Journal*, 8(3), 231-244.
- Feldman, D., Csikszentmihalyi, M., & Gardner, H. (1994). A framework for the study of creativity. In D. Feldman, M. Csikszentmihalyi, & H. Gardner (Eds.),

- Changing the world: A framework for the study of creativity* (pp. 1-46).  
Westport, CT: Praeger.
- Fishkin, A., & Johnson, A. (1998). Who is creative? Identifying children's creative abilities. *Roeper Review*, 21(1), 40-46.
- Friere, P. (1970). *Pedagogy of the oppressed*. New York: Continuum.
- Galton, F. (1883). *Inquiries into human faculty and its development*. London, UK: J.M. Dent & Sons.
- Galton, F. (1925). *Hereditary genius: An inquiry into its laws and consequences*. London: MacMillan.
- Gardner, H. (1989). *To open minds*. New York: BasicBooks.
- Gardner, H. (1991). *The unschooled mind: How children learn and how schools should teach*. New York: BasicBooks.
- Gardner, H. (1993). *Creating minds: An anatomy of creativity seen through the lives of Freud, Einstein, Picasso, Stravinsky, Eliot, Graham, and Gandhi*. New York: BasicBooks.
- Gardner, H. (1999). *The disciplined mind: Beyond facts and standardized tests: The K-12 education that every child deserves*. New York: Penguin.
- Gardner, H., & Wolf, C. (1994). The fruits of asynchrony: A psychological examination of creativity. In D. Feldman, M. Csikszentmihalyi, & H. Gardner (Eds.), *Changing the world: A framework for the study of creativity* (pp. 47-68). Westport, CT: Praeger.
- Gatto, J. (2002). *Dumbing us down*. Gabriola Island BC, Canada: New Society.

- Gedo, J. (1990). More on creativity and its vicissitudes. In M. Runco & R. Albert (Eds.), *Theories of creativity* (pp. 35-45). Newbury Park, CA: Sage.
- Glass, L. (1993). Striving for excellence: Meeting the needs of gifted students. *The Science Teacher*, 60(9), 38-43.
- Goldberg, M. (2004). The high-stakes test mess [Electronic version]. *The Education Digest*, 69(8), 8-16.
- Gordon, W. (1961). *Synerctics*. New York: Harper & Brothers.
- Gould, J., Weeks, V., & Evans, S. (2003). Science starts early. *Gifted Child Today*, 26(3), 38-46.
- Gross, M. (1999). *The conspiracy of ignorance: The failure of American public schools*. New York: Harper Collins.
- Guba, E., & Lincoln, Y. (1994). Competing paradigms in qualitative research. In N. Denzin & Y. Lincoln (Eds.), *The handbook of qualitative research* (pp. 105-117). Thousand Oaks, CA: Sage.
- Guilford, J. (1967). *The nature of human intelligence*. New York: McGraw-Hill.
- Harrington, D. (1990). The ecology of human creativity: A psychological perspective. In M. Runco & R. Albert (Eds.), *Theories of creativity* (pp. 143-165). Newbury Park, CA: Sage.
- Healy, J. (1987). *Your child's growing mind: A guide to learning and brain development from birth to adolescence*. New York: Doubleday.
- Helson, R. (1990). Creativity in women: Outer and inner views over time. In M.

- Runco & R. Albert (Eds.), *Theories of creativity* (pp. 46-57). Newbury Park, CA: Sage.
- Hennessey, B., & Amabile, T. (1987). *Creativity and learning: What research says to the teacher*. West Haven, CT: National Education Association, Professional Library.
- Hollingsworth, S., & Sockett, H. (1994). Positioning teacher research in educational reform: An introduction. In K. Rehg (Ed.), *Teacher research and educational reform: Ninety-third yearbook of the National Society for the Study of Education* (pp. 1-20). Chicago: University of Chicago Press.
- Holt, B. (1989). *Science with young children*. Washington, DC: National Association for the Education of Young Children.
- Hutchinson, L. (2003). Educational environment [Electronic version]. *British Medical Journal*, 326(7393), 810-813.
- Innamorato, G. (1998). Creativity in the development of scientific giftedness: Educational implications. *Roeper Review*, 21(1), 54-69.
- Isaksen, S., & Treffinger, D. (1985). *Creative problem solving: The basic course*. New York: Bearly.
- Jacob, F. (2001). Imagination in art and science. *The Kenyon Review*, 23(2), 113-122.
- Jacobson, L. (2002). The little scientists. *Education Week*, 21(33), 28-33.
- Jensen, E. (1998). *Teaching with the brain in mind*. Alexandria, VA: Association for Supervision and Curriculum Development.
- Johnson, A. (2002). *A short guide to action research*. Boston: Allyn & Bacon.

- Katzman, J., & Hodas, S. (1995). *Class action: How to create accountability, innovation, and excellence in American schools*. New York: Villard.
- Keith, A. (2001) Action research brings results. *Science and Children*, 39(3), 32-35.
- Lewin, R. (1992). *Complexity: Life at the edge of chaos*. Chicago: University of Chicago Press.
- Lincoln, Y., & Guba, E. (2003). Paradigmatic controversies, contradictions, and emerging confluences. In N. Denzin & Y. Lincoln (Eds.), *The landscape of qualitative research* (pp. 253-291). Thousand Oaks, CA: Sage.
- Lind, K. (1997). Science in the developmentally appropriate integrated curriculum. In C. Hart (Ed.), *Integrated curriculum & developmentally appropriate practice: Birth to age eight* (pp. 75-80). Ithaca: State University of New York Press.
- Loehle, C. (1990). A guide to increased creativity in research--Inspiration or perspiration? *Bioscience*, 40(2), 123-129.
- Maiorana, V. (1992). *Critical thinking across the curriculum: Building the analytical classroom*. Bloomington, IN: ERIC.
- Maslow, A. (1971). *The farther reaches of human nature*. New York: Penguin Books.
- Mayo, E. (1933). *The human problems of an industrial civilization*. New York: MacMillan.
- McCarthy, J., & Riner, P. (1996). The accelerated schools inquiry process: Teacher empowerment through action research [Electronic version]. *Education*, 117(2), 223-230.

- Miles, M. & Huberman, A. (1994). *Qualitative data analysis: An expanded sourcebook*. Thousand Oaks, CA: Sage.
- Milgram, R. (1990). Creativity: An idea whose time has come and gone? In M. Runco & R. Albert (Eds.), *Theories of creativity* (pp. 215-229). Newbury Park, CA: Sage.
- Mills, G. (2003). *Action research: A guide for the teacher researcher*. Columbus, OH: Merrill Prentice Hall.
- Montessori, M. (1964). *The Montessori method*. New York: Schocken Books.
- Montessori, M. (1967b). *Discovery of the child*. New York: Ballantine.
- Montessori, M. (1967a). *The absorbent mind*. New York: Dell.
- Montessori, M. (1974). *Education for a new world*. Madras, India: Kalakshetra Publications.
- Montessori, M. (1989). *To educate the human potential*. Oxford, UK: Clio Press.
- National Research Council. (1996). *National science education standards*. Washington, D.C.: National Academy Press.
- Oakes, J. (1985). *Keeping track*. New Haven, CT: Yale University Press.
- Perkins, D. (1992). *Smart schools: Better thinking and learning for every child*. New York: Free Press.
- Piaget, J. (1970). *Science of education and the psychology of the child*. New York: Orion Press.
- Polito, T. (1995). Frederick Froebel's illumination on kindergarten children's relatedness to nature. *Education*, 116(2), 223-237.

- Rayl, A. (1995). Striking a neural chord: Musical links for scientists and mathematicians of tomorrow. *Omni*, 17(9), 14.
- Reason, P. (1994). Three approaches to participative inquiry. In N. Denzin & Y. Lincoln (Eds.), *Handbook of qualitative research* (pp. 324-339). Thousand Oaks, CA: Sage.
- Roman, H. (2003). Multi-dimensional thinking: The key to the future. *The Technology Teacher*, 62(5), 21-24.
- Runco, M. (1990). Implicit theories and ideational creativity. In M. Runco & R. Albert (Eds.), *Theories of creativity* (pp. 234-250). Newbury Park, CA: Sage.
- Ryan, L. (2000). *Building and encouraging confidence and creativity in science*. Unpublished master's thesis, St. Martin's College, Lacey, WA.
- Sagor, R. (1992). *How to conduct collaborative action research*. Alexandria, VA: Association for Supervision and Curriculum Development.
- Simon, H. (2001). Creativity in the arts and sciences. *The Kenyon Review*, 23(2), 203-221.
- Simonton, D. (1990). History, chemistry, psychology, and genius: An intellectual autobiography of historiometry. In M. Runco & R. Albert (Eds.), *Theories of creativity* (pp. 92-111). Newbury Park, CA: Sage.
- Simonton, D. (2003). Scientific creativity as constrained stochastic behavior: The integration of product, person, and process perspectives. *Psychological Bulletin* 129(4), 475-494.
- Sousa, D. (2001). *How the brain learns*. Thousand Oaks, CA: Corwin Press.

- Spicker, H. (1996). *Project Spring II: Final report* (ERIC Document Reproduction Service ED 404 789). Bloomington, IL: Indiana University.
- Sprung, B. (1998). Your child, the scientist? *Scholastic Parent & Child*, 5(5), 42.
- Torrance, P. (1963). *Education and the creative potential*. Minneapolis: University of Minnesota Press.
- Torrance, P. (1981). *Thinking creatively in action and movement*. Bensenville, IL: Scholastic Testing Service.
- Trudeau, C. (1984). *Curriculum for the cosmic plan of education and environmental studies*. Unpublished manuscript.
- Tyler-Wood, T., Mortenson, M., Putney, D., & Cass, M. (2000). An effective mathematics and science curriculum option for secondary gifted education. *Roeper Review*, 22(4), 266-279.
- Vidich, A., & Lyman, S. (2003). Qualitative methods: Their history in sociology and anthropology. In N. Denzin & Y. Lincoln (Eds.), *The landscape of qualitative research: Theories and issues* (pp. 55-129). Thousand Oaks, CA: Sage.
- von Bertalanffy, L. (1968). *General system theory*. New York: George Braziller.
- Wiles, J., & Bondi, J. (1998). *Curriculum development: A guide to practice*. Upper Saddle River, NJ: Prentice-Hall.
- Winters, R. (2003). Grading the Philadelphia experiment. *Time*, 161(25), 52-55.
- Wolfe, P. (2001). *Brain matters: Translating research into classroom practice*. Alexandria, VA: Association for Supervision and Curriculum Development.

Zeichner, K. (1993). Action research: Personal renewal and social reconstruction.

*Educational Action Research, 1(2)*, 199-266.

Ziegler, M. (2001). Improving practice through action research [Electronic version].

*Adult Learning, 12(1)*, 3-4.

## APPENDIX A

Written Parent Survey/Oral Parent Interview  
(Completed between May 10-May 15, 2004)

Please relate any increased interests in any curriculum areas that your child has indicated to you during the course of this past year. Include any stories or incidents involving your child that may relate to this question.

What are your impressions of your child's creativity? (Creativity may be exhibited artistically, musically, and in imagination and creative thinking.)  
Please indicate any areas of growth or aptitude that you have noticed.

What feedback has your child conveyed to you regarding his/her science experiences in school this past year?

4. Do you think our science curriculum has been beneficial to your child? Are there any specific areas that you wish to comment on?

## APPENDIX B

Oral Student Interview  
(To be completed between May 10-May 15, 2004)

1. Look at all your journals. Which ones did you enjoy doing the most? Tell me about them.
2. Tell me about the lessons you liked the best.
3. Do you think you have a lot of new and different ideas?
4. How do you feel about science? Tell me about your feelings and things that you like or do not like about it.



## APPENDIX D

## Sample Science Lesson Plan for Both Groups

- Title:** Food Chains
- Objective:** Expose children to the concept of food chains.  
Develop an understanding and appreciation of the interdependence of all living things.
- Materials:** Shark puppet, large fish puppet, small fish puppet, tiny fish puppet, krill puppet, and seaweed puppet.  
Any story-based book on food chains appropriate for age level.  
Materials available for children to create their own food chain.
- Presentation:** Using the puppets, depict a story beginning with the piece of seaweed or algae. Be dramatic, and make it interesting and fun.  
Ask the children if they can think of any other food chains.  
Have them problem solve as to what would happen if one link in the food chain were missing.
- Extensions:** Make up a food chain song similar to "Farmer in the Dell"  
Have the children act out a food chain, laying down ground rules first.  
Have children create their own food chain constructions.  
Leave related books that are appropriate for this age level that are related to this subject in the book corner.  
Use food chain sequence cards, matching activities, etc. in language area.  
Utilize shark, krill, or other characters as counters in the math area.

APPENDIX E  
Parent Informed Consent Forms

Dear Kindergarten Parents and Guardians,

My name is Joan Gomes, and in addition to being a teacher on staff here at the Early Learning Center, I am also presently a student in Fielding Graduate Institute's School of Educational Leadership and Change, 2112 Santa Barbara St., Santa Barbara, CA 93105-3538 (phone: 1-805-687-1099). I am in the process of conducting my dissertation research under the supervision of Dr. Kitty Epstein, who may be reached at the school address or via e-mail at epstein4@infinex.com.

The purpose of this study is to examine if our science curriculum fosters creativity and problem solving in our kindergartners. You and your child are being invited to participate in this study because your child is a student at this learning center. I am requesting the assistance of our parents in the course of this study in the form of answering a survey and/ or an interview about your child's interest in this curriculum area and any observations or anecdotes you feel may be helpful.

I am also requesting permission from parents and the students to administer Torrance's TCAM (Thinking Creatively in Action and Movement) Test (at no cost) that is geared for young children ages 3 – 8. This will be administered near the beginning of the school year and again at the end of the school year to see if any changes in scores can be documented. The test generally should last between twenty to thirty minutes each time it is administered. The test results will be confidential, will not go into any school records, and only will be used for the purpose of this study. The results of each classroom group will be reported, not individual scores. They will be shared with you upon your request. If your child is willing, the test will be administered during rest time. If a child is at all reluctant, he/she will not take the test. All results and information will be kept in the strictest confidence.

I am also requesting permission for your child to answer a few interview questions regarding his/her feelings and to give his/her input about our science curriculum. I am also asking if you would consent to participate in a parent survey or interview at the end of the year. The survey and interviews will be open-ended and will consist of 3 –5 questions. The interview with your child will take approximately five to ten minutes to complete and will take place at his/her convenience between May 10 and May 15, 2004. Your survey will also be requested at your convenience from May 10-May 15, 2004 and will take five to ten minutes to complete.

The kindergartners from the Lokelani and Orchid rooms were selected to participate because they all currently participate in our science lessons. Participation in this study will be voluntary, and the refusal or withdrawal from the study of any participant will not affect them in any form. If you or your child chooses not to participate, any data or observations obtained regarding your child will be removed or destroyed whenever possible. All that is needed to withdraw from the study is for you to contact me or your child's teacher.

\_\_\_\_\_ (Initial here to verify that you have read this page.)

Confidentiality and privacy will be maintained at all times, and pseudonyms will be used. Data will be kept in a locked file cabinet in my home and will be destroyed after five years.

There is the minimal risk, if your child chooses to participate, that your child may experience emotional discomfort with the interview or the TCAM testing. There is a minimal risk that you may experience some emotional discomfort during or after the survey. Should you or your child experience such discomfort, please contact me at 734-3840 for a list of referrals of counselors. The teachers and I will be sensitive to their feelings and honor them by stopping participation in the activity, should this occur. All students will be participating in their classroom's lessons and activities regardless if they choose to participate or not as a normal part of our routine. The only difference is that student participants will be asked to take the TCAM test before and after the study, and they will be asked for their input via an oral interview. There is no financial remuneration for participating in this study.

This study will be reported in my doctoral dissertation and possibly in other publications.

The Institutional Review Board of Fielding Graduate Institute retains access to signed informed consent forms. If you have any questions or concerns at any time, I will be glad to answer them. You may also contact my mentor, Dr. Kitty Kelly Epstein, at [epstein4@infinex.com](mailto:epstein4@infinex.com).

Please sign one form and retain the other for your records.

Sincerely,

Joan J. M. Gomes

\_\_\_\_\_ I hereby give my consent for my own and my child's participation in this study.

\_\_\_\_\_ I do not consent to participate or have my child participate in this study.

\_\_\_\_\_  
Your Printed Name

\_\_\_\_\_  
Your Child's Name

\_\_\_\_\_  
Your Signature

\_\_\_\_\_  
Date

Dr. Kitty Kelly Epstein  
Fielding Graduate Institute  
2112 Santa Barbara Street  
Santa Barbara, CA 93105  
1-805-687-1099  
e-mail: [epstein4@infinex.com](mailto:epstein4@infinex.com)

Joan J. M. Gomes  
47-148 Hui OO Place  
Kaneohe, HI 96744  
1-808-734-3840  
e-mail : [Gomesj010@hawaii.rr.com](mailto:Gomesj010@hawaii.rr.com)

.....  
Yes, please send a summary of the study results to:

---

Name of Participant

---

Street Address

APPENDIX F  
Student Assent Form

Mrs. Gomes is studying how science helps us think better and differently. Her school is Fielding Graduate Institute in Santa Barbara. Mrs. Gomes is trying to find out what effects the science lessons have on students. The kindergarten children from the Lokelani and the Orchid rooms will be asked to help her because we all study science.

I agree to answer questions that she might ask at the end of her study. This will take about five to ten minutes, and if I do not want to do it, or if I feel uncomfortable doing it, she will stop, and it will be okay. I will also take a test at the beginning of her study and again at the end of her study to help her with her work. This test will be done at rest time and will take about twenty to thirty minutes each time we do it. I can also offer to share my schoolwork with her. If I feel uncomfortable answering her questions or doing her test, she will stop, and it will be okay. It will be fun. She will not use our names in her work. Nothing she does or asks will hurt me in any way.

She is doing this work to finish her schoolwork and to help us and other teachers and children. If I do not want to do this at any time, I will let her know, and it will be okay. She will not use any of my information and will simply throw it away. I can also tell my parents or my teachers that I do not want to do this anymore, and it will be okay.

Mrs. Gomes will report what she finds in her schoolwork and maybe other magazines or books. I will sign one of these forms and keep the other for myself.

\_\_\_\_\_ Yes, I want to be part of this study.

\_\_\_\_\_ No, I do not want to be part of this study.

\_\_\_\_\_  
My Name

\_\_\_\_\_  
My Printed Name

\_\_\_\_\_  
Date

APPENDIX G  
Staff Informed Consent Form

Dear Co-Teachers,

My name is Joan Gomes, and in addition to being a teacher on staff here at the Early Learning Center, I am also presently a student in Fielding Graduate Institute's School of Educational Leadership and Change, 2112 Santa Barbara St., Santa Barbara CA 93105-3538 (Phone: 1-805-687-1099). I am in the process of conducting my dissertation research under the supervision of Dr. Kitty Epstein, who may be reached at the school address or via e-mail at epstein4@infinex.com.

The purpose of this study is to discover if our revised science curriculum fosters creativity and problem solving in our kindergartners. Our focus at the ELC will be on nurturing creativity in our students this year. This study is designed to see if the revised science curriculum will enhance divergent thinking, problem solving, imagination, and creativity in our students.

I am asking that the three kindergarten level teachers here at the early learning center participate because all three of you comprise the upper division faculty and are involved with the science curriculum, kindergarten lessons, and the kindergarten children. I am asking your assistance in collecting short notes on your observations and any anecdotes on your students that you feel may be helpful, and to be interviewed at your convenience during the week of May 10-15, 2004. This survey should take between five to ten minutes to answer. Observations can be done in the course of your regular duties during the day. I will be glad to meet with you during our free time and collect information regarding these observations and anecdotes. I will be responsible for collecting the parent surveys, as well as your surveys. We can also devote time during our regularly scheduled meetings to review data and address any concerns. The total time involved in your participation will be approximately 10-20 hours over the course of the study, between November and May.

I am requesting the assistance of our parents in the course of this study in the form of answering a survey. The parent survey will be open-ended and consist of 3 –5 questions to be answered during the week of May 10-15, 2004.

The kindergartners from the Lokelani and Orchid rooms were selected to participate because they all participate in our lessons, and their number provides an ample sample size for the study. Participation in this study will be voluntary, and the refusal or withdrawal from the study of any participant will not affect them in any form. All that is needed from them or their parents to withdraw from the study is for them to contact any teacher. Teachers are then requested to contact me so the other teachers involved in the study can be notified, and the child and parent's data can be removed and destroyed whenever possible. If you as a teacher should choose not to participate, feel free to notify me. This decision will not affect you in any way, and your data will also be removed and destroyed. There is no financial remuneration for participating in this study.

\_\_\_\_\_ (Initial here to verify that you have read this page.)

Confidentiality and privacy will be maintained at all times, and pseudonyms will be used. The data collected during this study will be kept in a locked file cabinet in my home and will be destroyed after five years.

There is the minimal risk that you may feel uncomfortable collecting and sharing data, and participating in the staff survey. Should you experience such discomfort, please contact me at 734-3840 or 429-6058 for a list of referrals of counselors. If you feel uncomfortable, you may choose not to participate, and your data will be removed and destroyed whenever possible.

I am asking the upper division teachers to participate by collecting observations and anecdotes, and by giving their input into the study. This study is a cooperative effort among the staff members in hopes of increasing professionalism, collegiality, reflection, and dialogue, as well as being a benefit to curriculum and methods development in the field of education. Your input and comments will be respected, and you will have the opportunity to voice your comments both during the study and on the dissertation itself. You will benefit, not only from contributing to knowledge regarding educational practices in the field of early childhood, but also from enhancing your own knowledge regarding your methods and practices in your classroom.

This study will be reported in my doctoral dissertation and possibly in other publications. Confidentiality will be maintained and honored at all times.

The Institutional Review Board of Fielding Graduate Institute retains access to signed informed consent forms. If you have any questions or concerns at any time, I will be glad to answer them. Please sign one of these forms and retain the other for your records.

Sincerely,

Joan J. M. Gomes

\_\_\_\_\_ I hereby give my consent for my participation in this study.

\_\_\_\_\_ I do not consent to participate.

\_\_\_\_\_  
Your Printed Name

\_\_\_\_\_  
Your Signature

\_\_\_\_\_  
Date

Dr. Kitty Kelly Epstein  
Fielding Graduate Institute  
2112 Santa Barbara Street  
Santa Barbara, CA 93105  
1-805-687-1099

Joan J. M. Gomes  
47-148 Hui OO Place  
Kaneohe, HI 96744  
1-808-734-3840

e-mail: epstein4@infinex.com.

e-mail:  
[Gomesj010@hawaii.rr.com](mailto:Gomesj010@hawaii.rr.com)

Yes, please send a summary of the study results to:

---

Name of Participant

---

Street Address

---