MICHIGAN STATE UNIVERSITY LIBRARIES
3 1293 01411 2928
THESIS
5

LIBRARY
Michigan State
University

This is to certify that the

dissertation entitled

FAMILY SCIENCE: COLLABORATION, PEER INTERACTION, AND PARENTAL INVOLVEMENT TO BUILD HISPANIC CHILDREN'S INTEREST IN LEARNING SCIENCE

presented by

Sunethra Karunaratne

has been accepted towards fulfillment
of the requirements for

Ph.D. degree in Curriculum, Teaching, ~~and Educatio~~nal Policy

James J. Gallagher
Major professor

Date 6/26/95

MSU is an Affirmative Action/Equal Opportunity Institution

O-12771

PLACE IN RETURN BOX to remove this checkout from your record.
TO AVOID FINES return on or before date due.

DATE DUE	DATE DUE	DATE DUE
SEP 23 1997		

MSU is An Affirmative Action/Equal Opportunity Institution
c:\circ\datedue.pm3-p.1

FAMILY SCIENCE: COLLABORATION, PEER INTERACTION, AND PARENTAL INVOLVEMENT TO BUILD HISPANIC CHILDREN'S INTEREST IN LEARNING SCIENCE

VOLUME I

By

Sunethra Karunaratne

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Department of Teacher Education

1995

ABSTRACT

FAMILY SCIENCE: COLLABORATION, PEER INTERACTION, AND PARENTAL INVOLVEMENT TO BUILD HISPANIC CHILDREN'S INTEREST IN LEARNING SCIENCE

By

Sunethra Karunaratne

The Project under study was a version of the national Family Science Program, modified to generate the interest, skills, and self-confidence of Hispanic students' in learning science. The purpose of this study was to answer, "How did the Lansing Family Science Project help disadvantaged children and parents build an interest in learning science?"

Two hour sessions were held in an after-school setting for about six to eight weeks during a semester. An innovation and a modification of the national Family Science Project was the use of "*at-risk*" middle-school students as "*Junior Scientists*" to assist the elementary children in doing the science activities. On Tuesday afternoons they practiced doing the science activities to be done on Thursdays with the children.

Qualitative research methods were used to study the interaction among participants. Participant attendance was a major criterion for selecting subjects for the study. All people who had more than 60 percent attendance in the two years of the study were selected to be study subjects. Thus, the population included twenty children, fifteen junior scientists, and six parents. All the subjects were interviewed two times, once at the beginning and again at the end of each year.

Detailed analysis of the audio-taped interviews, participant observations and the children's documented work found that all three groups--elementary, and middle-school students, and the parents--enjoyed doing hands-on science activities and developed many academic and social skills. They were able to develop higher self-esteem and positive attitudes toward science and scientists. In addition, the children and junior scientists learned the science concepts underlying the activities. Parents were pleased that they were now learning science that they had studied, but not been able to learn, many years ago. They also demonstrated that they had many skills to impart to their children in education. Obtaining parents' participation was a restraining factor for the success of the Project.

Dedication

I dedicate this dissertation to my beloved parents who always considered their children's education be their top priority.

ACKNOWLEDGMENTS

This study was possible due to the support given in many ways by several people. Although it is a hard task to mention how and by whom I was helped, I know I want to express my sincere gratitude to my dissertation research guidance committee members. Untiring support was given by my dissertation director, James Gallagher, who conducted long sessions with me, and encouraged me throughout this arduous process. Jim, above all, I value the moral support given by you and your wife, Barbara.

Joseph Levine, from the Agricultural Extension Department, served as the committee member, outside my department. Joe, The Nonformal Institute, in which I participated with you, gave me a lot of insight to see with an open eye the overall picture of my dissertation. In addition, I value your support in all other instances, even when I stopped by without having an appointment.

My special thanks go to Diana Marinez, by letting me use her project for my dissertation research, for the financial support, and for her treatment of me as a colleague. Diana, you provided a role model not only for your project participants, but also for me.

I am grateful to Richard Navarro in many respects. I was here at Michigan State University because I worked with him even when I was still in Sri Lanka. Richard, you and Emerald, and your children, Narcisa, Dominica, and Ricky, always considered me part of your family. Immense thanks goes to you!

Besides his work as the Assistant Dean for International Studies in the college, John Schwille spent his time having regular meetings with me, both professionally and personally, directing, guiding, and encouraging me in my work. Thank you Jack, for all of that and also for the financial support given to me so I could participate in international conferences.

Among the other people, I want to thank the principal of the elementary school, the children, the middle-school junior scientists, and the parents for their cooperative behavior when conducted my research. Special thanks should also go to Margie Gallego, Sandra Hollingsworth, Anne Schneller and Graciela Walker.

During my stay at Michigan State University, I received awards from the AAUW (American Association of University Women), the P.E.O.(Philanthropic Educational Organization) sisterhood, a Thoman fellowship, and a Global Young Scholars Pan-Disciplinary Conclave. Support from these institutions helped me not only financially, but also by giving me moral support and experience.

This study would not have been possible without the support given by the Julian Samora Research Institute. My thanks for the many and diverse forms of support cannot be expressed in only a few words. Many thanks to Refugio Rochin, Rosemary Aponte, Maria Moon, Eva Rodriguez, Jeanie Limon, and Lucinda Briones.

Last, but not least, my thanks go to Sue Ashcraft, doing a skillful job of proof reading in a very short time.

TABLE OF CONTENTS

	Page
LIST OF TABLES	xiii
LIAT OF FIGURES	xiv
CHAPTER	
I. INTRODUCTION	1
Rationale for the Study	3
Research Questions	5
Main Research Question	5
Specific Research Questions	5
Summary	13
Organization of the Dissertation	13
II. REVIEW OF LITERATURE	18
Minorities and the Disadvantaged	20
Forces that Contribute to Being Disadvantaged	22
Hispanics as a Minority Group	24
Cultural and Experiential Background	25
Economic Status	29
The Disadvantaged and Science	30
Disadvantages and Gender	33
Factors that Help Alleviate Being Disadvantaged	34
Parental Involvement	35
Peer Interaction	36
Nonformal Environment	38
Pedagogy	39
Collaborative Groupwork	40
Self-Esteem	43
Programs	44
California Bilingual Programs	45
KIDS (Kids Investigating and Discovering Science)	46
La Clase Magica: A Computer Assisted Literacy Program for Neighborhood Children	46
PLAN Program (Program: Learning According to Needs)	48
National Urban Coalition's Say YES Schools Project	48
New Haven Parental Involvement Program	49
I Have a Dream Program	50
Latino Parental Involvement in the Boston Public Schools	50
National Family Science Program	51

III. METHODS OF STUDY 53
Rationale for Methodology 54
Selection of the Site 54
Access to the Site 55
Field Techniques 56
Subjects of the Study 59
Data collection 60
Participant observations 60
Interviews 62
Documents 64
Data Analysis 65

IV. FAMILY SCIENCE PROJECT 67
Family Science Program 67
Family Science Program Goals 68
Structure of Sessions 71
Who trains Family Science Instructors 73
Lansing Family Science Project 74
Objectives of the Lansing Family Science Project 74
Evolution of the Lansing Family Science Project 74
Pilot Year 76
Afternoon session 77
Evening session 78
First Year 79
Second Year 80
Training Sessions of Junior Scientists 81
Family Science Sessions 85
What Did a Regular Family Science Session Looks like? 85
Venn Diagram 85
Estimation 87
Snack Time 87
Session Introduction 88
Activity Time 88
Wrap-Up Time 93
Summary 94

V. WHAT DID THE CHILDREN GAIN FROM THEIR IN THE PARTICIPATION IN THE FAMILY SCIENCE PROJECT 96
Assertion 1 97
Discussion 102
Assertion 2 105
1. Sarah 107
2. Luz 108
3. Julia 112
4. Rita 116
5. Kate 121
Discussion 124
Assertion 3 126
Discussion 137
Assertion 4 140
Manipulative skills 145
Discussion 147

Observation skills 148
Discussion 153
Prediction skills 155
Discussion 158
Estimation skills 158
Discussion 161
Classification skills 163
Discussion 164
Discovery skills 166
Discussion 167
Data recording skills 168
Discussion 169
Communication skills 169
Discussion 170
Assertion 5 172
Discussion 180
Analysis 180

VI. WHAT DID JUNIOR SCIENTISTS LEARN FROM THE FAMILY SCIENCE PROJECT 183
Who Were Junior Scientists? 184
Assertion 1 188
a) Perceptions of Scientists 190
b) Likes/Dislikes about Science 193
Discussion 201
Assertion 2 208
Discussion 220
Assertion 3 221
Discussion 231
Assertion 4 232
Discussion 242
Summary 243

VII. WHAT WERE THE PERCEPTIONS OF PARENTS ABOUT THE FAMILY SCIENCE PROJECT? 246
Assertion 1 247
Work 254
Rotating shifts in work 255
Child care 255
Taking classes 255
Sickness 257
Discussion 258
Assertion 2 261
1. Mr. Parker 264
2. Mrs. Briones 266
3. Mrs. Arizmendi 269
4. Mrs. Velasquez 271
Discussion 273
Assertion 3 277
Mrs. Martinez 278
Mrs. Briones 280
Discussion 281
Summary 286

VIII. HOW DID LEADERSHIP AFFECT THE FAMILY SCIENCE PROJECT? 288
The Family Science Project Director's Involvement in Outreach Activities 288
a) Kindergaten Scientist in Residence Project 289
b) Playtime Is Science 289
c) Fifth Grade Science with Friends Project 290
d) La Clase Magica: A Computer Assisted Literacy Program for Neighborhood Children 290
e) Community Lecture Series 291
f) Kelogg Biological Station Summer Camp for Migrant Children 292
Background of the Family Science Project Director 292
What Motivated Dr. Rodriguez to Become Active in Women and Minority Issues? 295
Why did the Project Director Start the Family Science Project? 299
How Did Dr. Rodriguez's Teaching Affect Behaviors? 304
What Kind of a Culture Is Needed to Bring About Successful Changes? 308

IX. CONCLUSIONS, RECOMMENDATIONS, AND IMPLICATIONS 318
Summary of the Study 318
Children 321
Junior Scientists 322
Parents 324
Leadership and Institutionalizatio 325
Conclusions 326
1. Context for Learning 326
2. Engagement 328
3. Enjoyment 331
4. Building Confidence 333
5. Social Norms 336
6. Junior Scientists 336
7. Parental Involvement 337
8. Learning Community 338
Recommendations for Further Research 339
Implications for Practice 341

Bibliography 344
Appendix I 356
Postscript 356
Appendix II, III, IV 361
Steps in Making Hot Air Balloons 361
Appendix V 364
Original Letter 364
Appendix VI 365
Pretest 365
Appendix VII 367
Survey Instrument 367
Appendix VIII 369
Pre Interview for students 369
Appendix IX 371
Pre Interview for Junior Scientits 371

Appendix X 373
Pre Interview for Parents 373
Appendix XI 375
Post Interview for Students 375
Appendix XII 377
Post Interview for Junior Scientists 377
Appendix XIII 380
Post Interview for Parents of Students 380
Appendix XIV 383
Post Interview for Parents of Junior Scientists 383
Appendix XV 385
Interview Guide for the Principal 386
Appendix XVI 387
Consent Forms

LIST OF TABLES

Table		Page
1	Subjects of the study	58
2	Distribution of Family Science sites	69
3	Group distribution	129
4	Activity/skills	142
5	Predictions vs observations	146
6	Estimations	160
7	Sinking and floating	162
8	Time (in secs.) taken to move a bubble of water through a maze	167
9	Background of first year junior scientists	186
10	Background of second year junior scientists	187
11	Likes/dislikes about science expressed by the second year junior scientists	191
12	Attendance of parents	253

LIST OF FIGURES

Page		Page
1	Who's most likely to become a scientist or engineer?	3
2	Historical perspective in defining equality of educational opportunity	6
3	Strategies of Professional Development Schools to overcome failures in attaining equality of educational opportunity	12
4	Conceptual framework	19
5	Venn diagram	86
6	Steps in making hot air balloons	92
7	Julia's scientist	114
8	Rita's scientist	119
9	Group distribution	128
10	Towers	132
11	Filter paper strip	151
12	Drops of food color on milk	156
13	A scientist	177
14	A scientist	178
15	A scientist	178
16	Kasey's scientist	192
17	At-risk model	207
18	Ramiro's scientist	230
19	steps in making race cars	234
20	Families attended the Family Science Project	287
21	A scientist	309

CHAPTER I

INTRODUCTION

> *This experience so enraged me that I have continued to remain enraged at the fact that if this was happening to my kid, and I had the education and the money to intervene, what was happening to poor children whose parents were not educated and didn't have the money to intervene!*
>
> *I was already committed to assuring equal educational opportunities for women and minorities in science. But this experience strengthened my resolve and made me refocus at the early grade levels so that we could intervene prior to children falling behind* (10/28/93).

The Family Science Project Director, Dr. Maria Rodriguez, made the above quote when she was interviewed as to how she became involved in the Project. She had two daughters. During her oldest daughter's kindergarten experience, the family was called in for a conference because their daughter was not learning to read and also could not sit still for long periods of time. While they realized that she was not academically successful, they knew that she was bright and verbal, and had social skills beyond her years. They were also concerned with identifying what was interfering with her learning. Since they lived in a high-income community with many educated individuals, they did not expect to

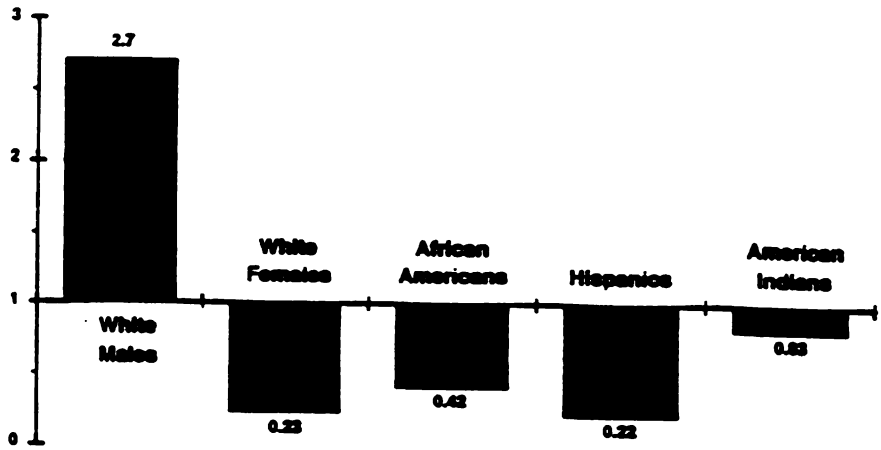
find that the explanation for her inability to learn to read was based on her being the child of a working mother and language minority parents. Although the teachers couched their questions in assuring the parents that they were looking at all possibilities, it was evident that even though the teachers knew who the parents were and where they worked, they believed that speaking a language other than English interfered with her learning to read English. However, their daughter did not even speak Spanish. The teachers knew from their interactions with the daughter that she was English dominant and very verbal, with an extensive vocabulary. Then it was interpreted that having a working mother meant that she spent less time with her children than a non-working mother. What they did not know was that she was the first grandchild in a family of eleven children (her father was the oldest), and she not only had attention from her parents, but also from the extended family.

This first, but not the last, experience in attempting to discover why their very bright and verbal daughter was not learning to read revealed to Dr. Rodriguez in a very personal way that in spite of their progress, Hispanics were still viewed as being second-class citizens whose language got in the way of learning. Dr. Rodriguez realized that without skills and money their daughter's future was doomed to go along

the same path as that of a good majority of other minority children.

Rationale for the Study

The opening quote shows an example of how a Hispanic girl was discriminated against. Research shows that American schools are being blamed for not providing equal opportunities to all students (Bowles & Gintis, 1976; Goodlad, 1984; Oakes, 1985). Minority groups, especially Hispanics, do not receive the same treatment as the dominant group of society, that is, whites, in the public schools (Kozol,1991). The possibility of becoming a scientist is very low for Hispanics, especially Hispanic girls (Figure 1).



The numbers compare each group's representation among engineers and scientists in the workforce with its representation in the adult population as a whole. For example, there are nearly three times (2.7) as many white male engineers and scientists and only about one-quarter (.23) as many white female engineers and scientists in the workforce as expected given each group's representation in the adult population.

Figure 1 Who's most likely to become a scientist or engineer? (Source: National Research Council, Washington DC., 1989)

Many elementary teachers do not have the necessary credentials to teach science (Mullis & Jenkins, 1988). More importantly, many are both academically and psychologically unprepared to teach this subject. This keeps them from effectively teaching science at the elementary level. To adapt to modern society and to lead a better life, all students need a background in science and technology. Interest in science needs to be developed in the very early stages of childhood. If it started very early, even before the children come to school, they start making successful connections between their everyday life activities and what they encounter in the daily science activities. These connections help children to approach scientific discoveries with an open mind. As Linn (1994) suggests, we need a culturally relevant, hands-on inquiry method of science for all students, so that the minority and low SES (Socio Economic Status) students get the opportunities to make connections between their experiences and what they learn in school.

The Family Science Project in Lansing was an innovative program designed to alleviate the disadvantages experienced by Hispanics, especially Hispanic girls, in learning science. Family Science was presented as an after-school program for elementary students and their parents by a Hispanic female professor. The students would work in small groups

doing hands-on science activities. A group of Hispanic middle school children called "junior scientists," assisted them in the activities.

Research Questions

Main Research Question

The primary research question which guided this research was: How did the Family Science Project help disadvantaged children and parents build an interest in learning science?

To help answer this general question, three specific questions were asked.

Specific Research Questions

1. What did elementary school children gain from participation in the Family Science Project?
2. What did middle school "junior scientists," who assisted with the program's implementation, gain from the Family Science Project?
3. What were the perceptions of the parents about learning science and the Family Science Project?

The main research question guiding this study is imbedded in the big issue of attaining educational equality. Hence, an overview of the historical analysis of "equality of educational opportunity" is provided to

present the theory that the definition of equality of educational opportunity has changed from a narrow to a broader definition as society has changed (see Figure 2), and that the goal of achieving equal education opportunities has not been met, except on a limited basis. When considering American schools, it is very clear that the definition of equality of educational opportunity has been understood and used in different ways by different people during different historical periods. Figure 2 shows how different categories were added on in order to better define equality of educational opportunity.

Narrow	1800	**a** = white, middle-class, male students
	1840s	**a+b** = providing a school for all children
	1870-1920s	**a+b+c** = Americanizing the immigrants
	1930s	**a+b+c+d** = providing opportunities for female students
	1950s	**a+b+c+d+e** = providing opportunities for different races and cultures
	1970s	**a+b+c+d+e+f** = providing opportunities for handicapped students
	1980s	**a+b+c+d+e+f+g** = students of different backgrounds
Broad	1990s	providing opportunities for students from different ethnic, racial, religious, cultural, ability, socio-economic status, gender, geographical locations, and urban/rural backgrounds.

Figure 2 Historical perspective in defining equality of educational opportunity

In the early 1800s, American schools were more or less homogeneous, with a population of white, middle-class male students (Katz, 1978). The people who were involved in making changes in schools were from the middle class, and their definition of equality of educational opportunities was meant to provide benefits for white middle-class students. Although there were a variety of culturally different American Indian tribes and African slaves in the country, they were not considered to be part of society. In addition to this, female children and children from lower socio-economic classes were also excluded. During this period, "all" meant only white, male, middle-class children (Katz, 1978).

When the common schools were established in 1840 by the efforts of Horace Mann and other crusaders for the common school, their objective was to provide free education at the elementary level. Education was seen by them as the great political and intellectual equalizer. The purpose of providing equal educational opportunity was meant to provide schools for everybody (Church & Sedlak, 1976), thereby helping the success of democracy (Labaree, 1987). Merely providing a school does not provide equality of educational opportunities, because within the same school structure students may receive different treatment, and hence, the education they receive is not "common" or equal (Cohen, 1984).

When the massive immigration to America occurred from 1840 to 1920, thirty to forty million people entered the country. Hence, there was an urgent need to overcome the problems of overcrowded urban ghettos, increased crime, and political corruption. At that time, the authoritative group believed that Americanizing immigrants would help solve most of the problems. The need was to produce "good" citizens, and achieving equality of educational opportunities meant socializing the immigrants to the dominant culture. Schools served this socialization function. During this period, the purpose was to bring about morality (Kaestle, 1983), which promised many benefits, such as good work habits, deference to adults, restraint from bad habits, and reduction of crime.

Although female students were considered to need an education, this education to that needed was to be limited, to serve as "good mothers and house wives" in the future. The opportunity for female students to achieve an education has increased since the 1930s, but studies over the years have indicated that minority and women are underrepresented in specialized talent fields, which training begins early in the educational process (Gorneck, 1983; Linn, 1994).

In the 1950s, with the initiation of desegregation, the definition of educational opportunity was further

expanded to consider students of different racial and cultural backgrounds.

In the 1960s there was a great concern about improving science education. At this time, equality of educational opportunity was defined in terms of subject matter. Today, American schools have to serve the needs of children from different ethnic, racial, religious, ability (both mental and physical), socio-economic status, gender, geographical, urban/rural, and cultural groups.

Contemporary research shows that the internal practices of public schools do not provide equal opportunities for all students (Labaree, 1987; Oakes, 1985; Bowles & Gintis, 1976). They argue that American public schools paradoxically promote both equality and inequality.

All students should have access to the same kind of knowledge, skills, and attitudes through a common curriculum, and they also should be exposed to equal opportunities to receive any kind of job in society. As Bowles and Gintis (1976) say, schools themselves are instrumental in the failure to achieve equality of educational opportunities due to social reproduction. Public schools reflect the structure of the wider society. When the wider society has a system of stratifying social classes, it is very difficult to

bring about equal opportunity for all students in the public schools.

Sorting children according to some criteria or standard begins early in the students' lives, legitimated by subtle and overt interpretations of the students' abilities. Ogbu (1974) discusses how the same remarks in the report cards of students were carried through for five years. Sorting children according to their performance on standardized tests is a way to legitimate inequalities in the education system. Fairness of this kind of testing depends on how it measures the true aptitude or achievement of students. If the tests are constructed favoring a particular societal group, then there is no fairness in using these tests to establish the sorting criteria.

Tracking is another way to legitimate the inequalities of students. Students are labeled at the very beginning as "fast" or "slow" learners. Fast learners are given gifted and talented programs which continue in the college-preparatory academic track in high school. Slow learners are given watered-down content, drillwork on disconnected reading passages, and fill-in-the-blank exercises.

"Giftedness" is a label given by the school to legitimate what the school does with a politically and socially constructed notion. Oakes (1985) and Goodlad (1984) emphasize that the low aptitude of students in

the low track is not because of intellectual weakness, but rather is the result of poor quality instruction, as well as less actual instruction time. The low track students have low aspirations and feel more negative about themselves (Oakes, 1985; Rist, 1970). This method of categorizing students helps maintain the society's class structure by offering white collar jobs only to those students who have the right credentials.

Having a common curriculum does not guarantee provision of equal educational opportunities. Anyon's (1981) study provided an example of how students from different social classes are treated differently, and thus receive different kinds of knowledge, despite having the same curriculum. Students from lower-class backgrounds are regularly denied access to middle-class knowledge that would encourage them to think critically about the world around them and empower them to act in their best interests. "Middle-class knowledge" emphasizes the abstract and the theoretical instead of the concrete and practical, thus maintaining the status quo of "cultural capital" of the society. Thus, schools mirror the social stratification of the wider society without promoting education equality.

Even today, the majority of public school teachers are whites. Most of them are not trained to handle a group of diverse learners (Kennedy, 1992). They are not aware of minority and working class group cultures, or

the problems encountered by minority and working class children. Ogbu (1991) suggests that the persistent failure of minority groups is not due to teaching or uncooperative students, but is instead related to the ways in which majority groups have treated them and how the minorities have responded to that treatment.

FAILURE	STRATEGIES TO COMBAT FAILURES
Standardized tests	Ongoing assessments, portfolios, mastery learning
Tracking	All students work together with adults
Labels, categories, predictions of students' ability	All students work as equals, respecting others' ideas during "conversation/dialogue"
Different knowledge groups for different social classes	Knowledge developed through dialogue
Different treatment of different racial groups	Developing shared conceptions
Credential selling	Promoting inquiry
Bureaucratic administrative structure	Teacher's authority not visible
Bureaucratic physical structure	All work together in groups
Poor teacher attitudes	Giving courses about diversity, working with university professors, community members and business people

Figure 3 Strategies of Professional Development Schools to overcome failures in attaining equality of educational opportunity

The Holmes Group created Professional Development Schools (PDS) to implement the principles of partnership. Of the six principles of PDS, in this study I refer to the principle that focuses on teaching and learning for understanding for every child. I summarize in Figure 3, the strategies suggested by the Holmes Group for overcoming existing failures in American educational system so as to achieve equality of educational opportunity.

Summary

Providing equal opportunities for all groups of children has never happened in multicultural American society. History provides evidence of expanding education's focus in order to achieve educational equality. Even today minority groups are subject to inequalities in educational opportunities due to the large institutional structure of schools, and the treatment schools afford minority groups. Attempts have been made to overcome the inequalities experienced by minority groups.

Organization of the Dissertation

In this chapter, a background was provided to state the problem of disadvantaged groups not receiving equal

educational opportunities. An overview is given below of how the other chapters are organized.

Chapter 2: Review of Literature. In this chapter, literature is reviewed in that area of research which discusses the place of minority groups in American society due to the career opportunities received so far, and the minorities' socio-economic status. A description is given of how minorities were discriminated as a race. Gender in the American schools, and Hispanics as a disadvantaged group, are also discussed. The programs or educational reforms that have taken place to overcome these disadvantages, and those characteristics considered to be nonadvantageous are presented. In the final section of this chapter I discuss the successes or failures of these programs, and how successful it would be to have a program like Family Science in order to build interest in science.

Chapter 3: Methods of Study. This chapter describes the methodology used to study the perceptions of the Family Science Project participants. First the selection of the site, and then access to the site, are described.

Second, the subjects of the study are described. Subjects were three types; namely, the elementary

children who participated in the Project (20), the junior scientists from the middle school (15), and the parents (5).

Third, the data sources and collection methods are described. As it is necessary to use multiple methods and sources of data in order to get a clear understanding of what is happening in a particular setting, data sources included the participants' observations, pre-and post-interviews with the children, junior scientists and parents, responses to a survey instrument, and documents. Some of the changes occurring during the growth of the Family Science Project since the pilot study are described.

Fourth, data analysis and the organization for data analysis are described. Data collected by different sources may have different meanings; hence, data from all sources were triangulated in order to minimize biases and produce an integrated whole, so as to understand what happened in the sessions.

Chapter 4: Family Science Project. This chapter describes the history, goals, structure, and distribution of the national Family Science Program. Then the Family Science Project in Lansing and its evolution during a three-year period are described. Modifications from the National Family Science Program in the Lansing Project, its objectives, clientele,

session structure, and conducting a typical Family Science session are also presented.

Chapter 5: What Did Elementary School Children Gain from Participation in the Family Science Project? In this chapter how children developed skills, understanding, and positive attitudes toward science, and how they also realized their potential to do science and be scientists by engaging in hands-on science activities in the Family Science sessions are discussed under five assertions.

Chapter 6: What Did Middle School "Junior Scientists" Who Assisted with the Program's Implementation, Gain from the Family Science Project? In this chapter the roles that the junior scientists played, their interactions with the children and their parents, what qualities and skills they developed in performing their role, and perception of the parents about their child's contribution to their school work due to their participation in the Project are discussed under four assertions.

Chapter 7: What Were the Perceptions of Parents About Learning Science and the Family Science Project? In this chapter how parents of Family Science session attendees perceived their children's participation in

the Project and the changes in themselves, and how much of their expectations were achieved are discussed under three assertions.

Chapter 8: How did Leadership Affect the Family Science Project? This chapter provides a brief biography of the Project Director, describes the leadership provided by her in implementing the Family Science Project, and discusses the importance of having strong leadership when implementing such a program.

Chapter 9: Conclusions, Recommendations, and Research Implications. In the first part of this chapter a summary of the study, and conclusions drawn from the study, are presented. Then recommendations for further research, and research implications of the study are discussed.

CHAPTER II

REVIEW OF LITERATURE

This chapter discusses the research literature pertaining to the study's question, "How did the Family Science Project help disadvantaged groups build interest in learning science?" When I stated the problem to be examined in this paper in Chapter 1, I gave some background information showing that minority groups do not receive the same equal educational opportunities as the dominant society, that is Anglo-Americans. In this chapter, I first discuss the relationship between being a minority and being disadvantaged, then I examine the forces that contribute to being disadvantaged. In seeking evidence to answer the research question guiding this study, I organized the factors that help alleviate being disadvantaged under several subheadings, such as collaborative group work, parental involvement, peer interaction, pedagogy, and nonformal environment, as indicated in the conceptual framework (Figure 4). The final section of this chapter describes programs that attempt to alleviate some of the disadvantages experienced by minority children.

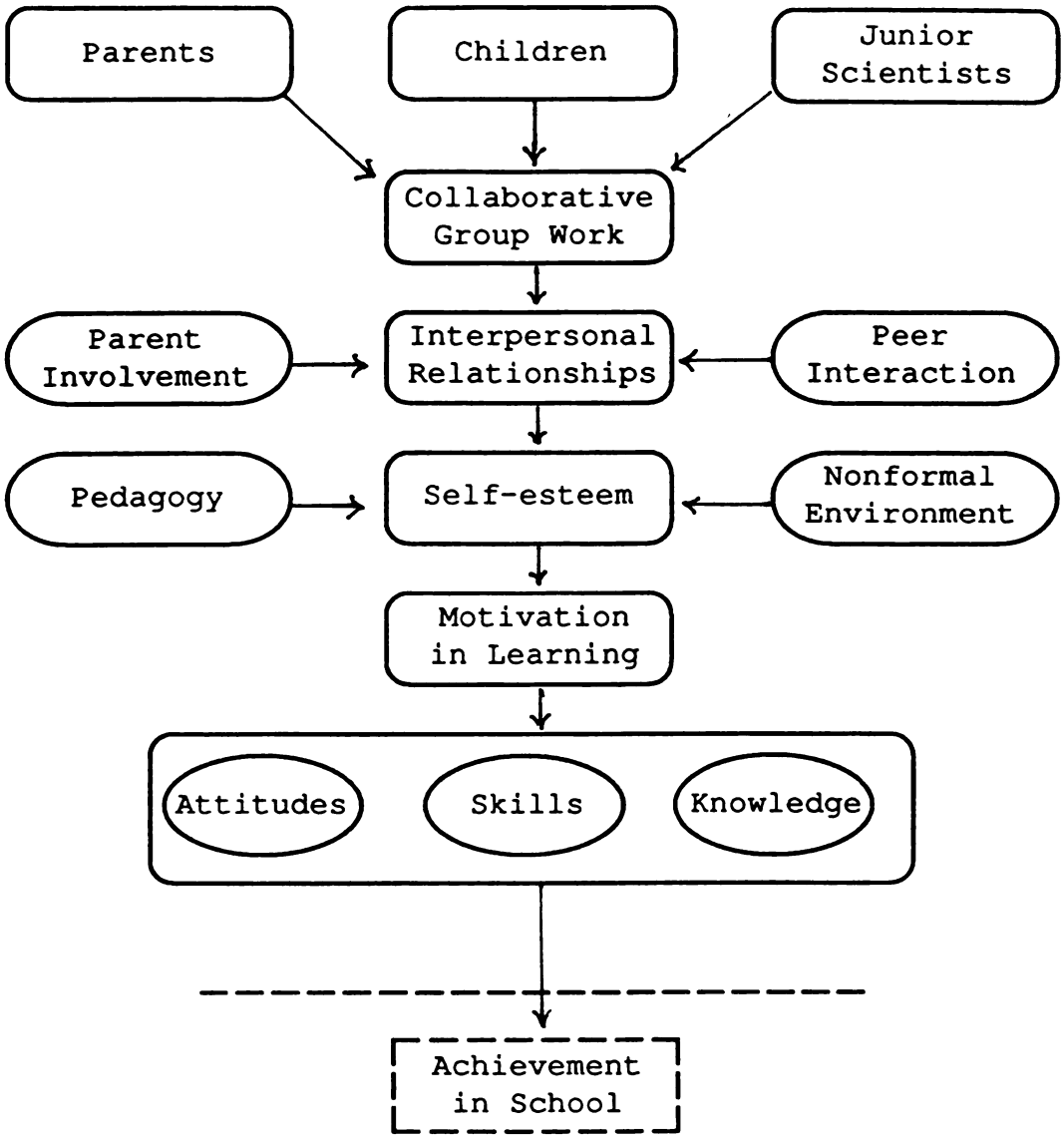


Figure 4 Conceptual framework

Minorities and the Disadvantaged

Research shows that children of different minority groups are considered to be members of a disadvantaged group (Burris, 1990; Chapa & Valencia, 1993; Samora, 1966; Treuba, 1989; Valencia, 1991). Many disadvantaged children can be considered culturally or experientially "deprived" only when measured by standards set by the dominant society. Sometimes the terms "culturally deprived", "underprivileged", "disadvantaged", "lower class", and "lower socio-economic group" are used synonymously. Fantini and Weinstein (1968) extend this synonymity to such terms as "culturally different", "working class", "slum culture", "inner-city dwellers", "culturally impoverished", "experientially deprived", "culturally handicapped", "educationally disadvantaged", "children of the poor", and many more. It appears that the definition of "disadvantaged" is very complex.

While there is a considerable overlap between minority and disadvantaged populations, the two are not synonymous (Burris, 1990.) According to Passow (1986), the term "disadvantaged" has two aspects with respect to compensatory education efforts: economic disadvantaged, which is operationally defined in terms of poverty, and educational disadvantaged, which is operationally defined in terms of below-average academic achievement. There are minority children who achieve academically, whose families do not live below the poverty level, and

who are neither economically nor educationally disadvantaged. According to Ogbu (1978) they are the *disadvantaged gifted*. This study does not focus on disadvantaged gifted students.

Ogbu (1986 & 1991) suggests that the persistent failure of minority groups in education is not due to bad teaching or uncooperative students, but rather is related to ways in which majority groups treat specific minorities. He distinguishes between three types of minorities: a) autonomous, "those who possess distinct group identity or sense of peoplehood, based on cultural, language, racial or religious differences with the dominant group" e.g., Amish, Jews; b) immigrants, "people who have recently moved more or less voluntarily to their host society;" and c) castelike or subordinate minorities "who have been incorporated to the society where they are found more or less involuntarily and permanently through slavery, conquest, colonization, e.g., Mexican Americans, native Americans, and American blacks."

According to Ogbu (1985), both the autonomous and immigrant minority groups comprise the disadvantaged gifted group. The autonomous group generally achieves at very high levels in school and in society as a whole, because they actualize a conscious choice to be different. They often consider themselves to be superior in some way to the surrounding majority

population. Immigrants generally do very well in schools and society as a whole for several reasons. They usually compare their standard of living, their overall wealth, or increased political freedom with what was the norm in their country of origin, and realize how much more opportunity is to be found here. These motivating factors continue to exert an influence on immigrants' adaptive strategies in their new host country and enable them to succeed. They are not threatened by learning the culture, language, or life style of the host nation since they can successfully accommodate to the new while retaining the best of their own cultural heritage, for example, Chinese and other Asian populations.

Involuntary minorities, on the other hand, have been forced to drop their language, culture and lifestyle in order to work in America. According to Ogbu (1985), they have been forced to live in the U.S., and so they resist their masters in subtle and indirect ways by creating and using a language of their own, "substandard" English; deliberately failing in the educational system; and creating alternative economic systems with the resources at hand.

Forces that Contribute to being Disadvantaged

Different authors have given different definitions for "disadvantaged." According to Fantini and

Weinstein, (1968), any child who receives an inadequate, irrelevant, or out-dated curriculum is disadvantaged. In stating the problem to be examined in Chapter 1, I described how minority groups do not receive equality of educational opportunities; hence they could be considered disadvantaged. Based on research findings, I also provided the factors such as the existing curriculum, tracking procedures, and the organization and structure of schools that help perpetuate an unjust social order for minority groups.

One theme often expressed in the literature concerned with the education of disadvantaged minorities is that their poor academic performance reflects the low value they have learned to associate with academic tasks. In the case of blacks, a significant proportion of whom can be categorized as economically disadvantaged, genetic factors have been advanced to account for this underachievement (Jensen, 1969). Others have attempted to isolate cultural or social-situational determinants of underachievement among minorities (Bond, 1972).

The economic status, cultural and experiential background, family stability, race and ethnicity are all forces which help shape one's advantage or disadvantage. One may be deprived due to one or a combination of theses forces, and the degree of being disadvantaged varies depending on the number of forces interacting on

an individual. In the following section I discuss how the tendency to be "disadvantaged" is higher when one is in a minority group. The subheadings Hispanics as a minority group, cultural and experiential background, economic status, and disadvantages in science and gender will be utilized to further delineate the topic.

Hispanics as a Minority Group. Although Hispanics use Spanish as their vernacular and share such important characteristics as strong family ties and a strong Catholic tradition, they are not a homogeneous group (Pena, 1989). They constitute about 60 percent Mexican Americans, 14 percent Puerto Rican Americans, 6 percent Cuban Americans, and 20 percent other Hispanics of South American origin (Pena, 1989).

Pe'rez and Dela Rosa Salazar (1993) suggest that by the year 2000, the Chicano/Latino student population will account for the majority of the overall national youth growth, due to their rapid population grwth. Lambourne and Baca Zinn (1993) report that the Latino population is growing five times faster than the rate for the rest of the population, due to the young age structure, high birth rate, and continued immigration. Riche (1991) predicts that there will be a demographic transition from an Anglo-white society rooted in western culture to a world society characterized by three large racial/ethnic minorities. This indicates that the

majority of students in the 21st century are going to be minorities. By the year 2000, Hispanics will constitute a greater share of American school children--about sixteen percent (Valdivieso & Davis, 1988). It is also reported that this group of the student population has the highest rate of high school dropouts (Valencia, 1991). Based on 1990 census data, Chapa and Valencia (1993) report that, compared to non-Hispanics (79.6% completing high school), the high school completion rate of Hispanics is low (50.8%). Of the various Hispanic groups, the Mexican-origin subgroup has the lowest high school completion rate (44%).

Cultural and Experiential Background. Compared to many countries in the world, America is a land of immigrants. Historically speaking, American Indian tribes were the early settlers, who even today are not culturally integrated into modern American life. According to Burris (1990,) after the settlement of the European immigrants, African Negroes were imported to America by these settlers. These Africans brought with them not only their African culture, but they also developed their own distinct cultural system in the midst of the dominant European culture. Later immigrant groups were composed of Asians, Germans, Swedes, Italians, Irish, European Jews, Puerto Ricans, and

Mexicans. Each of these diverse cultural groups had their own ways of doing, and looking at things.

Within a given urban neighborhood several distinct cultures often exist side-by-side, that is, Negro (black), Mexican, Puerto Rican, Irish, Italian and so forth have different cultures. Rakow (1985) describes that the cultural disadvantaged in the United States generally live in geographical patterns. In the South, and in the most of the urban areas of the North, the culturally disadvantaged center primarily on African Americans. Mexican Americans along the border states in Texas and California, the Puerto Ricans in New York, and the American Indians in the Southwest are also culturally different from the mainstream culture. These different groups celebrate their cultural activities either separately, or, in some cities Detroit, as a group effort as part of "Cultural week," where each day of the week one cultural group celebrates their culture by presenting different equipment, clothes and food, and performing cultural activities such as dances and plays.

Considering Vygotsky's (1986) premise regarding the impact of culture on a child's development, he felt that culture plays a very important role in a child's education. Cultural differences are important determinants of what is taught and learned in educational settings. All groups of people have a culture of some sort. For Vygotsky and his followers

human development is intrinsically social and educational. It is the acquisition of one's culture, including the practices and the symbol systems of the culture, that makes possible creative thought and activity (Edwards & Mercer, 1987).

Every child learns her/his culture; if s/he happens to belong to a subculture, this is what s/he learns, that is what s/he experiences. A child's experiences are many and varied, but these are not necessarily the experiences which the formal educational process recognizes, or are valued by the dominant culture. As with Anyon (1981), what minorities learn in school does not challenge their experiences and prior knowledge so they can make connections from what they learn to what they know so as to build up new knowledge. Each child brings her/his individual set of abilities, and prior knowledge and experiences to the classroom. But for children who do not belong to the mainstream Anglo culture, they find it difficult to make any connections to the things they are doing in the classroom because of the differences in their home and school culture.

Some authors have found that, due to the differences between the culture of the school and that found in the home, schooling becomes a discontinuous process for most children who do not belong to the mainstream Anglo group (Delgado-Gaitan, 1991). Lareau (1989) points out that the families living in poor

socio-economic conditions often face sustained isolation from the school culture, which might lead to miscommunications between the school and the parents. This miscommunication affects the children's education through the parents' resentment and apathy. Since schools require the participation of parents for activities which need a specific, culturally-based knowledge, it closes the door for minorities and disadvantaged groups.

Treuba (1989) points out that culturally different students who are not successful in cultural adjustment face obstacles to their success in school. Although there is an incongruency of minority culture and school culture, all minority groups, no matter what their origin, also possess rich and complex cultures of their own. But these cultures serve to set them further apart from middle-class American life. The American education system has not taken into account the benefit of integrating different groups' cultural values into its curricula. As Cheek (1989) points out, the tendency to view the dominant culture as positive and other cultures as negative hypothesizes that, by transforming the latter into the former, the whole problem of the disadvantaged will disappear. Looking back at American history, this was the vision that was held by American educators in the early 1900s, who thought that

Americanizing immigrants would help produce democratic citizens.

Economic status. Glick (1971) says that in the United States, two ethnic or racial groups, blacks and Hispanics, are distinguished by their inferior economic status when compared to the nation as a whole. Considering the economic standards, the probability of getting a good job is very limited for one in a minority group. He further says that Hispanics are underrepresented in federal employment in some states; Hispanics and blacks dominate low-skill jobs. If a person does not hold a good job, his level of income is very low, thus leading to economic hardship to have the basic items for living, such as buying adequate food, shelter or clothing, which apparently forces them to ignore the education of their children. It also prevents them from being involved in social and enrichment activities, which does not help them to experience a social life. Poverty and poor education are interrelated. Hence, the affluent get the best that an inadequate education system can offer while the poor get the very worst.

By and large schools are not ready for the disadvantaged poor, and they are also not ready for the schools (Scarpitti & Andersen, 1992). Unlike a child from the middle-class, when a minority child enters

school, s/he moves into a different world, one which mirrors the society from which s/he is cut off, and which evaluates her/him in the same degrading terms as the society to which they belong. For the first time the child feels that s/he is not a part of that community, and so develops an alienated feeling. This causes children of minority and lower economic groups to have low self-esteem.

The Disadvantaged and Science. The National Science Foundation's studies (1980, 1982) on degrees granted to women and other minority students in such fields as engineering, computer science, mathematics, physical science, biological science, psychology, and social science, clearly indicate that there is a continuing underrepresentation of most of these groups in most areas, especially at advanced levels. Only Asian Americans were represented at least in proportion to their numbers in the population as a whole, and were, in fact, *overrepresented* in some areas.

However, Crowley and Melissa (1986) argue that minorities are better represented today in science and technological fields than in the past. Fewer than 1 percent of all practicing scientists are Hispanics. In engineering, Hispanics represent only 3.2 percent of all full-time undergraduate students, 1.2 percent of all masters students, and only .7 percent of doctoral

students (ERIC, 1981). Hispanics comprise 9 percent, and blacks 12.1 percent of the total US. population (URL, 1995). Of the U.S. doctoral students in the sciences, there are only 1.3 percent blacks, while Asians, by contrast, are 7.7 percent of the science doctoral students, yet represent only 1.5 percent of the U.S. population (U.S. Department of Commerce, 1986).

A study conducted by the Research Triangle Institute (1988) on the pre-college science achievement of American youths versus their counterparts in sixteen other countries (Australia, Canada, Great Britain, Finland, Hong Kong, Hungary, Italy, Japan, South Korea, the Netherlands, Norway, the Philippines, Poland, Singapore, Sweden, and Thailand) shows that U.S. fourth and fifth graders ranked below half the other nations in science achievement. Results in the upper grades were even worse. They concluded that a majority of students at all levels within the American education system take the absolute minimum number of science and math courses required for graduation from that particular level of the system.

Considering American students as a whole, it appears that in the midst of an increasingly scientific and technologically-oriented culture, Americans are losing their understanding of the very technological and scientific principles and processes exemplified in artifacts of everyday life. Along this same line of

argument, although we do not see it, the middle class is also disadvantaged in learning science and technology. If it is happening to middle-class children, then the question is, "What kind of disadvantages are experienced by minority children?"

Historically speaking, science was considered a subject for the dominant culture and the elite group. Cheek (1989) reports that a study done by the Minnesota Science Assessment and Research Project (1985) reveals that at age 9, whites scored approximately 12 percent higher than blacks or Hispanics in science. Sixty two percent of whites reported experiences with science apparatus or science activities in their classes, while only 57.6 percent of the blacks and 57.6 percent of the Hispanics reported such experiences. He points out that in a school with more than 50 percent Hispanic and black population, not a single Hispanic or black was enrolled in physics. In a study conducted by Stanley and Greenwood (1983), in Title I and non-Title I (31% Black & 69% Caucasian) it was found that instruction in both school groups provided relatively infrequent amounts of academic response time and that this time was significantly lower among minority students in the Title I schools (all black students). It is a meritocratic belief that students are free to choose whatever electives they wish from a wide variety of curricular options (Cusick, 1983). The competencies are organized

hierarchically, and low track students are provided with a qualitatively different type of instruction which never enables them to achieve the same goals set for the higher track students, basically white, middle-class students (Oakes, 1985; Anyon, 1981).

Disadvantages and Gender. Studies over the years have indicated that minority and female underrepresentation in fields requiring specialized talent begins early in the educational process--courses pursued in secondary schools tend not to be college-preparatory, minorities and women are less likely to be identified for programs for the gifted, and the dropout rate is substantially higher for most minorities. According to the National Research Council (1989) study, in 1981 there were only 4,809 minority women who held doctorates in the science and engineering. Although this is a larger percentage of doctorates in science and engineering fields than in any of the other fields of existing U.S. doctoral students in 1981, the employment rate of science and engineering Ph.D.'s showed that there were lower full-time employment rates and higher rates of unemployment for *all* minority groups when compared with Anglo-American male scientists.

Grew (1986) reports that gains made by women and other minority doctoral students in recent years have been due in large part to federal funding that has

fueled efforts to attract and retain minorities in higher education in the sciences and engineering. He further states that money alone will not solve the problems, because deeply embedded social and cultural factors cannot easily be addressed by "throwing" money at the problem. Major impediments for increased participation by minority women, for example, include not only the gender stereotyped differential treatment women receive, but also the differential treatment received due to being a member of minority group in America (Grew, 1986).

Factors that Help Alleviate Being Disadvantaged

There are three key agents of socialization--the family, the neighborhood, and the sibling and peer groups. In schools there is a formal curriculum which is divided into classroom units. Although there is a hidden curriculum in the schools, the hidden curriculum at home is divided into family units. Just as the school curriculum produces a student culture, the hidden curriculum at home and in the neighborhood produces a sibling and peer culture. Further, just as the formal curriculum has a key teaching agent, the teacher, the hidden curriculum at home also has a key agent, the parent.

Parental Involvement. Iverson and Walberg (1982) state that ability and achievement are more closely linked to the socio-psychological environment and intellectual stimulation found in the home than they are to parental socio-economic status indicators such as occupation and amount of education. Because of the obvious importance of the parent to the shaping of a child's development, it is very necessary to link the continuous support given to the child in her/his school work and to the teacher. Baker and Stevenson (1986) note that better educated mothers tend to be better managers of their child's school career. While mothers provide security, understanding, and patterns for the child's speech, fathers provide opportunities for their children to socialize through games, conversation, and other, often more physical, activities in which male interests and feelings are projected. Baker and Stevenson (1986) also note that the effective influence of parents is cumulative and cannot be measured or at only one evaluated point in the child's academic career. Bronfenbrenner (1986) warns about the erosion of the essential institutions for human development, one of which is the family, and the other is the increasing number of single parent families.

Both the formal curriculum and the larger hidden curriculum serve to teach and socialize the child, and equip her/him with the skills, knowledge, and attitudes

which will underlie her/his adult functioning in the society. An important thing to note is that if the formal curriculum is to achieve its purpose, it must be consistent with, or at least accommodating of, the learning imparted by the hidden curriculum, and how it is taught.

Contemporary research has revealed the need for parental involvement in order to promote children's success in school (Beane, 1990; Delgado-Gaitan & Treuba, 1991; Fehrmann et al., 1987; Henderson, 1987; Rich, 1987). Parents of ethnically and linguistically diverse students, however, often fail to participate in the schools in numbers comparable to the majority group parents (Delgado-Gaitan, 1990). McCaleb (1994) states that although many schools encourage community input, many minority parents are intimidated by the large institutional structure of the school and schooling itself, and which prevents them from participating in school activities.

Peer Interaction. Peer participation can be both a positive and a negative force in a child's academic achievement. Beane and Lipka (1986) discuss three types of peer interaction in the success of schools: positive, neutral and negative. If the peers value school success, then the interaction leads to positive self-esteem. If some members of the peer group value school

success and some value social success, then that kind of interaction leads to neutral effects on one's self-esteem. If the peers devalue school success then it results in negative self-esteem.

Harris and Aldridge (1983a) present a model for peer tutoring, with three members in each group. They discuss (1983b) reasons given by teachers why peer tutoring did not work in their classrooms. Some of the reasons were: Teachers felt threatened when pupils taught; thinking that the peer tutors might teach something wrong; brighter students could get held back; "blind leading the blind"; behavior problems; and the parents might object. Harris and Aldridge (1983b), suggest that teachers need to believe that their students will follow them (the teachers) as the role model for their teaching. Also, students can share their frustrations better with their peers than with a teacher. Furthermore, they say that if a more capable peer helps less capable ones, then s/he develops more understanding of the subject matter when they try to explain things to less capable students.

Okawa (1988) says that, compared to other settings, peer tutoring works best in environments that have culturally diverse members.

Nonformal Environment. In a regular school, the classroom environment the teacher has the power and authority and students tend to be passive learners (Freire, 1970). Compared to this formal environment, nonformal environments allow students to be active participants by doing things, carrying on discussions, and so forth. An adult or an older student facilitates the activities. In informal settings the learners do not receive assistance, they learn through their experiences.

The after-school environment, where children can learn by doing things with their parents, is a nonformal environment. This kind of an environment helps children by doing hands-on science activities to develop science process skills. In addition to the science process skills that the children develop, they also develop communication skills by reporting findings and sharing ideas among group members and other groups. The interactions that occur in a nonformal setting with peers help develop good attitudes toward science (Sheriff et al., 1965).

From her/his birth, the child's environment has a strong effect upon her/his development. As an infant, of course, the child sees little of this environment and is probably aware of it even less. S/he is affected by it nonetheless, if only through its effects on her/his parents. As the child grows, the neighborhood begins to

affect her/him more directly. The adults the child sees, the child's relationship with parents of other children, and their roles in the neighborhood all serve to shape her/his developing view of the world, and to comprise a substantial part of her/his hidden curriculum. The setting of the hidden curriculum may vary, especially for the disadvantaged child.

Because of the similarities in the home backgrounds and culture, and the language they speak at home (Bernstein, 1971; Edwards, 1976), peer participation is high in nonformal environments. Mutual understanding and cooperation can overcome the obstacles that might discourage peer participation, as discussed by Harris and Aldridge (1983). Developing a good self-concept, confidence, high self-esteem, good attitudes, and science process and communication skills enable minority children to overcome some of their disadvantages in learning science.

Pedagogy. In intervention models, the power and authority that a teacher exercises in a regular classroom should be minimized. As mentioned earlier, the parents of disadvantaged groups are especially intimidated by the infrastructure of the school environment. To get more parental involvement, programs should provide a sound environment where parents' ideas are welcomed and appreciated. Family Science sessions

are generally conducted by personnel who have a background in working with parents. These personnel provide a good context for learning in the Family Science sessions, where parents can work with children in a relaxed environment. Instruction in these sessions are participant oriented. The children begin to understand scientific concepts through their experiences of doing hands-on science activities and engaging in discussion where the interaction of ideas enables them to come to a consensus.

Collaborative group work. Slavin (1990) discusses how cooperative learning affects the development of a learner's self-esteem. In cooperative learning, all the members of the group do not necessarily work to achieve the same outcome. Johnson and his colleagues (1994) distinguished three kinds of cooperative groups: formal, informal, and cooperative base groups. In formal cooperative learning groups, students work together to achieve shared learning goals by ensuring that they and their group mates successfully complete the assigned learning task. These groups last from one class period to several weeks. Informal cooperative groups are ad-hoc groups which last from a few minutes to one class period. In these groups, students do the intellectual work of organizing, explaining, summarizing and integrating material into existing conceptual

structures during direct teaching. Cooperative base groups are long-term, heterogeneous learning groups with a stable membership whose primary purpose is to allow members to give each other the support, help, encouragement, and assistance each needs to succeed academically.

In group work, the seating arrangement in a classroom is very important in order to encourage children to speak with each other. Galton and Williamson (1992) describe the importance of seating in groups. According to them, in the schools in the United Kingdom and overseas, elementary children sit in groups either around a table or at desks pushed together to make a square. They believe that when children are seated together they have a commitment to work together for a common goal. They distinguish four kinds of groups. First, in seating groups, each child has a separate task and intended different outcomes. Second, in working groups, each child has the same task and the same outcome. Third, in cooperative groups, each child has a separate but related task leading to a joint outcome. Fourth, in collaborative groups, each child has same task leading to a joint outcome. They conclude that when children are seated in groups, they are likely to achieve more, have increased motivation, and develop higher self-esteem than when they are seated in rows.

Katzenbach and Smith (1993) discuss how numerous interpersonal and group work skills affect the success of cooperative efforts. They suggest that in order to coordinate efforts to achieve mutual goals, students need to a) get to know and trust each other, b) communicate accurately and unambiguously, c) accept and support each other, and d) constructively resolve conflicts. These goals are especially important in the long term success of learning groups. McCaleb (1994) states that cooperative learning helps marginalized students attain higher achievement levels, but individualistic or competitive settings often mean that these students are not motivated. She further says that in those settings, males from the dominant culture are more likely to succeed, white females and students from lower status groups do poorly.

Eichinger, Anderson, Palincsar and David (1991) report that the tension between the norms that facilitate academic discourse and colloquial discourse affects successful collaborative activities. They suggest setting norms at the beginning to help the children understand the task. In Palincsar's, Anderson's and David's study (1993), they used four social norms, namely: 1) to contribute to the group's efforts and help others contribute, 2) to support one's ideas by giving reasons, 3) to work to understand others' ideas, and 4) to build on one another's ideas.

When students learn to work collaboratively to solve problems and generate new forms of knowledge, they are also creating bonds across cultures and languages. Galton and Williamson (1992) suggest that a student's achievement is high when the group is composed of children with mixed ability levels. The students learn to listen to different points of view and collaborate toward a common learning and discovery goal. They begin to appreciate the knowledge and effort that each member of the group brings to a task, and they discover that despite their differences, they have shared experiences: the school environment, more importantly, as human beings. As with Slavin (1990), cooperative learning affects a student's self-esteem. Collaborative efforts in group activities help develop self-confidence, which results in the development of high self-esteem in group members.

Self-Esteem. Kunjufu (1984) distinguishes between self-esteem and self-image by giving two definitions for each. According to Kunjufu, self-esteem is the possession of a favorable opinion of oneself, and should be viewed as more than an end result. The development of a self-image is a process or a catalyst affecting self-esteem. Self-esteem is defined as a likeness symbol, a mental picture, or the reliving of a sensation in the absence of the original stimulus. By improving

one's self-image, self-esteem could be enhanced. Kunjufu also states that the home, peer group, television, school, and church are five institutions which affect self-image and self-esteem.

Beane and Lipka (1986) distinguish between self-concept and self-esteem. To them, self-concept is a description one attaches to one's self. Self-esteem is a value judgment based on attitudes, beliefs and interests. For example, they explain that an adolescent who describes her/himself as a good student, describes her/himself as a bad student to peers who do not value education. The former label is an example of self-concept, and the latter is an example of self-esteem. They suggest that "enhancing self-perception" covers both terms self-concept and self-esteem, and that this is needed in academic development.

Programs

Successful programs designed for disadvantaged groups have the characteristics of being culturally pluralistic, multicultural in focus, and seek to encourage creative, divergent approaches to study and learning, small group strategies, and mentoring situations. Disciplines are taught and learned in divergent as well as convergent ways (Stanley & Greenwood, 1985). Scope and sequence, focus and emphasis may be culturally imbedded. All aspects of a

racial or ethnic group's experience can be studied in an intellectually honest, scholarly manner which enhances an individual's valuing of her/his culture, teaches the process at the same time, and develops an understanding of the disciplines involved.

California Bilingual Programs. Delgado-Gaitan (1991) discusses two major California state-funded programs for Spanish-speaking children. One is a bilingual preschool program and the other is a migrant program. Both those programs have a component of parental involvement for designing, implementing and evaluating the programs. The underlying concept of these two programs is that learning occurs through social interaction between the adult and the child. There were three models which required three different kinds of activities in these programs, namely, conventional, nonconventional, and autonomous. In the conventional activities, teachers and parents worked together to identify target areas, with the parents having some control in the decision-making process. The non-conventional activities required parent participation to help their children succeed in school. These parents had no participation in the decision-making process, but their participation allowed them to feel they were a part of their children's education. In the autonomous group, parents set the agendas and design, a context which invited

school personnel to share the decision making about the programs and policies.

KIDS--Kids Investigating and Discovering Science. KIDS was a bilingual science program founded by Dr. Eloy Rodriguez in 1990 for Latino children (K-6) at the University of California, Irvine, with funding from Honda Corporation and Chevron. For this program he developed curricular materials for the grade levels to consider undergraduate science courses, to encourage young minorities to critically think through investigation and discovery. Two elementary Latino teachers, two student assistants, and a surrogate parent were assigned to each of the grade levels. The children explored the university arboretum and marshes to observe flora and fauna, which raised their curiosity and interest in science. The goal of this program was to cultivate younger children as future scientists.

La Clase Magica: A Computer Assisted Literacy Program for Neighborhood Children. La Clase Magica (LCM) was a part of the Distributed Literacy Consortium organized by Michael Cole, and practiced in a few sites affiliated with the University of California, San Diego (Cole, 1990). The Lansing LCM project was headed by a professor from Michigan State University, and was designed as a partnership between Julian Samora Research

Institute and the community center. Sessions were conducted as an after school program in the community center. The program objective was to improve literacy through the use of computer games.

La Clase Magica provided an alternative learning environment to blend computer "adventure games" and education to learn more about math, reading, writing, social studies, science and geography. Activities were organized in a twenty room maze, and task cards were completed by using the computers. Children learned together with their peers, wizard assistants (LCM staff,) MSU amigos (teacher education students), and an omnipotent and omniscient being, the wizard.

Literacy and computer and communication skills were developed in the children through problem solving interactions between the children and the computers. The ultimate goal for the students was to progress through the maze and become a wizard assistant. Children who succeeded up to this point were congratulated after taking an oath to work successfully as a wizard assistant. This motivated the children to be in the program and to finish games. All of the games had three levels--beginner, good, and expert. To become a wizard assistant, they had to complete all the rooms in the maze, and complete ten expert level games.

PLAN Program (Program: Learning According to Needs). Abi-Nader (1991), who reports on the study, has participated in the program for six months as a participant observer. The program objective was to motivate students to continue their education to the college level. The program has three major strategies to motivate students; namely, 1) include a mentor program, 2) the oral tradition of PLAN, and 3) future oriented classroom talk. It is reported that the program is successful in obtaining an increased number of college acceptances and scholarships throughout the program's history.

National Urban Coalition's Say YES Schools Project. This program provides an effective intervention model for linking the home, school and community. The program's objectives were to improve the confidence of teachers and students in mathematics and science, to increase the interests and skills of colored elementary students, and to increase the number of colored children who were prepared for the advanced level of mathematics and science at the secondary level. Beane (1990) reports that the pilot "Say YES" program was conducted in the school year 1987-88, and was implemented in nine public elementary schools in two school districts whose enrollment was at least 75 percent African American

and/or Hispanic students. An essential component of the program was family activities.

It is reported that project classrooms indicated a significant improvement in math and science than the non-project classrooms. In addition, the project seemed to confirm the potential of activity-based instruction as a tool to increase student interest and achievement in mathematics, science, and reading.

New Haven Parental Involvement Program. This program was implemented in 1968 as a partnership between the Yale Child Study Center and two public schools in New Haven, Connecticut. An important component of the program was parental involvement in the governance and management of the schools. The original concept for this program evolved out of Comer's (1980) childhood, who was the founder of the program. He connected what he had received from his parents, that is, social skills and confidence, with his educational successes. He feels that most of the students who go to school do not have that kind of parental support. The current educational reforms do not place enough emphasis on interpersonal factors, and tend to assume that all children come to school equally prepared to participate. Because of this assumption, many disadvantaged students fail in their schooling. To avoid this the program used parental assistance in the classrooms.

It is reported that implementation of the program resulted in an improvement in academic achievement, and also helped to decrease behavior problems. When students observed parents interacting with school teachers in a cooperative way, students responded in a positive way to both academic and behavioral expectations of school personnel (Comer, 1986).

I Have a Dream Program. This is a nationwide program started by Eugene Lang. The structure of the program is flexible. The program's staff provides assistance to "dreamers," at-risk students, and their families by providing a sponsor to coordinate social, financial and academic services to help prevent school dropouts.

Lacey (1991) points out that the potential weakness of the program was consideration of paying college tuition as an incentive to keep at-risk students in school through graduation. Success also depended on how lucky a dreamer was to get a sponsor. Those who were lucky enough to have a sponsor succeeded academically and socially. Furthermore, the program does not have an impact on the quality of teaching or learning in the schools.

Latino Parental Involvement in the Boston Public Schools. Three models of parental involvement have been used in the Boston public schools: 1) Helping parents

to help children learn, 2) Parents' activity center and training program, and 3) "Good beginnings/Un Buen Comienz." The objective of the first model was to decrease the amount of time the children spent watching television, and to find ways that parents could help their children do their homework. This model was implemented in a Spanish, bilingual, kindergarten class. For the second model, activity centers were created in a number of classrooms to develop the parents' ability to assist their children in academics. The third model was designed to get Latino parents to help their children succeed academically. In all three models, the important component was to make connections between home and school. Rivera (1988) notes that greater parental involvement results in a higher probability of graduation, due to four factors which contribute to a low level of Latino parental involvement: 1) institutional, 2) cultural, 3) socio-demographic, and 4) socio-economic. He reports that an effective partnership between parents and school can make a positive impact on the educational performance of Hispanic students.

National Family Science Program. The Family Science program attempts to build a friendly and nonthreatening learning environment by allowing the child to work with the parent and teacher. Many scholars in the family

science field also have training in human development and specifically, cognitive development. Understanding how students think and learn should provide a strong foundation for family scientists to develop appropriate teaching methods. Applying knowledge about family communication skills to the classroom should also be helpful, and could provide a good model for students.

The above-mentioned programs have a common element for their success; that is, the connection between the home, school and community. Except for La Clase Magica and Family Science Program, parental involvement is requested in classroom situations in all other programs. Parental participation might be higher in a nonformal situation after school, where parents could have some authority. We need to understand the various explanatory models and theories regarding the concept of being disadvantaged as these provide the bases for designing programs. It is also necessary to be sensitive to the characteristics and behaviors of different racial and ethnic minorities which represent unusual potential. Being disadvantaged can be viewed from socio-political, economical, environmental, cultural, and psychological perspectives.

CHAPTER III

METHODS OF STUDY

The research question guiding this study was: How did the Family Science Project help disadvantaged children and parents build an interest in learning science? This question was addressed by examining the participants' perceptions about science. Specifically, the following questions were addressed:

1. How did children participate in the Family Science Project?
2. What did Junior Scientists learn from the Family Science Project?
3. What were the parents' perceptions about the Family Science?

This chapter describes the rationale for the methodology, the selection of the site, access to the site, field experiences, subjects of study, data collection, and the procedures undertaken in data analysis.

Rationale for Methodology

To answer the above-mentioned questions I needed in-depth evidence of the ongoing process, which could only be answered by qualitative research. Bogdan and Biklen (1982) explained that qualitative researchers proceed on the theoretical assumptions that meaning and process are crucial to understanding human behavior, that descriptive data is important to collect, and that analysis is best done inductively. This whole study was designed to understand the changes that occurred in three groups of subjects; namely, elementary children, middle school children, and parents. The data analysis gives a detailed description of the events that occurred among these three groups.

Selection of the Site

The early negotiations were made by the Project Director. According to her, the present site was not the first site selected. Since the Project Director had no experience with elementary children, she had decided to work with an experienced member of the Program for Educational Opportunity in Ann Arbor, who conducted training programs for teachers and people so they could conduct programs that dealt with equity or that would ensure equity. There was a field tested Family Science site in Ann Arbor, and there was only one other site which was field tested, in Austin, Texas. As both sites

were not located where information could be gathered about minorities or Hispanic children, Dr. Rodriguez wanted to consider a site where she could work in a setting that would deal with the needs of minority groups. She started working in a school in Detroit with a bilingual teacher, and conducted the programs in both English and Spanish. While working there, she started working in the community-based education programs of the Julian Samora Research Institute (JSRI) at Michigan State University (MSU). This involvement, as well as her involvement in the YES (Youth Empowered for Success) program, boosted her confidence to start a project in Lansing, Michigan. She selected the Highland Elementary School, since the school was located in a low socio-economic status neighborhood with Hispanic and black minority groups. Dr. Rodriguez went to see the principal to talk about the program and make early negotiations. The community liaison of JSRI made flyers to advertise the Project, and were delivered to the school office to be disseminated to parents through their children. In addition to that, she made phone calls to parents, and also visited them.

Access to the Site

I started working in the Project at its pilot stage. I went to the site on a Thursday afternoon to work in the Project. Dr. Rodriguez asked all the

participants to introduce themselves, saying their name, interests, and what they wanted to be or what kind of work they were doing. It helped me get an understanding of the group and their future plans. I also introduced myself as a student at Michigan State University, and said that I was glad to work with them. Dr. Rodriguez introduced me to the group as a researcher who came from Sri Lanka to study the Project. Many people did not know where Sri Lanka was, and I had to show it to them in the world map. Even on the first day that I went to the site I was happy to see the people doing science activities, and I talked to almost all the people. I became friendly with them and helped them by working in the groups. Even at the pilot stage, I received permission to conduct any interviews necessary and to observe them working. Because the third and fourth graders were minors, parental permission was received. Data that I used in this study was mostly from the first and second years of the Project.

Field Techniques

I went to the site every Thursday and worked in the small groups. Every day I wrote down my observations while I worked, and as immediately as possible included remembered details. The informal interviews I had with the participants during the pilot year helped me develop the research instruments. During the first and second

year of the Project, I received permission to interview participants whenever they joined the Project. I also received UCHRIS approval, after their careful and thorough reading of my proposal and instruments (interview guides for children, junior scientists, parents, teachers, principal, and the Project Director).

Unlike the pilot year, during the first two years of the actual Project we conducted an additional session on Tuesdays to train junior scientists. It was an effective way to use them, because then they were ready for the sessions and had a better understanding of what they had to do. The activities they had to do were new to them, so they had problems in doing those. During the Tuesday training session they learned about the scientific concept before they worked with the children, which helped them assist the children better than if they had done the sessions without prior training.

All subjects' identities were kept confidential in the field notes, interview transcripts, and this study by not using participants' actual names. The name of the school was also disguised. All participants were informed that the field notes and the tapes were protected by the researcher. Even if by any chance someone got access to a tape, no one could identify the speakers because of the use of pseudonyms.

Table 1

Subjects of the Study

CHILDREN

YEAR ONE			YEAR TWO		
Name	Grade	Age in years	Name	Grade	Age in years
Henry (Evening)	4	10	Andrew	4	9
Julia	4	10	Anthony	4	9
Kate (Evening)	4	10	Hilary	Kindergarten	6
Lucinda	1	6	Jaime	3	9
Luz	4	9	Jean	3	9
Reyena	5	11	Karena	3	9
Rita	4	10	Pat	4	10
Ofelia	4	9	Sylvia	3	9
Pamela (Evening)	2	8	Pamela	3	9
Sarah	3	8	Sarah	4	9
Solomon (Evening)	3	9	Solomon	4	10
Steve	2	8	Steve	3	9
JUNIOR SCIENTISTS					
Andrea	7	12	Alberto	7	12
Belinda	7	12	Christina	7	13
Myra	7	11	Kasey	7	13
Otila	8	13	Nora	7	12
Rafael	7	12	Rene'	7	12
Ramiro	7	12	Ricardo	7	12
Sarita	7	12	Rumaldo	7	12
Dorothy	6	12	Dorothy	7	13
PARENTS					
Mrs. Arizmendi					
Mrs. Martinez					
Mrs. Knapp (Evening)					
Mr. Parker (Evening)					
Mrs. Briones			Mrs. Briones		
Mrs. Smith (Evening)			Mrs. Smith		

Subjects of the Study

The Family Science Project was for the third and fourth graders and their parents. As I mentioned earlier, we had seventh and eighth graders from a neighboring middle school help the children in doing the hands-on science activities. All children, parents and junior scientists who attended on a consistent basis (60% attendance) were subjects for this study. This included eight elementary children from the first year, eight from the second year, and four who attended both years (20 children). As we selected different junior scientists, seven from each year were chosen. The one who participated in the Project in the first year was allowed to be in the Project because she was a sixth grader in the frst-year of the Project (15 junior scientists). These junior scientists consistently attended both the training and regular sessions. Six parents of children were chosen, based again on attendance. Six parents of junior scientists were also interviewed to get their perceptions of their children's participation in the Project. Data was also collected by interviewing the Principal of Highland Elementary School, a teacher from the middle school, and two teachers from the elementary school who had many children who attended the after-school programs. (As mentioned earlier, there was another program--La Clase Magica conducted by the JSRI of MSU at the community

center--to develop literacy skills through the use of the computers.)

Data Collection

Participant Observation. Every Tuesday and Thursday I went to the site when there were Family Science sessions. The sessions on Tuesdays were different from those on Thursdays, as they were held to train junior scientists. While they were doing the hands-on science activities, they talked about what was happening in school, and some gossiped about their boyfriends or girlfriends and the things that happened at home. They were not as task oriented as on Thursdays, and the session felt more relaxing, because there were no children on Tuesdays. They also talked about their problems with Dr. Rodriguez as if she were an older friend. These conversations helped me understand a little bit about their background and culture. At the beginning they controlled their conversations when they saw that the tape recorder was on. But later on they got used to it, and talked whenever they wanted to whether the recorder was on or not. I had my notebook with me all the time, and I never forgot to write down the important events.

The sessions on Thursdays were for all participants. I usually sat in a group and observed the

things that happened, paying special attention to how they started the activity, who initiated the discussion, what problems they had on proceeding with the activity, and what kind of dialogue took place among them to solve the problems. Some children were very talkative, while some were very silent and responded only by non-verbal cues. Because of these differences I had to be very careful in my observations of them and consider all their behaviors. Usually I used a tape recorder to get all the verbal interactions. It was helpful, because there were times they used some words and phrases which were foreign to me, such as "yummy," "yak," "nark," and "wow." Field notes were narrative descriptions, recording the content and process of how the group handle the task. I typed the field notes taken during the sessions immediately following the observations. Details were added while typing, based on my memory of the session's experiences. Pseudonyms were used for all participants and also for the name of the school.

When new children came to sessions, they were curious to know why there was a tape recorder. They always wanted to know why I used a sound grabber. Responses such as, "*to receive all the sounds clearly,*" did not convince them. I had to explain a little more about the purpose of using the sound grabber, telling them the importance of recording while they were doing the activities.

Interviews. I conducted interviews at two different stages, one at the beginning of the fall semester, and the other at the end of the spring semester. All the interviews with the children, junior scientists, and the parents were carried in their homes, except the very last two junior scientist interviews. Interviews with the principal and teachers were held in the school. I interviewed the Project Director when she was in the Julian Samora Research Institute. In the first year, I went with the community liaison person from the Julian Samora Research Institute. She volunteered to help me in this way because she knew the community and she could talk to the parents in Spanish, something I could not do. She interpreted all the Spanish interviews to me without any hesitation.

By the second year I was very familiar with the neighborhood, and I visited the participants of the Project at their homes to carry out the interviews. I visited some parents more than the others, e.g., Mrs. Briones, to get more information that I needed from them as they had been in the Project for a long time. I made myself known to as many people as possible by involving myself in such community activities as "Cinco de Mayo" and the Thanksgiving dinner. Most of the community activities were held in the community center where I worked as a volunteer. This involvement enhanced my

interactions with not only the parents, but also with other community members and well-wishers who worked for the community.

I interviewed almost all the parents of the children who attended on a regular basis. Although my interviews were structured (Appendix 10) so as to get information about their background, interests, and attitudes toward science, sometimes they took different directions depending on the responses given by the parents. Although at first they responded to me just by giving very brief answers, they later provided me with detailed descriptions about their past, their grievances, and their successes, if they had any, during their schooling.

I interviewed the children on the same day that I interviewed their parents. Some parents listened to our conversations. Some children preferred not to have their parents in the room when they talked to me. To show that I appreciated their voluntary participation, I acquiesced to their preference. The purpose of the children's interviews was to gather what they did in school, their attitudes toward science and scientists, and their perceptions about the Project. They were also asked to discuss the similarities and differences between how they learned science in school and in the Project. During the post interviews I asked the same questions as before (Appendix 13), and also added some

questions to get an idea of how they had felt when working in small groups.

Except for the last two interviews, all other interviews of the junior scientists were carried out in their homes. At the same time I interviewed their parents. Unlike the parents of the children whom I had met in the Project or in the school, I met these parents only during the interview time. I called and set up appointments with them for the interviews, so as to not disturb their routine plans.

I interviewed the principal of the school, two teachers from the elementary school, and also the middle school teacher who brought the junior scientists for the sessions to receive their perceptions about the Project.

Prior to each interview, participants were reminded that their participation was voluntary, and that at any stage they would be permitted to discontinue their participation without any penalty. They were also reminded that pseudonyms were used for all participants and the school.

Documents. At the first session all Project participants were asked to draw scientists and write what their scientists were doing. They drew scientists again at the last session. Some drew the scientists at the time the interviews were conducted. These drawings were powerful evidence for me to see their change in

attitudes about scientists. During the time that they had to do activities, they were given papers to do scratch work and to write their predictions and results. All of this work was collected as documents for the study. In addition to these, collected information about the participants' background was derived from giving them a survey instrument (Appendix 7), and from school records. The principal of the elementary school provided me with some demographics of the school and neighborhood.

Data Analysis

Field notes were read very carefully to understand what events and patterns of events occurred during the sessions. Assertions were developed considering the events that had occurred and the overall patterns of behavior. I tried to collect enough evidence to test my assertions, and at the same time explored the data for any evidence. Transcriptions of the interviews were read several times with the following questions in mind: How did Family Science help these people to learn science? Were there any observed changes regarding what they talked about? Patterns of consistent and inconsistent responses were noted and included in the interview analysis.

At the first stages of the preliminary analysis, I developed some assertions, searched for more assertions,

and tested assertions to find linkages among the different data gathered from the observations, documents and interviews. I used the responses from the teachers and principal to supplement some of the issues brought about by the children. At the same time, I tried to organize and reduce my data. It was a difficult task to decide what to include and what to leave out. But finally I decided to stick to the subsidiary research questions, and searched for the data for which I could find answers to my questions. I had to re-read transcriptions of the audio tapes in order to get an understanding of some of the interactions.

CHAPTER IV

FAMILY SCIENCE PROJECT

This chapter describes the project that I studied. First I will describe the national Family Science Program, and then the Family Science Project in Lansing, Michigan, and then I will discuss modifications of the national program.

Family Science Program

Family Science is a national education program for children and parents to learn science by means of hands-on science activities. The program is specifically aimed to build interest in science among females and minority groups. The Scientific Manpower Commission (1988) reports that females constitute 52 percent of the U.S. population, but only 5 percent of the scientists are women. Entry into scientific careers is also very limited for children from minority groups. Taken together, the minority groups comprise 20.4 percent of the population, whereas only 5 percent of these members occupy the professional scientific workforce.

Family Science is an outgrowth of the successful Family Math Program developed by EQUALS, Lawrence Hall

of Science, University of California, Berkeley. Northwest EQUALS of Portland State University developed the Family Science curriculum and the science activities book with funding from a three year grant from Chevron, and support from the National Urban Coalition, Washington, DC. In 1994, Family Science was distributed in about half of the states the United States (Table 2). Family Science programs are also found in Australia, Costa Rica, and Sweden.

Family Science Program Goals

The Family Science book developed by Northwest EQUALS (1994) states the goals of the program under three headings:

1. To provide an opportunity for families to have enjoyable science experiences by presenting:
*a non-threatening, hands-on approach to learning about scientific processes, concepts and topics;
*cooperative learning activities which develop problem-solving abilities, questioning strategies, and communication skills;
*strategies for providing encouragement to all students, especially young women, and ethnic and racial minorities in science, mathematics, and technology-based studies; and

Table 2

Distribution of Family Science sites

State	City	Number of sites
Alaska	Kenai	3
Arizona	Flagstaff	1
	Phoenix	4
	Tucson	2
California	Anaheim	1
	Berkeley	3
	Camarillo	2
	Hayword	4
	Longbeach	1
	Modesto	2
	Morena Valley	1
	Oakland	5
	Palo Alto	1
	Richmond	3
	Salinas	2
	San Bruno	3
	San Francisco	4
	San Leandro	2
	Santa Ana	2
	Ventura	2
	Woodacre	1
Colorado	Denver	3
	Greeley	3
Connecticut	Hartford	3
DC Washington		4
Delaware	Wilmington	2
Florida	Melbourne	2
Georgia	Atlanta	3
Hawaii	Honolulu	2
	Mililani	2
Idaho	Worley	1
Illinois	Decatur	3
Louisiana	Gretna	1
	Harvey	2
	Metairie	1
	New Orleans	2
Massachusetts	Springfield	3
Maryland	Baltimore	2
	Chevy Chase	2
	Silver Spring	3
	Takoma Park	1
	Washington	1
Michigan	Ann Arbor	3
	Detroit	2
	Lansing	1

Table 2 (Cont'd).

Minnesota	Minneapolis	4
	Richfield	1
	Shoreview	1
	St. Paul	4
Montana	Hays	2
North Carolina	Charlotte	6
	Durham	3
	Huntersville	1
	Mt. Holly	1
New Jersey	Englewood	3
New York	Bronx	1
	Hastings-on-Hudson	1
	New York	1
Oregon	Alsea	2
	Beaverton	1
	Carlton	1
	Corvallis	1
	Dayton	1
	Grand Ronde	2
	Milwaukee	2
	Portland	5
	Salem	2
	Sweet Home	3
	Tygh Valley	2
	Woodburn	1
Pennsylvania	Philadelphia	2
Tennessee	Corryton	1
	Erwin	2
	Knoxville	2
Texas	Port Arthur	3
	San Antonio	2
Washington	Milwaukee	4
Wyoming	Ethete	1
	Lander	2

International Sites
Australia
Costa Rica
Sweden

*community classes that allow time for families to test, tinker, and talk about science with other families.

2. To relate the learning of science to future studies and work by presenting:

*information about science curriculum, college requirements, science-based, and other occupations

*opportunities to meet and talk with career guests in family classes

*activities which highlight the relevance of science to daily life, and the work force, as well as across cultures

3. To involve parents in their child's science education by supporting:

*informal learning activities which compliment their child's school experiences;

*parental interest in school science and mathematics programs;

*learning experiences which use inexpensive and readily available materials; and

*opportunities for adults and children to be partners in learning

Structure of Sessions

The sessions are structured so as to build interest in science, and are usually offered in a series of three

to eight one-to-two-hour sessions for parents and children. Each session consists of activities to stimulate interaction among the participants. A resource table holds the items necessary for the day's session. A welcome table is used for name tags and sign-in sheets. The name tags help the participants to talk to each other by using their names.

The day's activities are started with an opener--an initial activity for the participants. The participants are provided with directions and steps to be taken. These opening activities help participants communicate with each other, and broaden their awareness of the many "openers" found in their daily lives, such as problem solving in the kitchen. Various openers are grouped together around similar topics so as to be more effective. An example of an opener might be to have participants make air craft from a given piece of paper. The first task would be to find out how fast a rectangular piece of paper can move in the air, and then how fast it can drop. The observations from this activity open the discussion about the participants' experiences, as well as raising many "why" questions. Involvement in these openers help test ideas, discuss similarities, and extend the investigation. Openers also establish a friendly, positive climate of exploration, discussion, and questioning.

Since the sessions are planned around the parents' convenience, they may do two or three activities depending on the time each requires. Each day before leaving the room participants clean their work areas and then do a wrap-up activity where they get a chance to talk about what they have learned and the problems they had in doing the activity. This is the time when they can share their experiences and culture as well as discuss the scientific concept presented.

Who Trains Family Science Instructors?

Family Science instructors are trained by "Programs for Educational Opportunity" (P.E.O.), an organization which has education program specialists loced in regional central offices. In Michigan, the central office is located at the University of Michigan in Ann Arbor. Specialists from Programs for Educational Opportunity conduct workshops for those teachers and educators who are interested in starting sessions for children and adults in their own areas. At these workshops they are given guidance on how to start their own Family Science Program. As family involvement is the key to program effectiveness, the workshop participants are given different methods for contacting parents. The training also includes how to make flyers to advertise the program. During the workshop trainees perform all the activities that they must do to set up a

Family Science session, such as setting up the resource and welcome tables, and doing the openers, activities, and wrap up.

Lansing Family Science Project

Objectives of the Family Science Project in Lansing

The Family Science Project in Lansing has the same goals and objectives as the national program, but there were some modifications. Because of those modifications, I asked the Project Director to state her new objectives. Her response was:

> *The objective was really to get kids and parents doing something in science. The idea is not to have parents teach their kids science, but to give them experiences that would increase their skills so that then what they did in school made more sense when it was reinforced at home, that it was important.* (10/28/93)

Evolution of the Family Science Project in Lansing

The Family Science Project that I studied in Lansing was part of the North Lansing initiative, developed through a partnership between the Julian Samora Research Institute at Michigan State University and the Cristo Rey Community Center. A series of three to eight Family Science sessions were offered at various sites for both parents and children. These sessions were one to two hours long. But, the sessions of the Lansing Family Science Project were offered in a series

of six to eight, one-and-a-half-to two-hour sessions during a school semester. This schedule was used because of the assumption that less than five weeks was insufficient for the development of an awareness of the importance of learning science. The same roster of participants participated the entire school year (fall and spring semesters). The Lansing Family Science Project was modified from the national Family Science Program in that it used the assistance of middle school students, called "Junior Scientists," to help the children and parents. This idea was due to the Project Director's past experiences with parents in different programs. During an interview she said:

> *One of the problems is that the parents won't come and so we need to provide surrogate parents and so that's when I got the idea of connecting junior scientists* (10/28/93).

She further said that it was necessary to have an adult-child ratio that was reasonable to work with. According to her, the parents in that school neighborhood dealt with so many different situations from those of middle-class families, that it was often difficult for them to attend regularly. Also, many had not had positive experiences of their own in school. Consequently, they would not necessarily respond to a flyer sent home from school. Because of these restraining factors, she decided to make other connections between the school and the community, and to

establish the reputation of the program through middle school students.

Pilot Year

The Lansing Family Science Project was presented in two sessions, one in the afternoon and the other in the evening on the same day of the week (Thursday) for the convenience of the parents and children. All sessions were held in a kindergarten classroom at Highland Elementary School. Most of the students at this school come from low socio-economic status families. According to the principal of the elementary school, 93 percent of her students receive free or reduced-price lunch.

Another modification of the Lansing Family Science Project from the National Program was to not have "openers," since the openers had not been designed for non-English speaking parents. All the parents who participated in the Lansing Project had been literate. In addition to that, the Project Director thought that doing openers was not an activity that these parents could perform independently. Explanations for most of the activities demanded more scientific knowledge than many parents possessed.

After negotiating with the school principal and the community, the pilot program conducted sessions at the same site on Thursdays from 3:00 to 5:00 P.M., and from 6:00 to 8:00 P.M. Before the pilot program started, it

was advertised by sending flyers home with the children, and announcing the program at parent teacher conferences.

Afternoon session: In afternoon sessions, middle school students--seventh and eighth graders--worked with the younger children from Highland Elementary School. The middle school students were called "Junior Scientists." They wore white lab coats just like scientists working in a laboratory. Each junior scientist assisted one or two children. During normal day, the people worked in four groups. Each group had a junior scientist and a parent to help three or four children.

For the pilot program, assistance from the middle school students was received through the YES (Youth Empowered for Success) program. The teacher who was in charge of the YES program at the middle school brought the junior scientists to the elementary school, while others walked from their school, which took them about fifteen minutes. The Project Director brought snacks and drinks for all the sessions, and set these on a table by the junior scientists.

According to the structure of YES, only two training sessions were allowed because these students were also involved in another leadership improvement program in the community. Two training sessions

provided about four hours of training, which was not enough for the middle school students to adequately understand the concepts underlying the hands-on science activities. This was a limiting factor in the success of the Family Science Project. Most of the hands-on science activities were new to the junior scientists. Often the junior scientists were more engaged in doing the activities than in helping the elementary school children. Moreover, it was difficult to work with two unknown groups. In most of the sessions the activities did not go the way they had been planned.

Evening session: In the evening sessions, the parents worked with the children without the assistance of the junior scientists. Evening sessions were offered for those parents who could not attend the afternoon sessions. For these sessions, Dr. Rodriguez received assistance from an Anglo American female scientist at Michigan State University. She volunteered to help the Project Director because of her interest in working with minority groups in science-related projects.

The hands-on science activities were the same for both the afternoon and evening sessions. The only difference was that there were no junior scientists to assist children at the night time sessions.

Both the afternoon and evening sessions had a very informal atmosphere, and enabled me to see

characteristic features of the Hispanic culture. Parents gave hugs all the time for good work that the children had done, and in turn, children accepted those with a motivation to engage in more science activities.

First Year

The major change in the first year following the Pilot project was to hold a training session for the junior scientists every Tuesday so that they could prepare for the session on the following Thursday. This facilitated the children, and aided the junior scientists' understanding of the scientific concepts underlying the hands-on science activities.

There were also some modifications made in the teaching style and presentation. Since the junior scientists had practiced the activities on the previous Tuesday, instruction sheets were abandoned because neither the junior scientists nor the children read them. Also, the children were given time to play and talk with the junior scientists and parents during the snack time.

During the evening sessions, an undergraduate education student from the Teacher Education Department at Michigan State University also provided assistance. She earned independent study credit for her participation in the Family Science Project. The attendance in the evening sessions was not consistent.

Sometimes there were twelve students and fourteen parents, while sometimes there were only two parents present. But on an average, there were about eight people in attendance. Two parents came with their children consistently.

Second Year

The training given to the junior scientists on Tuesdays facilitated them helping the children with hands-on science activities. From the experience gained during the first year, the hands-on science activities were reorganized under scientific concepts related to air pressure, heat, light, and so forth. It was also realized that some of the activities took longer than others. Most of the children did not have experience with some manipulative skills, for example using an eye dropper, which the Project Director had assumed would be very simple. Children also become bored with some activities, such as waiting for glue to dry. To keep the children involved, other activities were planned for these times. Such difficulties were easily resolved by the Project Director, a research scientist, as she gained more experience with elementary and middle school children.

The evening Family Science sessions were not offered in the second year of the Project, due to the inconsistent attendance by the parents, as well as the

loss of the evening coordinator, who moved to another state to accept other employment.

Training Sessions of Junior Scientists

Training sessions conducted for the junior scientists occurred each Tuesday after school for about one-and-one-half-hours. Except for two sessions held at the middle school, all other sessions were held at Highland Elementary School. At the first session, the junior scientists were instructed about the routine activities done at the regular Family Science sessions with the children. Without assigning different jobs to people herself, the Project Director gave the junior scientists the opportunity to decide which task each would be responsible for during the session time.

One task was to set up the resource table. From the experience they had on Tuesdays, they knew what things were needed for the activities on Thursdays. In addition, Dr. Rodriguez brought everything packed separately so that they could set up items quickly.

Dr. Rodriguez described two other tasks needed for every session. One was to tape down a plastic sheet on which Venn diagram was drawn. As the junior scientists were unaware of what a Venn diagram was, she had to explain while drawing a Venn diagram:

> *Venn is the mathematician who developed it. We usually make two circles using a permanent marker. Doesn't have to be perfect. They'll be overlapping. On each circle I write something. On*

> *one I put something on science, say "I like science." This one I put, "I like Fall." The rule is that you can sign your name only once. If you don't like them, where do you sign? ... "outside" If you like science you have to sign in this circle. What circle do you use if you like both?...(middle)* (10/6/92).

Although she asked the junior scientists to draw the two circles for the Venn diagram and write two sentences in the circles, she was the one who prepared the Venn diagrams for all the sessions.

It was a very rare occasion that a child signed outside the circles. Some children told the Project Director that they did not like to write their names outside the circles. Taking that response under consideration, the questions were then structured so that more children could sign inside.

Another job that the junior scientists had to do was put some object like candy in a glass jar while counting, and ask the participants to estimate how many were inside. The participants were given yellow stickers so that they could write their name on the back and the number on the front, and put it on a line plot hung on the chalk board. Dr. Rodriguez said:

> *Estimation is a life skill. But this is something that you can do with practicing. I always put the number here (back of the lid). Nobody knows what you estimate. This is a contest of yourself. Number of almonds here is 28. Goal here is not to guess 28, but close to 28* (10/6/92).

Both signing the Venn diagram and estimating were two things that all the participants did in all the

sessions. These help in developing life skills, such as categorization, separating sets, and estimating in everyday life. One parent said that the estimations she had done in the sessions helped her buy groceries for her parties.

The first science related-activity that the junior scientists performed focused on surface tension, a property of water--"Water drops on a penny." For the first activity the students worked individually, but in the training sessions they often worked in groups. The task that they had to accomplish was to discover how many drops of water could be placed on a penny before it spilled over onto the table top. Water was added using droppers. As the junior scientists did not have experience in using droppers, they had to practice first. Then they started the activity by adding drops of water. Some were able to add 45 drops and some only 25. They were surprised to see how wrong they were when they compared their predictions and their actual observations.

Dr. Rodriguez asked the junior scientists to describe the "filled pennies." The junior scientists observed the curvature on top and how the water held to the sides. This led to the discussion that molecules in a water drop are pulled in many directions by weak bonds, they pull the surface molecules back into the drop and behave like "stretchy skin," and that this

property of water is called the surface tension or "water's secret skin." Then came discussions regarding the techniques to be used to add more drops. At the same time students had a question which side of the penny to be used. When they were looking for the side of the penny, Christina said, "*Oh, look I can read these letters very well now.*" Then it came the discussion of the magnifying power of water when it is shaped like a lens. The activities that they performed in these sessions opened up discussions, which led to an understanding of the scientific concepts underlying the activities.

Generally, Dr. Rodriguez discussed what had happened in the previous session with the children, and asked the junior scientists if they had any suggestions for performing the activity differently. There were times during earlier sessions of the semester that the junior scientists complained about the children's behavior. Sometimes the junior scientists did most of the work for the children. Whenever Dr. Rodriguez noticed such behavior, she insisted that, "*your job is to help them learn, not to do things for them.*"

Towards the end of the semester, discussions always focused only on the activities. Little time was needed to talk about the behavior of the elementary school children. By that time they had developed some necessary skills for working with the children.

Family Science Sessions

As mentioned previously, all Family Science sessions were held in one of the kindergarten classrooms at Highland Elementary School. This particular classroom was chosen because of its accessibility to disabled people, and because it was the only classroom with movable desks and chairs. Dr. Rodriguez believed that neatly arranged rows of desks and chairs did not help engender the relaxed and interactive atmosphere required for the group activities.

What Did a Regular Family Science Session Look Like?

Generally the middle school students from Paterson Middle School came to the elementary school before it closed for the day. The elementary children came to the sessions right after school. They waited at the door in a line if the door was not fully opened, which meant that the room was not yet ready.

Venn Diagram. As soon as they walked in, they put on their name tags which were on the welcome table, and then signed the Venn diagram. All participants had to sign the Venn diagram. One day (2/11/93) the statements in the two circles of the Venn diagram were, "Cold air is heavier than hot air" and "Hot air balloons go up" (Figure 5). On this particular day, three signed in the circle stated that cold air is heavier than hot air.

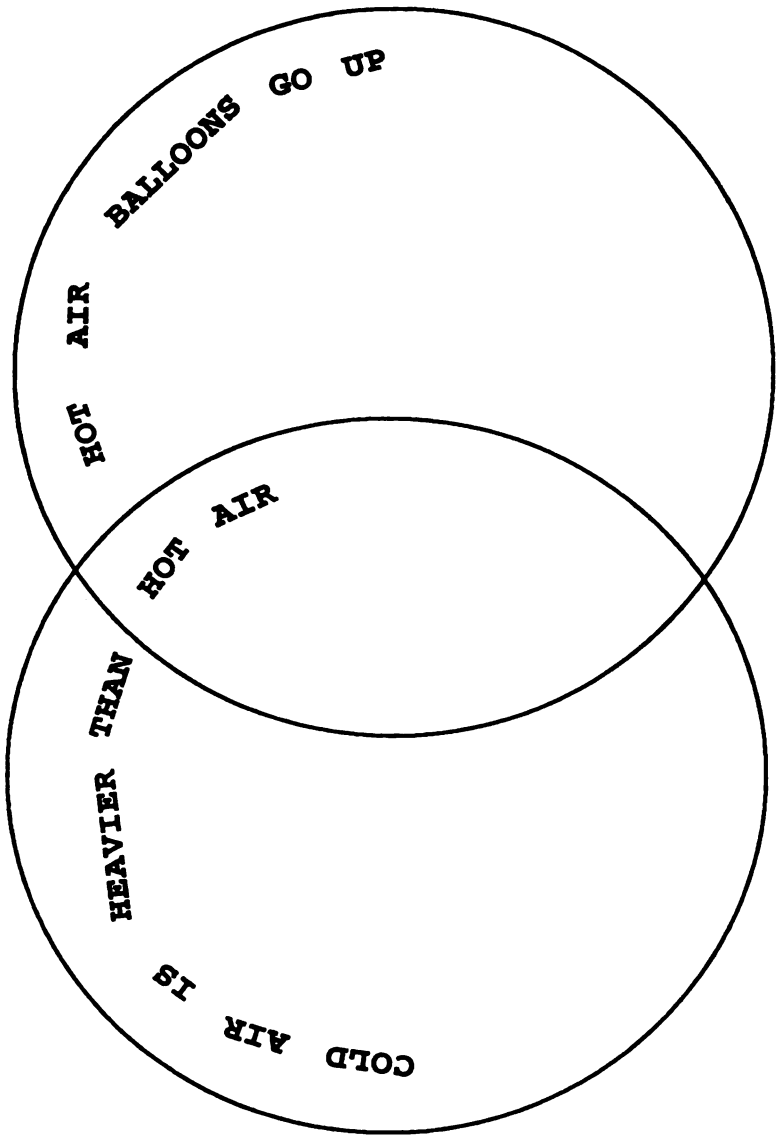


Figure 5 Venn diagram

One signed in the "Hot air balloons go up" circle. Seven signed in the middle for both the circles. One junior scientist signed outside the circles. I observed that there were times when children forgot to sign in when there were too many children at the table. But when they remembered it later, they went to sign in, even while they were having snacks. These routines helped the children behave as members of a learning community.

Estimation. The second activity was estimation, which was on the resource table. Children, parents and junior scientists had to do estimation. One day (12/10/92) there were 76 mints in a closed glass jar to estimate. Their estimates ranged from 25-89 (25, 32, 33, 35, 36, 43, 45, 50, 50, 52, 60, 60, 65, 70, 70, 73, 89.) The children knew that the actual number was written underneath the cover of the jar. Except for two or three times, they did not cheat by looking at the underside of the cover.

Snack Time. After signing the Venn diagram and doing the estimation activity, the students hung up their coats and sat in their groups. The junior scientists had arranged the desks and chairs into four groups. When there were more people than expected, they arranged an extra table. They also organized the snack table and served the drinks. While having snacks, the members of

the groups socialized themselves by talking about the things that had happened at home and school. This took about ten to fifteen minutes. Everybody had their name tags on, and addressed group members by their names, even on the first day.

Session Introduction. The majority of the Family Science sessions were introduced by means of a problem or a content exposition by the Family Science Project Director, to involve the participants in a discussion. In most cases, her exposition was interspersed with a series of questions that required short answers from the children. These served to maintain the children's attention and advance the lesson in regular short steps. Children were told what they had to do in order to satisfactorily complete their task. Often this was coupled with a series of instructions and resources to be used.

Activity Time. As there was no standard curriculum for Family Science, hands-on activities were selected based on the interest that could be developed in the participants. The resource book for Family Science, developed by Northwest EQUALS in 1994, gives a compilation of science activities which could be used in the sessions. It served as the curriculum for the Family Science Project. Since the Family Science

instructors could choose their own activities, Dr. Rodriguez chose the activities that she felt both the children and parents would like.

Most of the children told me that they liked the activity of making hot air balloons; hence the following description of this activity so one can get a picture of how the science-related activities were done in the sessions. It took two sessions to finish this activity. On the first day Dr. Rodriguez asked questions referring to the Venn diagram responses:

> *Today we are going to learn about hot and cold. We are going to study about hot air and cold air. Let's see how many people have signed, "Cold air is heavier than hot air?" Three, and one signed hot air balloons go up. Why do you think the hot air balloons go up?* (2/11/93)

After this discussion, while holding the balloon that had been made by the junior scientists on Tuesday, Dr. Rodriguez said:

> *Today we are going to make hot air balloons, so that we can discover things about hot air and cold air, and we are going to work in two big groups. Hot air balloons are as large as this. You are making green and white Michigan State balloons* (2/11/93).

The participants said, "Wow." One asked Dr. Rodriguez, "Does it really go up?" She replied that this was what they were going to discover. She said that each group would get green and white tissue paper to make balloons. Without even waiting to receive the paper the children stood up to start the activity. The

children were very excited about making hot air balloons, and they were also happy because they knew that they could take the balloon home to show their friends and family members.

The first task was to make panels. Dr. Rodriguez said:

> *You will need to glue five of these sheets together. You may decide where to put green. You have to make ten panels. Once you make the panels you have to cut up the patterns* (2/11/93).

The junior scientists had practiced making balloons and inflating them before they came to the session with the children. Rafael worked in a group with another junior scientist, Sarita, a parent, and three children. They decided to work in pairs to glue the sheets. Rafael worked with Steve. Sarita worked with Steve's sister, Sarah, and Steve's mother worked with another girl, Amy. Steve was impatient to make the balloon and repeatedly asked Rafael when they could finish making it. He did not like to wait until the glue dried. Rafael had to remind him that it was necessary to be patient to use the dried sheets to cut the patterns. He further said that, "*If the glue doesn't get dry enough, sheets might get torn.*" Steve's mother noticed Steve's impatience and involved him in a conversation:

> *Mom: Steve, would you please bring us your glue.*
> *Steve: We need it.*
> *Mom: That's O.K.* (Steve brought the glue can to her)
> *Mom: We are on our next. Go help Rafael to speed up.*

Steve went back and told Rafael: I want to select colors.
Mom: How do you want the green? We have white, green, white, green, white.
Steve: White, green, white, green, white.
Rafael: Do you want it as the first one?
Steve: Yeah (2/11/93).

After making the panels, they were ready to cut the patterns (see Figure 6). They used the master pattern made by the junior scientists from brown butcher paper in order to cut the ten patterns. Rafael and Sarita held five panels together and asked the others to cut around the master pattern. As one panel was about ten feet long, it was difficult to cut alone without support from the rest. They took about ten minutes to cut the pattern. When they finished cutting all the panels, they started gluing (Appendix 2). They again worked in pairs to glue the edges of the ten patterns. Steve was a boy who wanted to finish everything at once. Because of his impatience to finish, he just dragged the paper and tore it. Rafael did not worry. He said, "*That's O.K. We can paste it.*" The others finished the rest of the panels and waited for Rafael and Steve. It was a difficult task for Rafael to keep Steve working. (During a conversation with Steve's mother, it was brought to my attention that Steve was mentally impaired.) Steve's mother always kept an eye on what Steve did, which was helpful for the junior scientists. The following example shows how Steve was motivated by his mother and Rafael:

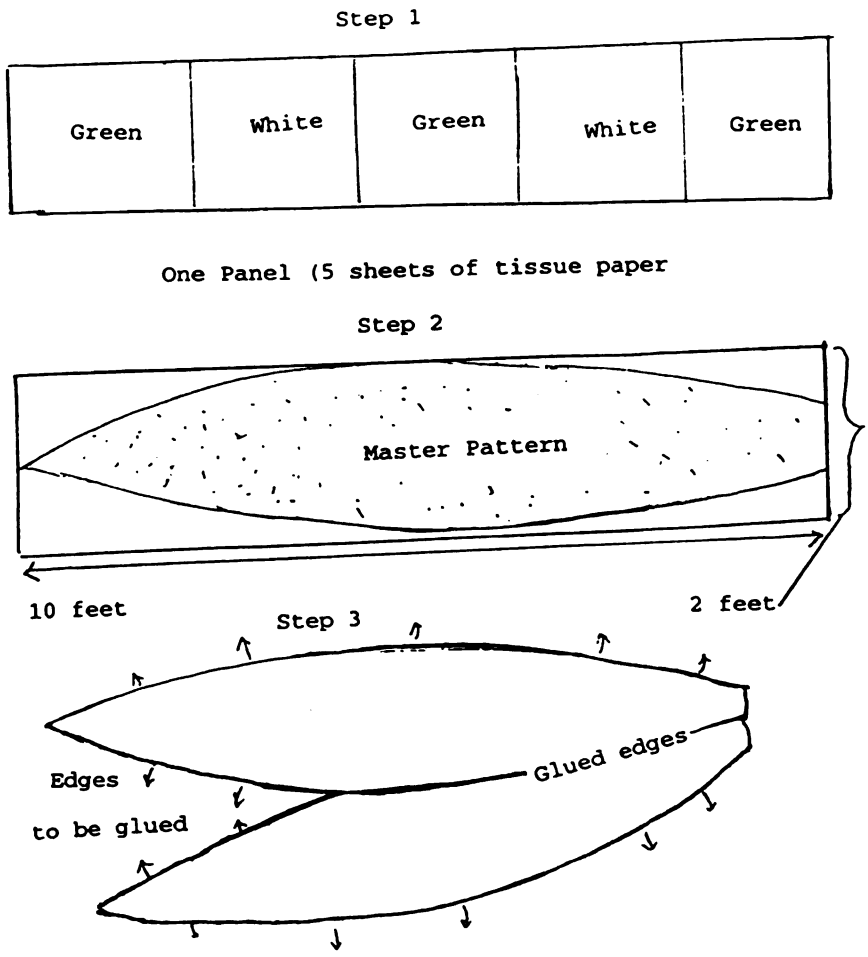


Figure 6 Steps in making hot air balloons

Rafael: Steve, come on Steve, you need to help us.
Mom: This is going to be Rafael and my balloon. We are doing all the work.
Steve: I think it is mine.
Mom: Look, I like the way Sarah was doing.
Rafael: I like what Sarah is doing too.
Mom: Steve, Rafael and I are doing all the work. The balloon is ours.
Rafael: He is a kid (very softly). *Steve, let's do some gluing together.*
Mom: O.K., you get the glue.

Steve brought the glue to Rafael, but he noticed that Steve was squeezing it.

Rafael: Don't squeeze glue, don't squeeze anymore.
Steve: I can do it by myself mom.
Steve: We need more green (2/11/93).

Steve was back to work. Both big groups could not finish gluing all the panels together in one session. Because the children were disappointed that they had not finished, and were also impatient to see the balloon go up, Dr. Rodriguez took the children to the gymnasium of the school to inflate the balloon made by the junior scientists. They used two hair dryers and a hot air popcorn popper to blow hot air into the balloon (Appendix 3). In about seven minutes the balloon got inflated, and all said, "*One, two three,*" and let the balloon to go up. It went up to the ceiling and it swayed around for a minute before returning to ground level (Appendix 4). People clapped with joy.

Wrap-Up Time. After deflating the balloon, it was folded with everybody's help. Everyone came back to the

classroom, cleaned up the areas, and started the discussion:

R: Does the hot air balloon go up?
Group: Yes
R: O.K., why did the balloon go up?
Group: It has hot air. It is light.
R: What happens when you blow hot air into the balloon?
Group: Hot air goes up.
R: What happens to the air already in the balloon?
(No answer)
R: Was it hot or cold?
Group: Cold
R: Cold, why was it cold?
One child: Because hot air went up (2/18/93).

Then Dr. Rodriguez explained to the group that air is made up of molecules and heat makes molecules move fast. She also said that when the molecules were far apart, the air inside the balloon was less dense than the air outside the balloon, which made the balloon float in the air. Rafael had a question. "*Why do helium balloons go up*?" Dr. Rodriguez asked the group the question. When there was no response, she asked again, "*Which is heavier, cold air or hot air? Helium is a gas. Which do you think is heavier, helium or air*?" She was able to get the answer that air is heavier than helium. Steve, his sister and mother missed this discussion because they went home after Steve started a fight with his sister.

Summary

The Family Science Project in Lansing followed the same structure as the national Family Science Program

and had the same objectives. All Family Science sessions were held on Thursday afternoons from 3:00 to 5:00, in a kindergarten classroom at Highland Elementary School, for third and fourth graders and their parents. In the pilot year and first year of the Project, there was an evening Family Science session from 6:00 to 8:00 P.M. on Thursdays for those people who could not attend the afternoon session. Junior scientists from Paterson Middle School helped the children in doing hands-on science activities. Every day they signed a Venn diagram and did an estimation activity. The number of activities that they completed in a session varied, depending on the time it took to finish each one. Generally during each session they did two or three activities, but some activities continued over two or three sessions. After doing the activities they cleaned up the work area, and then they discussed their experiences, which led to an understanding of the scientific concept. At the beginning and close of each session, there were warm greetings with hugs, as is common in the Hispanic culture.

CHAPTER V

WHAT DID THE CHILDREN GAIN FROM THEIR PARTICIPATION IN THE FAMILY SCIENCE PROJECT?

The results of the study are given in Chapters 5, 6, 7, and 8. This chapter (Chapter 5) discusses the impact of Family Science on the children in grades 3 and 4. Chapters 6 and 7 discuss what the junior scientists and parents learned from the Project. Chapter 8 discusses the unique features of the Project, such as the positive impact on the Project that the qualities of the leadership had.

To discuss what the children learned from the Project, an overview of a regular Family Science session is provided in this chapter. Family Science sessions were conducted at Highland Elementary School after the regular school sessions, from 3:00 to 5:00 P.M. on Thursdays. The third and fourth graders who participated in the Project attended sessions with or without their parents. These children worked with parents (not necessarily with their own parents) and middle school students (junior scientists) in small groups to do hands-on science activities. Most of the time those activities could also be done at home from

items available in the kitchen. There were about six to eight sessions in a semester.

The results of Chapter 5 are presented under five assertions; namely:

1. The hands-on science activities engaged the children in learning science.
2. Children liked doing science in the Family Science sessions better than reading science in school.
3. Interpersonal relationships developed in the group activities promoted better understanding of the concepts underlying the hands-on science activities.
4. The elementary grade students acquired a variety of skills from the Family Science Project.
5. The Family Science Project helped the children envision new possibilities for their future.

Assertion 1

The hands-on science activities engaged the children in learning science.

The activity on microorganisms was selected to describe in this section due to three reasons: a) its high involvement, b) participants had to ask questions to get more information, and c) the session could not finish on time due to continued discussion. This activity on microorganisms took two sessions (10/22 &

10/29/92), but the participants were surprised to learn the number of microorganisms that live all around us.

The given problem in the activity was to discover where microorganisms could be found. On the first session on microorganisms (10/22/92), one of the statements on the Venn diagram was, "*Microorganisms live everywhere.*" After the snack time (evening session), Dr. Rodriguez started the session by asking, "*What are microorganisms*?" Most of the people answered, "*bacteria*". One said, "*bugs.*" When there were no more responses from children, Mr. Parker said, "*Micro is very small, you cannot see and the organisms are anything that lives. So, microorganisms are small living organisms you cannot see.*" This was the same kind of explanation given by Dr. Rodriguez in the afternoon session. The groups were given the question, "*How would you show somebody that microorganisms are everywhere*?" Each person was given four petri-dishes in which to culture their samples. They were asked to use cotton swabs to take the samples. Dr. Rodriguez brought sterilized petri-dishes with agar from her laboratory. Agar is a solid medium used to grow microorganisms. Dr. Rodriguez demonstrated how the samples could be taken:

> *Take a cotton swab. Touch it at the middle. I want to know whether there are microorganisms growing on the table. So I touch the table like this, and then touch agar. I have to cover my petri-dish like this. Now I take another petri-dish. Let's make a line. I do listerine here, and on this side the cotton swab that touched the table* (10/22/92).

People did not have any idea about using controls in experiments. It was difficult for Dr. Rodriguez to explain why she used a cotton swab touched in listerine in half of the petri-dish and without listerine in the other half. After her demonstration, people took samples from different parts of their body, such as their hair, arm pit, finger nails, toes, and tongue. They also took samples from different places in the room, such as the desk top, toilet seat, door knob, window sill, and carpet. Each one had to record what they did (i.e., from where they got their sample), and what they expected to see.

A week after (the October 29th session), they observed what had happened to their cultures under the microscopes. The children, as well as the parents, were very excited to use microscopes. To give them an awareness of infection, and as a safety measure, they were asked to not open the petri-dishes, or touch the growths, or put their hands in their mouth. Some of their observations are given below:

R: When you describe, you have to say from where did you get your sample, the color of your colonies, and whether they look shiny, smooth, or fluffy.
Henry: I did my foot and the snacks. I think it is a mold.
R: What color is it?
Henry: One is black, the other one is green.
Mr. Parker: I took this sample from under my arm. I used listerine on one side. But it seems to have had an effect on it. It is creamy in color. It is fairly smooth....I had antibiotic on this side. It seems like that there isn't

any growth....This one came out of my ear. See the things I got.
Group: Yuk, ugh, ugh (10/29/92).

When this activity was done (afternoon session), Jose had a cough. He wanted to take a sample when he coughed. During the discussion time he explained to the group what he got in his culture medium. The others also described their colonies:

Jose: I did cough. They are green and white, smooth and shiny.
Solomon: I did the toilet seat. Green and white spots. They are fluffy.
R: Does it smell?
Solomon: No
Anthony: I did my mouth. I put listerine on this side. It really doesn't help. They are brown, cream and white.
R: Browns are very rare.
Pat: I did the waste basket. It is red and it smells.
Myra: I did the sink. I got yellow shiny spots over it. There is a cream one with a yellow dot inside.
R: It could be two kinds of organisms growing, one over the other. That's a good observation.
Steve: I did the toilet seat. I got green with a white border and dark green with a white border. Shiny, very light yellow.
Sarah: I did my dirty mouth. I got white small colonies.
Jean: I got a fuzzy green thing here. I did the window sill.
Julia: I did the drinking fountain. I got yellow growths everywhere. It smells.
Solomon: It smells like my dad's feet.
R: Some organisms like moisture. What happens when you wear nylons? Moisture gets collected, and organisms love that moisture and grow.
Andrew: I did the floor. I got creamy colored ones, fuzzy ones, and some yellow. Some shiny ones.
R: Babies put everything in their mouth. How can they survive?....Microorganisms are everywhere. ....If you know science, how can science help us? (10/29/92)

When everyone had shared their observations with the whole group, the discussion focused on different kind of microorganisms--virus, bacteria and fungus. They were amazed to see that everywhere they tested had microorganisms, which were not visible to the naked eye. Dr. Rodriguez showed them a picture of a virus and different shapes of bacteria, and described how small these organisms are. People talked about their warts on their hands, cavities in their teeth, how they got chicken-pox and the flu, and how doctors gave them antibiotics, and so forth. Almost everyone had a question to ask during the discussion time, which had not been a common thing in the previous sessions. All the questions were something related to a disease. The type of questions and the way they asked them (*Do we get sick when we happened to touch microorganisms?)* impressed on me that they were afraid that they might get infected very easily.

As everyone in the group was so focused about knowing the diseases caused by microorganisms and bad things such as food spoiling or rotting, Dr. Rodriguez asked the group, "*Are there useful microorganisms*?" Not a single child was able to say anything good about microorganisms. A mother said, "*Injections like penicillin.*" Dr. Rodriguez had to develop on what the mother had said to explain how immunity develops, and that there are beneficial microorganisms like

penicillium and soil bacteria which decompose organic matter, to get the students to know something more than what they had learned only by doing the activity. When Dr. Rodriguez started wrapping up, because it was almost ten minutes past the usual closing time, a boy asked, "*How do you get AIDS*?" This was the time when people talked about their basketball fan, Magic Johnson, and AIDS.

Children, as well as the parents were surprised to see how many microorganisms live all around us, and they wanted to know about them. Mr. Parker was Henry's father, and they had attended all Family Science sessions from the pilot year until the end of the first year. In the summer of 1993, they moved to South Carolina. When he was interviewed in the spring of 1993, a question was asked regarding which activity he had liked the most. He said:

> *I will never forget what we saw and learned about microorganisms. I have a physics background. It was amazing for me to see all those growths from different places. I think even the kids loved the activity and were surprised to see how many organisms are around us* (6/1/93).

Discussion

By doing the activity on microorganisms, the children as well as the parents developed an understanding of microorganisms as well as many skills which they did not have before, for example, the use of a control in experiments. After Mr. Parker's

description of his growth with listerine, Anthony described his colony in the same way. Although it seems that Anthony imitated Mr. Parker's style in his response, this too is a type of learning. Children develop concepts from the things around them, and what they see and hear (Heath, 1983).

> *Mr. Parker: I used listerine on one side. But it seems to have an effect on it.*
> *Anthony: I put listerine on this side. It really doesn't help* (10/29/92).

The activity on microorganisms required different skills. The participants had to use a petri-dish to culture the microorganisms. It was the first time they had used this piece of equipment when doing an activity. Holding the petri-dish, infecting the medium with a cotton swab, and covering it were all new skills that they had to develop. Each child took several samples, about five. On the first day of the experiment they enjoyed the activity of taking samples from different places. They were debating whether or not this was science that they were doing. One said that he never knew a toilet seat cover was something for a scientific experiment. Children also loved to work with new things, such as petri-dishes.

On the second day, they were able to describe their colonies using the shape, color, smell, and appearance. In order to do this description, they needed to carefully and compare the samples. They had to share

their observations with others by reporting them to the whole group. The discussion in the whole group helped the children to understand some features of microorganisms. They were able to report what they had observed, because they carried out a methodical procedure which required a variety of manipulative and science process skills. To describe their findings to the group, first they had to carefully observe what type of colonies they had grown. By reporting these observations to the group, they developed communicating skills.

In addition to the development of skills, they also learned about microorganisms, developed an understanding of where microorganisms live, and how beneficial and harmful they were. An interesting feature to note from this activity is what made them be so engaged? They did an activity that was closely related to day-to-day life. All had had the experience of sickness, getting the flu, sore throat, and so forth so they could articulate this in their discussion. It made them interested in doing the activity.

Assertion 2

Children liked doing science activities in the Family Science sessions than reading science in textbooks in school.

As revealed by the children, they wanted to learn science by doing hands-on activities. They did not like to sit in one place and listen to the teacher, or read about science in books, which they referred to as "reading science." Some children did not have science in the school, and even if they did they read things in the book and had demonstrations of some other things. But the children liked to do things rather than listening and reading. Anthony was motivated to attend Family Science when he came to know that they could do fun activities. The following excerpt reveals that Anthony wanted to do something other than reading, and decided to come to the Family Science sessions:

Me: Who asked you to come to Family Science?
Anthony: Myself
Me: You selected it? Why did you select it?
Anthony: Because I like science, because you do fun stuff.
Me: Who told you that we are doing fun stuff?
Anthony: My friends
Me: O.K., what do you mean by "fun stuff?"
Anthony: Don't you know, the stuff that we do.
Me: We do lot of things. Tell me what do you really mean as fun stuff?
Anthony: We do more stuff here than in our classroom. We do reading sometimes, we never do projects, nothing.
Me: What do you do for science in school?
Anthony: Nothing in science.
Me: You are in the fourth grade, and you don't do science?

Anthony: We don't do science.
Me: I am sure your teacher would have shown you something, some experiments for science.
Anthony: You mean here?
Me: No, not here, in the classroom.
Anthony: No, no, never (11/12/92).

Luz, Rita and Julia who were fourth graders, perceived science in school the same way as Anthony did. They said that they never had science in school. Luz said that she had a good teacher who used to show some fun things for science, when she was in the third grade, but that the fourth grade teacher did not teach science. It appears to me, from what they told me, that they did not have science experiences in school.

The perception of the junior scientists about science was the same. They did not have experience in using most of the basic science equipment, like pipettes, droppers, and measuring cylinders. One junior scientist said, "*Science in school is mainly what teacher does. He'll explain to us.*" Even the skills like cutting and pasting were improved at the sessions, which was observed very visibly when they made hot air balloons.

To give an overview of how children felt about science in school, and how they perceived what they learned about science at the Family Science Project, five profiles of children are presented; namely, Sarah, Luz, Julia, Rita, and Kate.

1. Sarah

Sarah joined the Family Science Project at the pilot level, when she was in the third grade. She used to come with her brother and mother, and she never missed the sessions. She said that she liked science and wanted to be in the Family Science Project to study science. As she was in the Project since it started, I couldn't get her perceptions about scientists and science before she joined the Project. She was the only one who drew a female scientist at the pre-interview stage. Not only that, after she had drawn a female scientist, she showed her scientist to Dr. Rodriguez and said, *"I don't like my picture. This is you* (Dr. Rodriguez.)" It seemed to me that Dr. Rodriguez had become a role model for Sarah to have high aspirations. She wanted to be a scientist. Her perception about scientists was also different from the other children's perceptions. To her scientists were females, but they could be anyone, "*Scientists are younger women. They can be anybody. They are nice. They help people with stuff like* (Dr. Rodriguez.)"

Sarah did not work with her mother in the same group. She liked to work in a different group, but I noticed that whatever she did, she showed it to her mother. Most of the time she worked with the junior scientist, Myra. When I asked her whether she had any preference about working with a particular junior

scientist, she said that it did not matter, but that she preferred to work with a female. She said that she liked the way Myra helped in her in the group activities. Myra helped her hold things together when it was hard to put the three mirrors together, and she had given Myra some tricks required in the experiments. She believed that working in a group helped her do the science activities. "*It is easier to work with someone. We can use all of our ideas.*"

Sarah was planning to work as a junior scientist in the future when she goes into the seventh grade.

2. Luz

Luz was a fourth grader who was in the Project in the first year. She came to sessions with her younger sister, Lucinda, and her mother. She missed some of the sessions because she suffered from bronchitis. At the time she joined the Project, her interest was in doing some science activities. As the following interview transcript shows, Luz enjoyed what her third grade teacher did, and appreciated the teacher's suggestion that she join the Family Science Project. She felt that she had missed science in her fourth grade class, and wanted to be in a program that dealt with science. The behavior of Luz's fourth grade teacher was a bad reflection on her, because she did not teach science:

> *When I was in the third grade, I learned all the planets and everything. And we did a play on the planets. But then when I went to the fourth grade I really didn't know science that much. We didn't do science at all.*
>
> *My third grade teacher asked me to join Family Science. When we did science, we would do it like at the end of the year. We did like papers of rain and stuff. But we didn't do it like she* (Dr. Rodriguez) *taught us. She* (regular teacher) *just gave us a piece of paper. And we read it out loud. But it was also only a few times. She doesn't teach that much. Her favorite subject is social science.*
>
> *Family Science helped me to learn science a little better* (5/3/93).

When Luz was promoted to the fifth grade, she had a teacher who taught science, sometimes with help from a Michigan State University graduate student. She was happy with the fifth grade teacher and the projects that she asked them to do. Because Luz talked about the teachers, I asked her how would have she felt if her fourth grade teacher had come to the Family Science sessions. Her response implies that Luz considered that her fourth grade teacher had not learned science, and that prevented her from teaching science:

> *I wouldn't care if she was there. I think she'd think we were learning, and we were. I mean I think that we were learning, but at the same time we got to play. I don't think she really learned science. But I think if she went to them then she'll learn, and teach them in her class.*
>
> *I think* (Dr. Rodriguez) *knows more than her.* (Dr. Rodriguez) *teaches at a higher level, but she tells us what that, meaning of that word. So it's like she teaches at a higher level, but you really don't notice it because she guides you* (5/13/94).

What Luz described about the teacher was told by her mother and some of the other fourth graders, too. Luz liked Family Science, and came to most of the sessions with her six-year-old, first-grade sister, Lucinda. She said, "*I like it because we don't have to sit there and listen to people talk.*"

According to Luz's fifth grade teacher, Luz developed her ability to ask questions from Family Science. She was very pleased with Luz's behavior. (This was in the second year of the Project.) She said:

> *(Luz) has developed a very good sense of questioning, I think. She's the one I've really noticed more than any one else. And....well, just think...I don't know what she was like last year. But the development and the types of questions she asks are really, really good. I don't know whether her mother has participated with her. I think that has a lot to do with it, when there is a parent there on a consistent basis. The kids that come are kind of hit-and-miss, and you know, might not have somebody* (5/27/94).

When I compared what Luz was like when she started Family Science to what her fifth-grade teacher told me, I could see a tremendous growth in her. At the time Luz joined the Family Science Project, she could not even tell her name in front of the group. Dr. Rodriguez tried to make her talk by giving her some clues to which to respond. Failing that, Dr. Rodriguez gave Luz another chance, after all the other children had introduced themselves. Luz still kept quiet. When I interviewed Luz during the pre-interview, she did not tell me what she wanted to be, but at the post-interview

she said that she wanted to be a brain surgeon. The way she responded at the post-interview stage compelled me to ask why she had been so shy at the beginning. She said:

> *I was shy, because I didn't know nobody. I mean I knew people who were in my class, but I'm saying I didn't know any junior scientists.*
>
> *After a while I got comfortable in being there, because they could help me and stuff* (5/13/94).

Luz's case provides many ideas about the role of a teacher. She made all the comparisons of the teachers when she was only in the fourth grade. She compared her negative attitudes toward the fourth-grade teacher by comparing her with the third-grade teacher, fifth-grade teacher, and Dr. Rodriguez. The main idea from Luz's statement that the teacher educators should consider is that a teacher needs to build a good rapport with the students. From what Luz told me, her fourth-grade teacher taught social studies most of the time, which made the children think that that was the teacher's favorite subject. And, at the same time, the children assumed that the teacher did not know science because she did not teach science. This is a good example to show that it is not only teachers who label the students, but students, too, put labels on the teachers according to their behavior. Teachers need to recognize what students bring with them to the class, and to

integrate that rich source of information in their teaching.

3. Julia

Julia was a fourth grader who joined the Project during the first year of the Project because of Luz's interest. Luz and Julia lived very close to each other, and visited each other very often. Luz told me that Julia was not only a friend, but also like her own sister. They were also classmates. The neighborhood where they lived was composed of different ethnic groups. Julia said, "*I am black, white and Indian.*" Her answer surprised me, and prompted me to reply "*What?*" She repeated the same answer. Although I wanted to pursue why she had said that she was a member of three different ethnic groups, I did not ask the same question again. I was uncertain why Julia had said that she belonged to three ethnic identities. Her mother was a white. I did not see her father, but her hair made me think that her father was black. I interviewed Luz before my interview with Julia. Luz very proudly said, "*I am Mexican. I speak Spanish, and I can understand it well, but I can't write.*"

Of all the children who wanted to be junior scientists, Julia was one of them. To her the most interesting thing about the Family Science sessions was making things. To her, "making things" meant doing the

activity and having a product like the periscope, kaleidoscope, tower, tee-shirt with chromatography design, and so forth. The following narrative shows how much she enjoyed making things:

> *I like Family Science, because the way we make things, like what I made last week* (race car). *Now I can make things that I didn't make before. Junior scientists know how to make those better. I want to be a junior scientist, and one day a real scientist to make things. We don't do science. We do math, not science at all. I don't think she* (teacher) *knows science* (5/25/93).

Even the scientist that she drew was holding something (Figure 7). The scientist had a table in front of her with labeled bottles on it, and written on the table was "*Do not remove.*" I asked what she meant by writing that. Her response was, "*Scientists are busy people. This one, she is doing a workshop and went to the bathroom, leaving her stuff ready for the workshop.*" It gave me the impression that she had drawn Dr. Rodriguez. But as Sarah told me, she did not tell me that it was Dr. Rodriguez. There was a caption saying, "*She is getting ready to do an experiment on making a play horse.*" I had to ask the meaning of the caption to understand what she thought. Then she said, "*That is what she is going to do in the workshop.*"

When Julia was telling me about the lack of science in fourth-grade class she was angry. That was the first time her mother had heard that Julia did not have science in school. When I interviewed the mother, she



She is getting ready to do an experiment on making a play horse.

Figure 7 Julia's scientist

tried to control her anger by not finishing what she wanted to say about the teacher:

> *I think that is something that she could go to. She might learn something at the same time. She signed up for a couple of things which didn't work. I think she enjoys it. The way she talks about it. I wish it would last long. Each week she tells me the different things that she does. This is a thing that she can learn science and help her. I didn't know until she told you now that she hasn't had science in school, which I think she needs. I don't understand why she (teacher) is doing that. Last year she had a very good teacher. He asked us to come and watch them in class. This woman....* (5/25/93).

Julia's mother was a college student. Although she said that she looked at Julia's homework, it appeared to me that she could not have done it regularly, or spent time with her, because she did not know that her daughter did not have science for a whole year. Julia's interests matched the Project's activities, which led her to have high aspirations.

At the time that Julia passed on to the fifth grade in the spring of 1994, Dr. Rodriguez taught science for her regular class in the school. Another professor from MSU, who was the director of the "La Clase Magica" Project, also taught some reading classes, which I videotaped. I wanted to get Julia's perception about the teaching they had in the classroom compared to other teachers to understand how the nonformal environment worked for them. Her reaction was:

> *It was different. With* (Dr. Rodriguez) *we did experiments and with* (Dr. Vallejo) *we wrote autobiographies. With other classes that I was in you do work out of the book. I like it better with them. When we do experiments you put more work into it. And I like...And I like making things better than I like to write. Like in Family Science, it helps me to do team work. Like the way with* (Dr. Vallejo), *the other teachers don't ask you to write autobiographies, or about what we like, or about our childhood* (5/10/94).

This gave me the impression that Julia thought regular teachers in the school did not ask questions regarding the children's background, but that children would have liked it if they could have shared these things with other students. Julia's statement, "*The other teachers don't ask you to write autobiographies, or about what we like, or about our childhood,*" says a lot about how children feel when they are asked about their lives. By asking children about their experiences, teachers can help keep children engaged and interested in classroom activities.

4. Rita

Rita also joined the Project during its first year, when she was a fourth grader. Her mother came to the sessions late, a little after they had started, because she had to come after work. Rita lived with her mother and brother. Her father had left them, and they moved to the house, where I interviewed them (10/12/92). It was very close to the school, about a five-minute walk. At the time I did the pre-interview, they had just moved

in and were remodeling the house. When I talked to Rita, her brother, who was in high school, also joined us. According to her brother and mother, "*Rita was a baby.*" I had to repeat each question that I asked of Rita. I was not sure whether it was due to my accent or because she needed time to think. But the questions that I asked were very simple, just so I could get some information about her (Appendix 8). To her, scientist was a person who worked with fossils. When I asked, "*What are fossils*?" she could not tell me. Her response linked the word "*science*" with the word "*fossil*" that she had heard somewhere, without having any real meaning for her. For most of the questions her response was, "*I don't know.*" Even if she said something, it was just a one-or-two word answer.

At the post-interview stage (5/3/93), she answered me without any hesitation in complete sentences. "*I like Family Science, because I got to do a lot of fun experiments. I didn't like it when I had to wait.*" To her, "fun" meant doing a lot of things. The image of a scientist was also changed at this stage. She said, "*Scientists discover things. They discover things like cures for illnesses. They can be males, females, anybody. But you have to work hard.*" Her drawing of a scientist was a female with long hair holding a conical flask with the caption, "*She is trying to figure out a medicine for an illness.*" (Rita had long hair.) On the

desk of the scientist there were test tubes, a flask with fumes and a microscope (Figure 8).

Rita was the only child who attended both the Family Science sessions and the La Clase Magica (LCM) sessions for one year. She attended Family Science when she was in the fourth grade, and LCM in the fifth grade. When she was in the fifth grade, Dr. Rodriguez taught science to her class during the spring term, and Dr. Vallejo, who was the director of LCM, taught reading. I interviewed Rita toward the end of the spring term (5/10/94), to find out her perceptions about their teaching compared to the regular teachers in the school, and to see whether she had made any connections between the nonformal, after-school programs with her formal school work. She said she liked the science that she had in Family Science better:

> *Doing science in the classroom is different, because we don't get to do a lot of stuff. I like Family Science better. We get to know people and do science experiments* (5/10/94).

Rita felt that she had developed her thinking skills by participating in both the Family Science and La Clase Magica programs. In the classroom, they had the opportunity to talk with friends at a site in Texas through electronic mail. This program, called "Science with Friends," was also directed by Dr. Rodriguez. The use of computers in the classroom and in LCM helped her



Figure 8 Rita's scientist

use the computer at home to write letters and to stories.

> *I like both. In Family Science you do interesting stuff. But you have to figure out a problem or something. You have to think in LCM, too. If you are playing a math game on the computers, you have to think of the answer. I like working on computers and playing games. Now that I have a computer at home, I write letters. Sometimes my autobiography and stories* (5/10/94).

Rita believed that she had improved her reading, writing, and speech (especially Spanish) because both the project directors talked to her in Spanish. She said:

> *I can only speak Spanish, understand it. I don't know how to write it.* (Dr. Vallejo and Dr. Rodriguez*) speak to me in Spanish. Some amigos* (people who helped them) *spoke Spanish too* (5/10/94).

Rita's classroom teacher, Mr. Blake, had worked as an amigo when he was an undergraduate at MSU, and continued to work in LCM even after he had joined the staff of Highland Elementary School. I wanted to know from Rita how she had felt when Mr. Blake was in the school and in LCM. She liked it when he was in LCM. "*I like when he is over there, because he doesn't give us work.*"

It is evident that the children did not like to do writing, and the other work that they had to do, seated at one place. They were always motivated when they could talk and do something. The only thing that Rita could remember (pre-interview stage) about science in

her school was a dissection that she had done when she was in the third grade *"We dissected worms. We saw little things like eggs. They looked like eggs, but that was part of its body."* This indicates children like to do hands-on science projects.

5. Kate

Kate attended the evening Family Science Project sessions for two years with her mother. They did not miss any of the sessions, and they used to be there on time, also. In the first year, she was in the third grade and was eight years old. She was the only child in the family. As I had seen her mother in the sessions, when she was in the fifth grade I asked her about her father. She said:

> *He doesn't live with us. He lives very close on* (Hamilton). *I usually go to my dad's or he will come and pick me up. Sometimes my mom will take me over there* (5/13/94).

Kate had come to Family Science upon her mother's request; "*Because my mom thought it would be fun for me and her to do, and she thought it would be a good thing for a family thing.*" She repeatedly told me several times for different questions that she enjoyed the Project. I wanted to know why she enjoyed it. To her, Family Science sessions were interesting because she felt more comfortable there with her mother, and it was a very relaxed atmosphere compared to the classroom.

Further inquiry on what she learned in school for science versus what she learned in the Project, brought the following reply:

> *I learned a lot more stuff than I learned in school because we hardly don't, we didn't hardly have science in our class. It was more fun to be there than in the school. We just read a book and talked about it. That's science* (5/13/94).

I asked Kate what she thought about science. Her response was, "*You get to do experiments and you get to learn more stuff.*" Her response impressed on me the fact that she considered science to be the only benefit that she received from her Family Science participation. I asked her how she would have felt if her teacher was in the Family Science sessions. She said, "*I won't behave differently, because I know that like my teacher is going to be learning more science with me and my friends.*" I felt that those children had been led to think that their teachers did not know science because they did not teach science.

Kate had gone to LCM twice. I wanted to know what she liked and disliked about the programs. She said that she had always wanted to be in the Family Science Project, because she went to it with her mother. Her mother was not home in the afternoons, because she had to be at work. Kate used to go to another program in the community center. When I was there for some volunteer work, I saw Kate in another person's program.

I asked her about that when I interviewed her. She said:

> *Oh, it's on every day from three to six. I never did my homework over there. I did my homework when I got home from there. We color. We, the junior leaders, had to do work...and stuff. They have to do work for like errands and stuff. You do fun things. It keeps kids from being bored at home* (5/13/94).

According to Kate, she had gone to that program because her mother asked her to go, telling her that it was illegal for a minor to stay home alone without an adult. She spoke about the other two programs--Family Science and LCM--as being programs that would enhance her learning in school. She said that she had developed an interest in learning Spanish because of attending the two programs. I was curious to know whether she could speak Spanish, or what had motivated her to learn Spanish. She said:

> *A girl in our class Maria, she speaks Spanish, and the girl behind her speaks Spanish to her. When I was in Family Science,* (Dr. Rodriguez) *always said things in Spanish, too. When I hear it, I feel like I should know it. I thought it is better if I can understand another language. My father is an Indian, and I'm Indian too. My mother is white* (5/13/94).

The interaction with students of different races might have developed into an interest to appreciate other cultures.

Discussion

Research evidence (Millar, 1989; Lemke, 1990; Driver, 1989) discusses the importance of incorporating children's ideas into teaching situations. Furthermore, they say that children's ideas are built on their experiences. Integrating these experiences helps increase children's curiosity about what they do. As presented under this assertion, the children loved to do the science activities. This was mainly because of the nonformal setting, and because they were not have a afraid of being criticized for a wrong answer. In the group discussions to solve the problem they did in the activity, they were able to easily communicate with the others because all of them had a similar vocabulary. These conversations, or the dialogue that they had, helped them think and understand the scientific concept.

To me, it's not unusual that elementary teachers have a fear of teaching science. Because of the experience I had with the elementary teachers in Sri Lanka, I was able to understand the teachers' fears about science. Since most of the teachers did not have a background in science, they neither considered themselves to be experts in the field, nor had the confidence to teach science, and so tried their best to avoid teaching the subject. As Luz and other students mentioned, it appeared to them that their fourth-grade teacher did not know science. They made this assumption

because of their experiences in learning, and because of her excessive teaching of other subjects such as social studies instead of teaching science. From what Luz, Julia, and Rita said, they wanted to learn science, but their teacher did not provide them that opportunity. As Julia said, children love to share their experiences with their teacher and class. We should not forget the rich source of information that children bring to the classroom that we can articulate in our teaching (Duckworth, 1990). Only then will teachers be able to help children discard their misconceptions (Roth, 1990). Science helps children think critically.

An important thing to consider from these findings is that, as we try to make children realize their potential to learn science, elementary teachers should also be convinced that they could teach science without a strong background in science, if they have the interest and commitment, because learning science is a social process. An important requirement of effective science teaching is an environment in which children can interact verbally and nonverbally and engage in some kind of science activity.

Assertion 3

Interpersonal relationships developed in the group activities promoted better understanding of the concepts underlying the hands-on science activities.

The participants of the Family Science Project did hands-on science activities in small groups except when they made hot air balloons and during individual activities. In a small group there were generally two to three children, a parent and one or two junior scientists. In a regular day there were about four small groups.

All the junior scientists said that they liked the program and learned science. Some especially mentioned working in groups with the children. Rafael said:

> *I learned to work in groups. I want to learn ideas from everybody. It was pretty fun to work with younger kids. They had their own decisions. I had mine. We discussed and worked together to see which ones were better* (5/25/93).

In the regular sessions, the Project Director, Dr. Rodriguez, gave the students a problem to solve by assigning them to engage in an activity. During the activity time, each one in the group had the right to bring out any idea that s/he wanted. The others had to listen to each member. If they agreed with the speaker, they could add to or clarify any of the things, and if

one did not agree, then s/he had to give an explanation as to why s/he disagreed and make suggestions for better solutions. As Lemke (1990) suggests, these discussions, "talking science," helped them develop a better understanding of what they were doing, rather than following a step-by-step demonstration.

The activities, such as when they had to build a bridge to support a chalk board eraser, or erect a tall tower using straws, needed several trial-and-error attempts to reach a group consensus. At the post-interview stage, when I asked about the group activities, they told me how difficult it was to make their tower stand erect. For this activity, the problem was to build a tower as tall as possible from drinking straws, strings (balls of yarn) and scotch/masking tape as materials. They were allowed to use any amount of tape, straws and strings to build a tall, erect tower. Dr. Rodriguez said:

> *Your job is to build a tower. One straw over the other. Figure out how many straws you need....Anchor the tower on table using masking or scotch tape....Try to anchor it with one string, two strings, three strings, four strings....If you are designing a tower, what is the minimum number of strings you use? Figure out how tall you can build* (11/19/92).

There were four groups working at four tables. Except for one group, the other three groups had a parent with whom to work (Figure 9, Table 3).

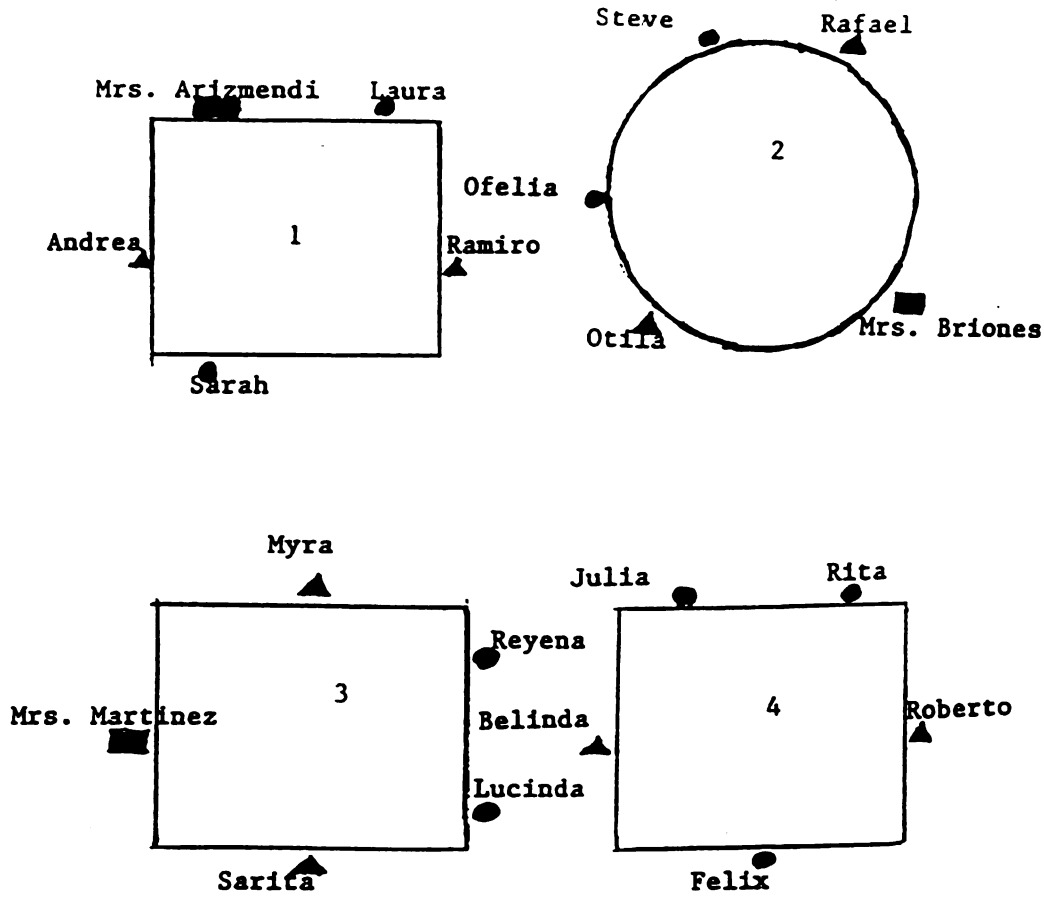


Figure 9 Group distribution

Parent

Child

Junior Scientist

Table 3

Group distribution

Group	Junior Scientists	Children	Parent
1	Andrea, Ramiro	Laura, Sarah	Mrs. Arizmendi
2	Otila, Rafael	Steve, Ofelia	Mrs. Briones
3	Myra, Sarita	Luz, Reyena Lucinda	Mrs. Martinez
4	Belinda, Roberto	Felix, Julia Rita	------

The group members had to anchor their tower onto the tables. Each group tried to make their tower the tallest. The first task was to put one straw over the other, which was not an easy task to start with. The following excerpt reveals how Group 1 started building the tower:

> *Andrea: Let's stack straws*
> *Ramiro: How many?*
> *Andrea: Can you remember how she put one straw over the other? It's hard.*
> *Sarah: Squeeze that end*
> *Mrs. A: Do two at a time. O.K., try to put this thing.* (the squeezed end of one straw to the end of the other straw, 11/19/92).

They tried to anchor the tower after putting the straws together. Ramiro did not talk much, but he asked Andrea to hold the tower. As it was leaning, Sarah helped Andrea hold it. Ramiro tried to put tape at the

base to hold the tower. Mrs. Arizmendi suggested using strings to strengthen the base. But Ramiro said that he could stand the tower up without any strings. He asked the others to hold the tower until he could balance it. Andrea and Mrs. Arizmendi put tape on the table in the form of braces. When it stopped swirling, everyone in the group tried to put on tapes to balance the tower. It looked like the roots of a palm or coconut tree (Figure 10a). They were finally able to stand the tower up erect.

The other three groups tried to keep the tower erect while building it. Otila and Rafael started with a three-straw tower. Then they tried to add more straws to the tower. When it started leaning, Rafael suggested anchoring the tower using strings:

Rafael: I think we need to put some strings at the middle.
Mrs. Briones: How many strings we should use?
Otila: Maybe four

They used a round table, and, with the help of everyone, they tied the strings connecting the middle of the tower to the underside of the table. When the tower stood erect, Rafael tried to add two more straws to the top of the tower. To do that he had to stand on a chair to reach the top of the tower.

Ofelia: This reminds me of the radio tower.
Mrs. Briones: Yes, the antenna on the freeway. It has several string like things. We should add more strings.
Rafael: I am wondering to balance with three. I think it is better with three.
Ofelia: What's wrong with this?
Rafael: If we can do it by three, why four? (11/19/92).

Although Ofelia's idea of the transmission antenna would have helped them in thinking further, it was not done. When they were trying to tie the strings to the table, they had difficulty in fastening the ends of the strings from the tower. Mrs. Briones brought some heavy books from a book shelf and balanced the strings. When Rafael got the idea to balance the tower using three strings, they undid the strings, and tried to balance the tower using three strings. It took a while to balance the three strings. One thing they found was that, when it leaned to one side, they then had to pull the strings in the other directions. Another thing that they tried was adjusting the distance between the strings. With fine adjustments of the distance between the strings, they were able to stabilize their tower.

The two junior scientists--Myra and Sarita--worked with Luz, Reyena, and Lucinda. Mrs. Martinez also worked in the same group. They had a square table on which to work. At first, they tried to erect a five-straw tower using tape. When the tower leaned to one side, they tried tying on strings as an alternative, without having any confidence that it might work. The following excerpt reveals that their attempts were achieved by imitating and learning from the other groups:

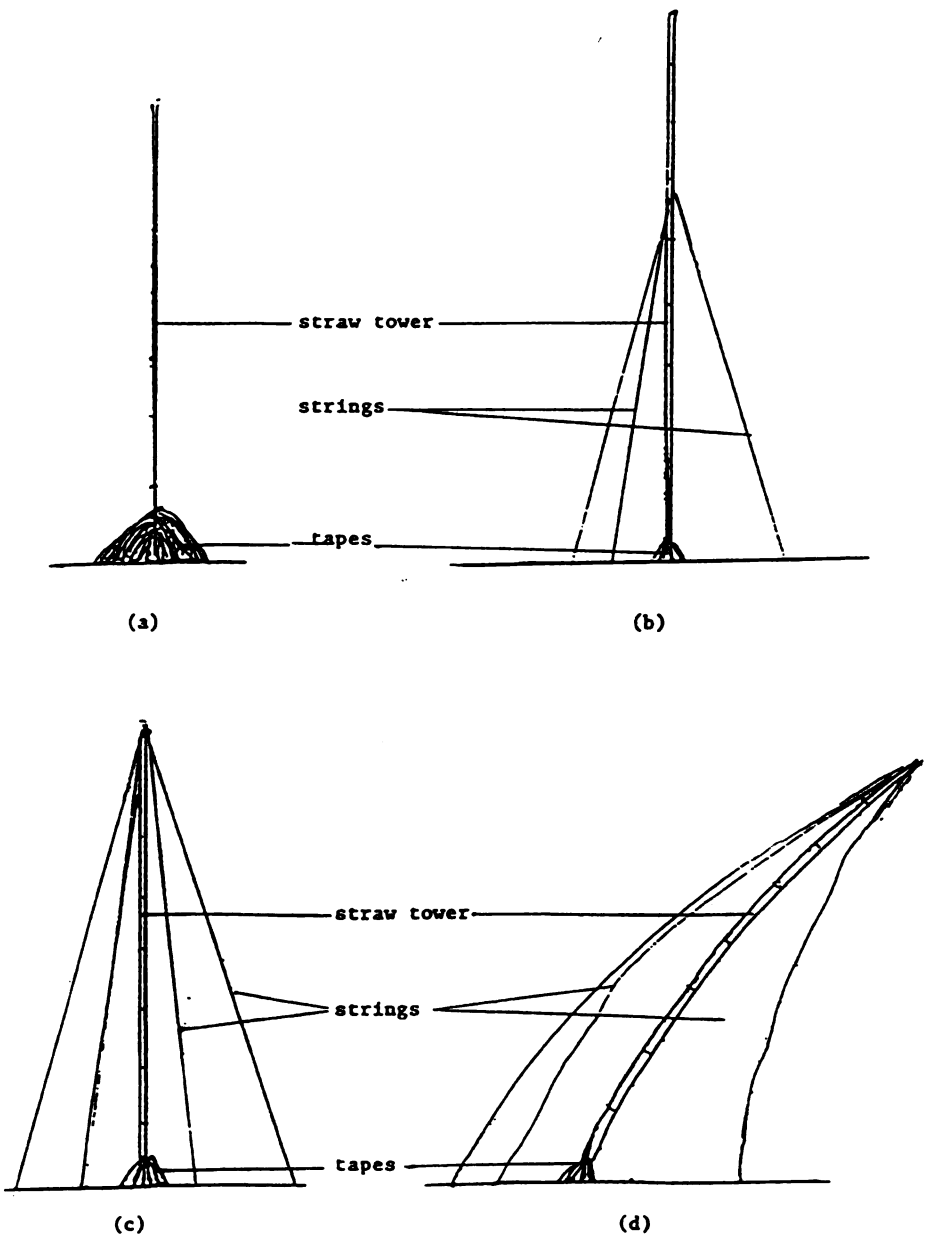


Figure 10 Towers

Sarita: Look what Ramiro does? Let's put tape here.
Mrs. Martinez: They are using masking tape.
Myra: (Lucinda), *go get masking tape.*
Luz: This thing doesn't work. (Luz thought masking tapes could not hold the tower.)
Reyena: Where are we going to use strings?
Sarita: Maybe, maybe to the top. (She always had the habit of looking at what other people did. When she said, "maybe," she was looking at Otila and Rafael's design.)
Myra: To the top? Where?
Reyena: To the corners.
Myra: Corners?
Lucinda: Four corners of the table.
Mrs. Martinez: Who is going to tie the strings to the top?
Myra: I am the tallest, I can do it (11/19/92).

Myra stood up on a chair to tie the strings at the top. Then the other members of the group helped by tying the other ends of the strings to the table legs. When it balanced, Lucinda wanted to add another straw to the top. That successful adding encouraged them to add straws one by one. But after adding two more straws, it was hard for them to make the tower stand erect, and they gave up adding the third one. Their tower had eight straws in total. It reached almost to the ceiling.

Group 4 also had a square table on which to work. The junior scientists Belinda and Roberto worked with the three children--Felix, Julia, and Rita. They also started out with a five-straw tower. Unlike the other groups, they started balancing the tower by using string. It was successful at the beginning. When they added more straws to the tower, however, the tower

tended to bend to one side. Then they tried using tape at the base, as the other groups had done. At one point, the tower broke in the middle. One-half hung on to the strings, and the other half stayed on the table with the tape. After fixing the two halves, they tried to straighten the tower, but they failed (Figure 10d).

Except for Andrea's and Ramiro's tower, all the other towers had eight straws. Myra's and Sarita's tower was the only tower that did not stand erect. During discussion time, two questions were asked, "*Why did the group 4's tower not stand erect? Which group's design was the best for stabilizing the tower*?" These questions led the participants to think. No one gave a quick answer. Dr. Rodriguez had to break down the question into very simple sub-questions to provoke their thoughts. *"Let's see, how many used only one string? Nobody? Two strings? Three strings?"* Otila and Rafael's group raised their hands. They had to explain what they did. Luz said that it was Rafael's idea to have three strings. As no one else in the group responded, Rafael said that they used four strings at first, but then he thought that it might be more evenly balanced with three. Then came the question, "*Which design is the most stabilize*?" Pointing to the group 3's design with four strings, group 2's design with three strings, and group 1's design with no strings, Dr. Rodriguez asked, "*Which design is better? Why do you*

think one is better than the others?" Again, there was silence for awhile.

Then Dr. Rodriguez tried to get an explanation as to why group 1's tower was standing erect without any strings. Ramiro's group had an erect tower, but it was shorter than the others. They were able to stabilize the tower only from using tape because of the way they constructed the tower. Ramiro first cut the edge of a straw and inserted the end into another straw. The others learned from him how to insert one end of a straw into another. When they inserted one end of the straw into the other, they made a cut and inserted the end of the one straw as much as they could, which gave the tower additional strength. When they constructed the tower, even the taping was done by Ramiro at first, and then the others imitated him.

Dr. Rodriguez tried to give the students some clues to make them think by saying, "*Try to think about the towers that you have seen.*" It helped Ramiro to come up with evidence to support his design:

> *Ramiro: I can remember the towers in cities do not have any kind of support like strings.*
> *R: Can you remember the shape? Is it uniform? uniform....all the way up, or different?*
> *Ramiro: Broad base, gradually narrows*
> *R: Which tower do you have in mind? I am not giving you an answer. Think about it. When you go in the car, look at towers to see how they are supported. Talk to your parents* (11/19/92).

Mrs. Briones asked Dr. Rodriguez about the transmission antenna with braces in the broadcasting station mentioned by Ofelia. Without giving an answer, Dr. Rodriguez again posed the question to the whole group. Then Rafael said, "*I think even that tower* (group 3's tower with four strings) *could be balanced by three strings.*" Rafael's response was close to the concept in civil engineering and architecture that utilized a triangular configuration to give a building structural stability (Roth, 1994). Then the discussion was directed so that they could understand the stability of triangular configurations.

It appears from the conversation in group 3 that there was not as much thinking as in the other groups. The initial statements of Sarita, Mrs. Martinez and Reyena were made by looking at the other groups' designs. Reyena's question of asking where to use the string does not reveal any thinking, because they were either given string with which to work, or else the other people were using string. The important thing to take note of from this group is that they learned by imitating the others. Although the four string configuration is not a stabilized configuration, it worked fine for them because the tower was anchored to the middle of a square table. Lucinda asked to tie the strings to the four corners. (I could not get any evidence from her as to why she had suggested anchoring

the tower using the four corners of the table.) Because the table was square, the four strings tied to the four corners helped stabilize the tower. But no one questioned why she used four strings or why the strings were tied at the top.

The tower of group 4 also had tape at the base and strings to support the tower. But it did not stand erect. When Dr. Rodriguez asked them to compare their tower with the others by looking at how the strings were connected, the tape was glued, and where it was anchored, Felix noticed that their tower was not anchored in the middle like in group 3. The others also agreed with his assumption, but they did not have time to redo it.

Group 2 used four strings at first, and then used three strings. Rafael was guided by the initial question asked by Dr. Rodriguez, "*What is the minimum number of strings you must use*?" According to him, when he was looking at the table, he suddenly remembered the symbol of "Benz cars." The Benz symbol helped Rafael think a stabilized structure with three strings--a triangular configuration.

Discussion

The examples given earlier show that the group members were able to get an understanding of the concept by sharing with each other. Their prior knowledge

allowed them to articulate the scientific concept. While they were engaged in the activity, they did not have any knowledge of what principle they should use. But by trial-and-error, and from learning what the others were doing, they were able to refine their construction, and later during the discussion acquire some knowledge about what they had done. As Collins (1987) described, the knowledge that they gained through these activities could be called "craft knowledge." He defines craft knowledge, in contrast to scientific knowledge, as an acquired skill. They worked as members in a community. Being a member, one had to share her/his ideas and skills with the others. The participants in the group experienced themselves to be part of a community in which they shared their knowledge, skills and attitudes. In this nonformal context, they learned effortlessly while they were engaged in an activity. In these activities, learning was driven by skills, and from them knowledge was acquired.

The group interaction enabled the children to talk with the junior scientists and parents to find solutions to their problems. They had a focus for their discussion, because they had been given a problem. The junior scientists knew what they had to do because of their experience of doing the same hands-on science activities on Tuesdays. So, in this context,

conversations were focused so as to achieve a stated goal. The same question or given problem could be understood differently by the members in the group, because it was a mixed ability group. Questions that the children had were discussed in the group to facilitate an understanding, and by pooling their experiences they were able to achieve a new level of understanding. This understanding was beyond the level that the children had had before, because after the discussion and working together with the others, through social interaction, they were able to do the activities. As Edwards and Mercer (1987) said, people share their knowledge not only within the school, but also in many places outside school. In the Family Science sessions, by doing different activities the participants were able to develop a variety of skills and dialogue. In developing these skills, they did much sharing. By pooling their ideas they could come to a consensus and also solve the problem. Thus, they developed knowledge through mutual understanding.

In a regular classroom setting, because of the authority that the teacher has, it is easier to misunderstand what the teacher says due to the limited ability to initiate a dialogue with the teacher or share ideas or a mutual understanding. In the Family Science sessions, they were not alone. They knew that junior scientists and parents would help them in doing the

activities. As Vygotsky (1978, p.26) says "*Children solve practical tasks with the help of their speech, as well as their eyes and hands.*" The opportunity that the children had in the Family Science sessions in doing the activities and communicating what they were doing with others helped them understand what they were doing. This was possible because of the assistance given by the junior scientists or parents during the group dialogue, and Dr. Rodriguez's facilitation during the wrap-up time. This is comparable to Vygotsky's concept of the zone of proximal development (ZPD). He defines ZPD as:

> *The distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers* (1978, p.86).

Group activities in the Family Science sessions helped children go beyond their ZPDs to understand the scientific concept underlying the hands-on activities.

Assertion 4

The elementary grade students acquired a variety of skills from the Family Science Project.

Elementary grade children were assisted by junior scientists and parents in doing science activities. As Figure 9 shows, junior scientists were seated in such a way that each group had a junior scientist in it, so that all the elementary children could receive their

assistance. Parents were also divided among the groups so that each group had at least one parent in it. Participants were seated in the groups so that they could talk to each other and see what each one was doing. This kind of an environment was necessary in group work, in order to involve the group members in the discussions. Neatly arranged rows of desks and chairs does not engender the relaxed, interactive atmosphere required for group dynamics. This was the main reason that the Family Science sessions were conducted in the kindergarten classroom where the desks and chairs could be moved.

Science activities that the participants of the Family Science Project did were interactive and hands-on in nature, and as such were different from the activities that they had to do in school (Table 4). Their science classes at school were predominantly reading, worksheets, and whole class discussions. The Family Science activities, however, were based on the *same* scientific concepts that they had to learn in school. In addition, doing hands-on science activities helped the children develop science process skills. The remainder of this chapter (Assertion 4) reports the children's skill development in the following skill categories: manipulative, observation, prediction, estimation, classification, discovery, data recording,

Table 4

Activity/skills

Activity	Manipulative skills	Science process skill/s							Social norms			Understanding
		Predicting	Observing	Measuring	Estimating	Recording	Inferring	Discovering	Patience	Sharing of ideas	Acceptance, respecting	
Water drops on a penny	holding the dropper, dropping,	X	X	X	-	X	X	X	X	X	X	surface water has a secret skin, "surface tension" water drop has magnifying property
Water drops on a piece of wax paper	holding, moving the bubble, making a sizeable drop	X	X	X	X	X	X	-	X	X	X	surface tension

Table 4 (Cont'd).

Affect of detergent on bowl of water with pepper, talc, milk and food coloring	adding drops	X	X	-	-	X	X	X	X	X	X	surface tension
Apples on a string, blow between	tying, holding	X	X	-	-	X	X	X	X	X	X	air has force
Plastic bag under books, blow up	holding, stacking, lifting, blowing	X	X	-	-	X	X	X	X	X	X	air pressure
Paper air planes, parachutes	cutting, folding, balancing	X	X	X	X	X	X	X	X	X	X	air pressuere
Hot air balloons	copying the template, gluing, cutting,folding,	X	X	X	X	X	X	X	X	X	X	Hot air is lighter than cold air
Hot water volcano	holding, cutting, fixing connections	X	X	-	-	X	X	X	X	X	X	Hot water is lighter than cold water
Hot/cold water circulation	placing equipment, connecting tubes	X	X	-	-	X	X	X	X	X	X	Hot water is lighter than cold water
Pick up balloon with cup	blowing, placing	X	X	-	-	X	X	X	X	X	X	Outside and inside pressure
Rainbow trout	taking liquid to the glass tube, sealing	X	X	-	X	X	X	X	X	X	X	Density
Diasappearing penny	Pouring, placing the penny	X	X	-	X	X	X	X	X	X	X	Reflection, refraction

Table 4 (Cont'd).

Mirrors, Periscope, Kaleidoscope	holding, pasting, assembling mirrors	predicting, observing, inferring, hypothesizing	patience, sharing ideas	Reflection, images
Lenses	holding	predicting, observing, inferring, hypothesizing	sharing ideas	Reflecton, refraction, magnification,
Microbiology	holding petri-dishes, culturing	predicting, observing, discovering, inferring	sharing results, safety measures	Beneficial and harmful microorganisms
Acids in our food, cabbage indicator, Drugs in our environment	using droppers and test tubes, adding reagent	predicting, observing, discovering, inferring, hypothesizing	sharing ideas, accepting ideas	Acidity, basicity Indicators to measure acidity and basicity
Chromatography	using droppers, drawing, coloring	predicting, observing, inferring, hypothesizing	collaboration, sharing ideas	Many colors compose of different colors
Osmosis	pouring, adding, holding	predicting, measuring, observing, inferring, hypothesizing	patience, sharing ideas,	Movement of water from a higher concentration to a lower concentration
Building bridges	holding, cuttiing, connecting,	predicting, observing, estimating, discovering, inferring	collaboration, accepting ideas	Center of gravity, balancing forces
Building towers	holding, tying, connecting, taping	predicting, observing, estimating, designing, discovering	collaboration, accepting ideas	Balancing forces, stabilized configurations
Mouse trap cars	removing fixed parts, aligning, tying	predicting, observing, measuring, estimating, discovering, inferring	collaboration, patience, accepting ideas	Velocity
Bubbles	holding, making bubbles	predicting, observing, discovering, inferring	patience, collaboration	Surface tension

and communication. Each section describes and then discusses evidence of skill development in a particular category found in various children. Assertion 5 discusses the development of attitudes. The chapter concludes with an analysis of the results.

Manipulative skills

The hands-on science activities required good manipulative skills. For example, the activity on hot and cold water required such manipulative skills as holding, pasting, fixing, adding, pouring, and measuring. Making the hot air balloons required manipulative skills of holding, spreading, copying, cutting, gluing, and hanging. Children develop these skills as they experience performing different activities.

Manipulative skills that the children perform help develop science process skills. According to the children they did not have an opportunity in school to do hands-on science activities to develop their manipulative skills. Of the different kinds of manipulative skills, the skill of adding drops that the children did in two activities, is discussed in the following two paragraphs to illustrate the importance of developing this skill. The activity, "water drops on a penny," required more patience and manipulative skills than the other activities. During the wrap-up time of

this activity, Dr. Rodriguez discussed the different techniques that the children had used to add more and more drops, which required trained manipulative skills. The children used different techniques. The children shared their strategies for adding the drops with the others, as the following excerpt reveals:

> *R: Can everybody wipe your penny now? Someone tell me what techniques you used?*
> *Jose: I did it slower and small drops*
> *Karena: I spread them on* (10/21/93).

They were able to put on more drops of water after they had practiced than when they started (Table 5). Some of the younger children had better manipulative skills in adding drops than the junior scientists did.

Table 5

Predictions Vs Observations

Name	# Predicted	# Observed
Jaime	1	40, 51, 46
Jose	22	18, 33, 44, 51, 31
Karena	21	45, 49, 50, 51
Steve	5	12, 13, 16, 25
Sylvia	3	12, 24, 21, 22, 23

When they did the activity on tee-shirt chromatography, they had to add alcohol drop-by-drop on a particular color in order to separate it into different colors. Using a dropper was a manipulative skill that they had not developed before. Because of

the way they had used droppers in an earlier activity, they were asked to try dropping water onto tee-shirt material samples, in order to experiment on the tee-shirts without wasting alcohol. Dr. Rodriguez demonstrated how to add alcohol on the colors in their designs to separate the colors. To get the design they had to add alcohol dropwise. It was necessary to consider the size of the drops and also the angle of the added drops to get the desired design:

> *There are two ways you can drop alcohol. There is an opening at the top. You can add a drop by drop. .... Drop-by-drop right above your design like this or to sides of the design like this. Isopropyl alcohol is expensive. It's a chemical. Be careful in using it. Do not squirt* (11/18/93).

Discussion. Hands-on science activities require manipulative skills. In the pilot year of the Project, there were some activities for which the use of a dropper was needed. Having a background in working with college biochemistry students, Dr. Rodriguez assumed that using a dropper was a skill that everybody had. Due to her experience in working with elementary and middle school children doing the pilot year of the Program, she changed her style of introducing the activities which needed droppers, in the first and second years. She made them practice using the dropper before doing the activity. Although all the manipulative skills that the children developed are not discussed here, a summary of some of the skills

developed while doing the activities are given in Table 4 under the heading "activity/skills."

Observation skills

All the hands-on science activities that the children did needed to be observed carefully in order to make suggestions or solve the problem(s) given in the activity. When they did the activity "water drops on a penny," the children had to do observations so they could think about the properties of water. Dr. Rodriguez asked everybody to fill up the penny with water. (Hereafter in this study, "R" is used to designate Dr. Rodriguez.):

R: O.K., now everybody fill up your penny with water. Now look at the water on the penny and describe the penny.
Karena: It looks like the same penny.
R: If I have to describe who is (Karena) *then I say* (Karena) *has black hair. You have to say something like that to describe the penny. Look at the penny through the water. Say what does you see? Is there a man in the middle? Look at the guy's hair. Can you see short hair like* (Rumaldo's)*?*
Sarah: He got curly hair.
-----: He got a beard. (Name unknown)
R: Are you sure that he got a beard?
R: How can you see a man only when you put water on the penny?
Jaime: Makes it bigger, magnifies
Sylvia: It makes a dome.
R: If it makes a dome, what can you tell me about water?
Sylvia: They pack together (10/21/93).

The above excerpt shows the children's observations, and how Dr. Rodriguez helped them to

describe their observations. Then the children were asked to observe whether they could break the surface of the dome:

> *R: Now put a drop of water and try to break it with a toothpick. Did you break it?*
> *Group: No* (10/21/93).

This led to the discussion that water on the top of the penny acted as a tight skin and a lens, which magnified things on the surface of the penny. Dr. Rodriguez pretended the she and the junior scientists were molecules of water. They held each other's hands and made a close compact circle to show how water molecules stick together:

> *R: In third grade you learned about water. Water is made up of molecules. We are now going to talk about molecules. Let's see what they look like. Come here junior scientists. We are part of water. Do we like to stick together? Yes. We like to be together. Water likes to stick together.*
>
> Dr. Rodriguez held hands with the junior scientists and made a circle.
>
> *Karena, you are the soap molecule, try to get into our circle....*
>
> (Karena entered the circle, breaking the hands of two junior scientists.)
>
> *R: Now I want you to touch the soap with the toothpick and then touch your drop of water.*
> *Jaime: C--o---o---l*
> *R: Did it stay together?* (10/21/93).

The discussion that followed the above narrative provided them with knowledge about surface tension by comparing their observations of the water on the penny

before and after touching soap. Dr. Rodriguez used simple terms and described "surface tension" as the attraction that water has to each other on a surface. She further said that some people called surface tension "water's secret skin." At the discussion time, they talked about examples of surface tension that they had seen, such as bubbles and insects walking on water.

An activity that all the participants took a long time to finish, and which needed careful observations was, chromatography. There were three activities for chromatography. The first activity on chromatography was to separate colors using different colored markers. Dr. Rodriguez started the session by asking a question about the meaning of chromatography:

> *R: What is chromatography?*
> *Mr. Parker: Something to do with colors.*
> *R: Right, separating colors. What property did you use to separate yellow and blue blocks?*
> *Henry: Color*
> *R: Yes, color is a property. But one color may be composed of several colors....We are going to do real chromatography to separate colors* (10/28/93).

After introducing chromatography, Dr. Rodriguez described what they had to do in the activity. They were given filter paper strips, and were asked to write the name, color, and brand name of the pen at one end. On the other end, about one inch from the bottom, they drew a line using a pencil so they would know where they had started, then they draw a line from the colored marker. Then they had to hang the filter paper so that

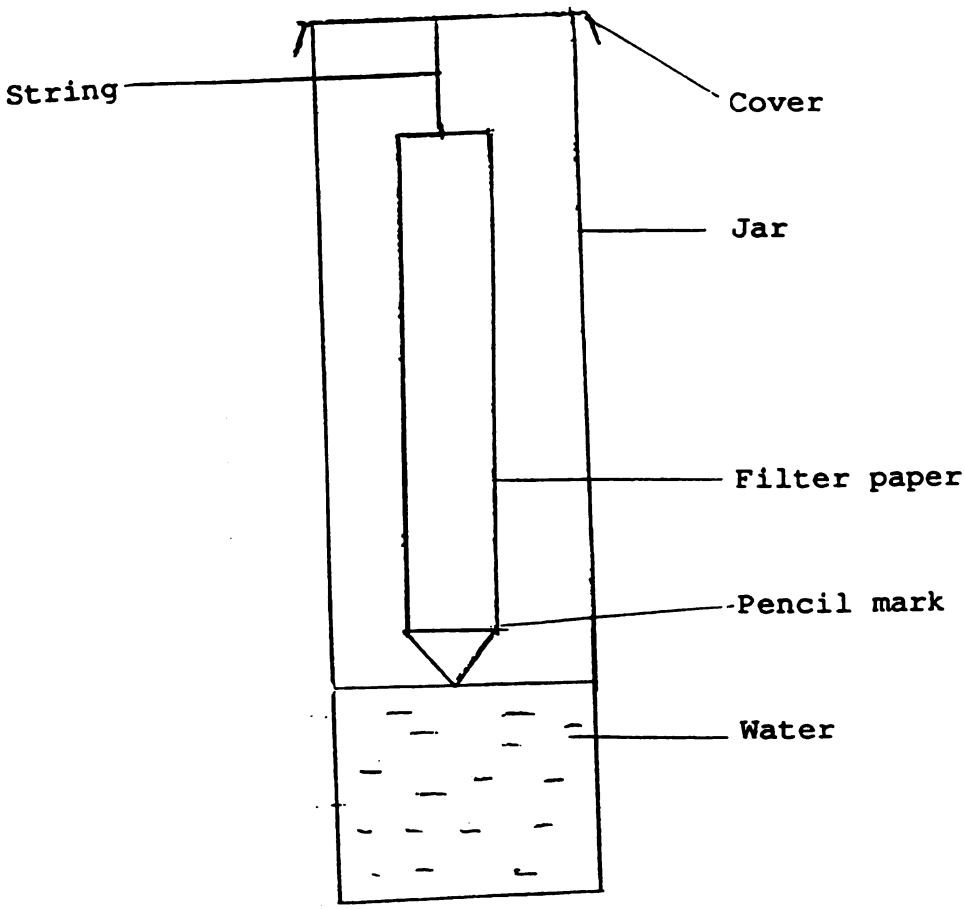


Figure 11 *Filter paper strip*

it touched the water's surface (Figure 11). Many students were not able to follow the instructions in the order given. Some forgot to draw the pencil line before they drew a line from the marker. This blurred the starting position where the colors separated, since there was no pencil line with which to compare. Things such as tying and hanging the filter paper strip so it would touch the liquid needed manipulative skills so that the students could then do their observation. Since the members of the group helped each other in tying and hanging, they were able to overcome that difficulty.

A discussion followed when everyone had finished with their observations. Each person shared with the others what color they had used and how it had separated into different colors. For example, Henry said, "*I started with red. At first it got wider and then started to turn yellow. Then it went up and turned to pink.*" At the end of the activity they wanted to keep the filter paper strips with the different colors spread allover as book marks.

The second activity that they did on chromatography was to find the mystery color that Dr. Rodriguez had used in the given filter paper strips. They had to match color separations using different colors and different name brands to identify the mystery color. It involved not only observation skills but also thinking

skills, as well as some hypothesizing to eliminate and identify the color.

The last activity on chromatography was to make a permanent picture on a tee-shirt. To design their picture on the tee-shirt, they had to observe what was happening when alcohol was added at different angles and the colors that they could get from different permanent markers. When Solomon finished doing the tee-shirt, he took it to the window to get more ventilation than inside the classroom. While Solomon was waiting for his shirt to dry, I started a discussion with Solomon:

> *Me: Did you like making tee-shirts?*
> *Solomon: Yeah.*
> *Me: What did you learn in doing chromatography?*
> *Solomon: You could use it to catch forgers. I want to be an FBI agent.*
> *Me: What techniques did you use in doing the tee-shirt?*
> *Solomon: I drew it and put different color dashes.*
> *Me: How did you get this pattern?*
> *Solomon: I just dropped it right on one side.*
> *Me: If you would have added it this way, what would have happened? I am going to make a tee-shirt too. What hints could you give me to put a pretty design on the neck line?*
> *Solomon: You want to put a line, have the line go around. Put dashes, and put it on sides so that it goes to your neck line. If you want to go down, put it on top.*
> *Me: Why did you use alcohol?*
> *Solomon: Alcohol spreads.*
> *Me: Why does it spread?*
> *Solomon: I learned that alcohol spreads. Water and vinegar do not spread permanent colors. Alcohol has stronger films than water and vinegar* (11/18/93).

Discussion. What Solomon meant by "alcohol spreads," was alcohol could separate even permanent colors, unlike that water and vinegar which cannot dissolve permanent

colors. Solomon's responses gave me sufficient evidence that he had good observation skills, while doing the tee-shirt material samples. Without having carefully observed, he would not have been able to direct me on how to do the neckline for my tee-shirt. Developing observation skills is very important in the scientific process, and also in everyday life. Although Solomon did not use the scientific terminology to describe the different solvents' actions, the understanding he had on solubility and the skills he had developed from the activity were sufficient for a fourth grader.

[Some children used this activity on chromatography to show their gratitude to people they loved. Andrew lived with his grandmother, who was a teacher's aide in the school. On the back of his tee-shirt he wrote, "I love you, grandma," and on the front he had a big heart with the letters "grandma" on it. One mother did "I love my children."]

In the activity of water drops on a penny, Dr. Rodriguez's method of the children's observations and sharing with others allowed her to have them figure out how water molecules were attracted to each other to form a tight skin. When the children failed to break the surface of water on the penny using tooth picks, they realized that the surface of water acts differently than other surfaces. Using terms like "water's secret skin," along with the scientific term "surface tension" in the

discussion, helped the children understand the concept without rote memorization. At the same time, the discussion on the things found written on the penny, such as the letters and the figure of a man, enabled the children to visualize the magnifying property of water.

Prediction skills

In each activity the children were given a problem and they had to first predict what would happen, and then find out what really would happen. Making predictions helped them think. For some activities they were able to predict closely to what actually happened. But for other activities, such as milk and food coloring, and water drops on a penny their predictions were far from reality.

When they did the activity with milk and food coloring, the participants were given bowls of milk and asked to wait until the milk settled. Then they were asked to add four drops of four different colors to the milk, as shown in Figure 12. Dr. Rodriguez asked them to do predictions on what would happen to the four drops of food colors before they touched the tooth pick dipped in soap into the center of the milk. No one was able to accurately predict what really happened in this activity. They were surprised to observe what was happening to the colors, as the following excerpt reveals:

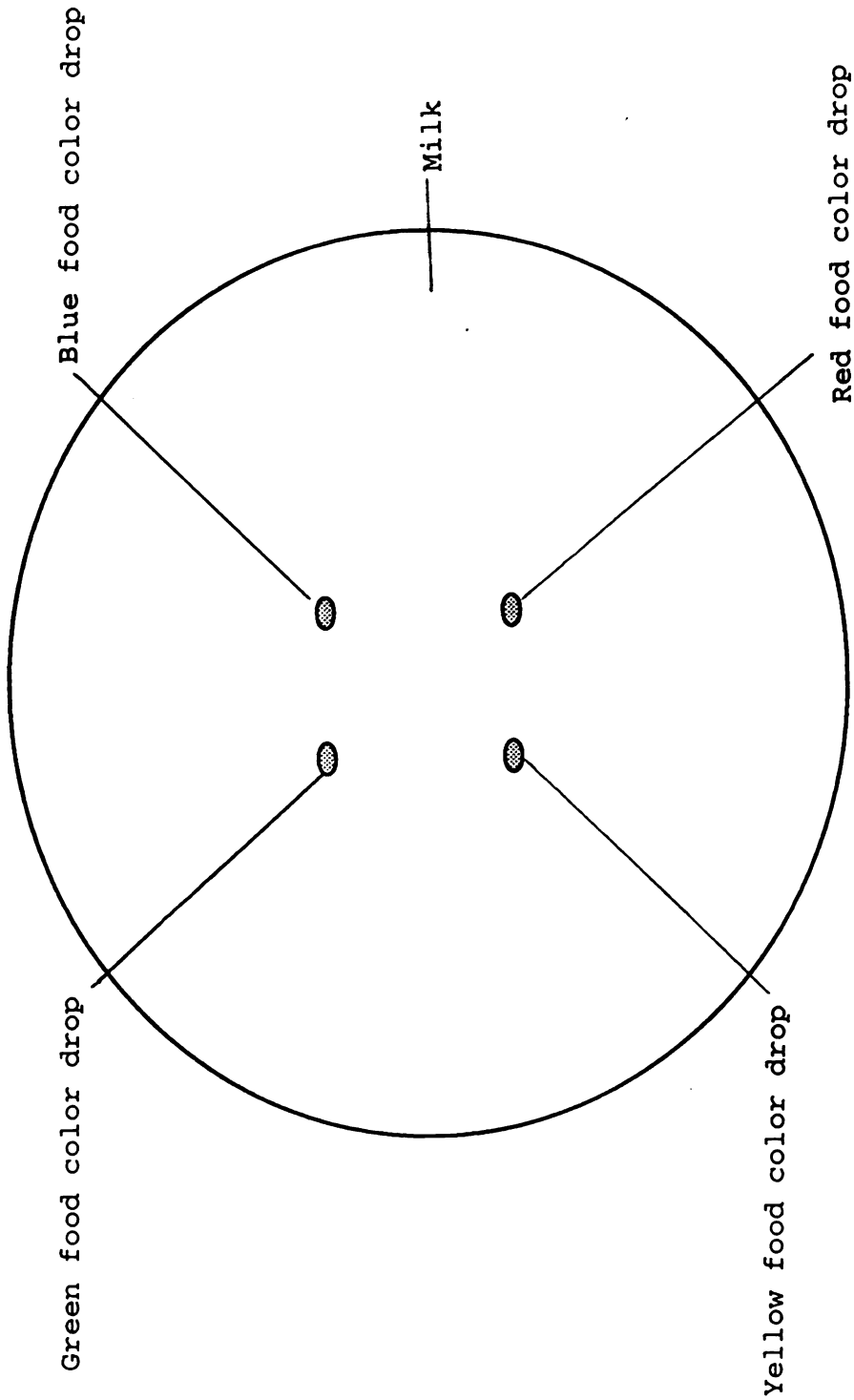


Figure 12 Drops of food color on milk

Alberto: Go off to the sides.
Rumaldo: Going to mix.
R: After you touch a fat drop of soap at the center, you have to look at least for a minute. Then you can experiment.
Kasey: Oh! I like it. Oh! My gosh!
R: Take the toothpick out of it and keep watching.
Rumaldo: Look at, it's going. My g-o-s-h! Isn't that c-o-o-l? Magic. I would show my mom.
Kasey: I never thought that it would have happened. It's good that we do predictions (10/21/93).

They had the same kind of excitement for this activity that they had had when they did the activity "water drops on a penny." Dr. Rodriguez introduced the water on a penny activity by saying:

> *There is a penny in front of you. Put the penny in front of you and tell your junior scientist how many drops of water you can put on the penny. Then try to put on as many....Now test your predictions* (10/21/93).

Before doing the activity, each one had to predict how many drops of water they could add on the penny. They could not believe how many drops a penny could hold. They tried it several times, to add more and more water drops on the penny. With practice they were able to add more drops than when they started (Table 5). People like Jaime, Jose, and Karena, who did the activity with lots of patience, were able to add more drops than the others. This was the first activity that they did since joining the Family Science Project. In the wrap-up time, they discussed what techniques were useful for adding more and more drops. After this

activity, the students did predictions whenever it was necessary.

Discussion. Dr. Rodriguez wanted the children to develop the habit of predicting. Predicting what would happen when they did the activity encouraged them to think about what would happen in the activity. For example, it was simple to think about how many drops of water they could add onto a penny, or what colors there are in a yellow marker. For some children, it was just like guessing what would happen, however they were thinking about how close they could come to what they would actually find. So, making the children predict about the outcome of the activity helped them think about what they were doing. Dr. Rodriguez emphasized importance of predicting and data recording when doing science activities by having the children make predictions before each activity. It was interesting to note how some children wanted to make a prediction before each time that they tried water drops on a penny.

Estimation skills

As described earlier in Chapter 2 with the description of the Family Science Project, for every session the participants had to do an estimation of items in a jar such as candies, jelly beans, and mints. The objective of doing estimations was to use their

observation skills and thinking to practice making judgments in everyday life.

One day (11/18/93), there were some colored Halloween candy cones for the students to estimate. Each candy had three colors--yellow, orange and black. It was difficult for most of them to do an estimation close to the real number. Their estimates were: Hilary, 28; Sarah, 47; Jose, 49; Harold, 100; Ricardo, 100; Anthony, 102; Sylvia, 102; Mrs. Briones, 105; Pat, 109; Andrea, 113; Jaime, 126; Solomon, 132; Mrs. Smith, 140; Jean, 150; Kasey, 160; Pamela, 205; and Christina, 250. Participants then stuck their yellow stickers on the line plot (range of 0-250), with their estimated number on top and their name on the back. Dr. Rodriguez would then go to the line plot which was hung on the chalk board. Looking at the line plot, Dr. Rodriguez said:

R: O.K., let's see. We have all the way to 50 from 28, and a lot about 100s. We have a few 150s and a 200. The actual number is, ... there are 133 candy cones.
Solomon: I am the closest.
Mrs. Briones: That's not what we do.

Dr. Rodriguez heard what Mrs. Briones told Solomon, and said:

R: This is a competition only about yourself. That's why you put your name on the back. The idea is not to guess, but to come close. Do you think this one was easy?
Solomon: No.
Jaime: Really, it did not look like 133.
R: What would make it difficult?
Jaime: Different shapes and sizes.
Steve: Different colors.
Jaime: Glass magnifies.

R: That's a good observation. Sometimes glass can fool you. In this case, I don't think glass distorts. I think this group is doing really good (11/18/93).

Table 6 summarizes the estimations made by ten children in five sessions occurring every two weeks. It shows that the participants were able to get closer and closer to the actual number with practice.

Table 6

Estimations

Name	27 mints	76 jelly beans	123 marsh-mellows	150 crackers	30 packing stuff
Andrew	45	82	101	140	28
Anthony	35	70	150	160	37
Jaime	36	79	127	155	32
Jean	40	80	131	145	33
Karena	41	30	100	148	30
Pamela	40	60	115	140	39
Pat	39	53	125	171	20
Sarah	37	41	95	168	34
Solomon	38	27	130	150	35
Sylvia	18	90	110	140	31
Average	36.9	61.2	118.4	151.7	31.9
Deviation	7.9	-14.8	-4.6	1.7	1.9

Henry was a fourth grader who attended the evening Family Science sessions. He came with his father, and never missed a session. His teacher told me that Henry demonstrated some of the things to his class that he had done in the Family Science sessions. This was further

revealed when he described to me how he demonstrated making helicopters and kaleidoscopes to his class. According to him, it was done upon the request of his science teacher. In responding to a question asking him about what he had learned by doing estimations, he said, "*Wait a minute. I'll be right back.*" He came with a glass bowl full of marbles. He said that he got some money from his father for doing some work at home. He wanted to spend that money to reuse his fish bowl as a glamorous object. He said:

> *I had fish in it. Everytime something happened to my fish. I thought I should use it as an ornament to decorate my desk. I wanted to fill it up with marbles. I estimated it might need 130. There is 126. Didn't I close*? (6/1/93).

Discussion. Estimation is a skill that is needed everyday in almost everything. Participants of the Family Science Project were able to develop their estimation skills with practice. As Table 6 shows, the deviation between the actual number and the predicted number decreased with practice in doing estimations. A positive impact of doing estimation in the Family Science sessions was that the children as well as the parents tried to apply what they had learned in the sessions to day-to-day life. Henry was happy to say that he was able to buy a sufficient number of marbles because of the experience he had in doing estimation. His feeling that he had learned by doing estimation, as

well as his demonstration, show his confidence that he is learning, and it also shows a positive impact on his developing self-esteem. Some parents told me that the estimations they had done in the sessions had helped them buy groceries for parties and in catering.

Table 7

Sinking and Floating

Item	Sink	Float	Group 1	2	3	4
Basket plastic	-	X	W	R	R	W
Bead	X	-	R	W	R	R
Clip	X	-	R	W	W	R
Clip plastic	-	X	R	R	R	W
Fork	X	-	R	R	R	R
Large cork	-	X	R	R	R	R
Nail	X	-	R	W	W	R
Paper	-	X	-	-	R	-
Penny	X	-	R	R	R	R
Pin	X	-	-	-	R	-
Plastic fork	-	X	W	W	R	R
Plastic knife	-	X	W	W	R	R
Plastic spoon	-	X	W	R	R	R
Rock	X	-	R	R	R	R
Rubber stopper	X	-	-	R	R	R
Small cork	-	X	R	R	R	R
Styrofoam ball	-	X	R	R	R	R
Tag	-	X	R	W	W	R
Toothpick	-	X	R	W	R	R
Wheel	-	X	R	W	-	R
Wooden block I	-	X	R	R	R	R
Wooden block II	X	-	W	W	W	W

R = Correct prediction W = Wrong prediction

Classification skills

People need classification and categorization skills in day-to-day activities. The activities in the Family Science sessions enabled the children to understand different principles and methods that could be used in classification.

One day (10/21/93) the participants of the Family Science Project were given wooden yellow and blue cubes to separate. They put the yellow ones in one set and the blue ones in another set. Then they were asked to put the blocks in water. Some yellow blocks floated, while others sank. Then the discussion focused on properties that could be used in classification. The children realized that, in addition to color, there were other properties that they would have to use to classify the cubes. This opened the discussion on "density." Why did some yellow blocks sink, while others floated? Given this problem, they had to do an activity on "sink and float." The children had to make two sets from the given number of items (about 20) as things that sink and things that float. After making the two sets, they tried each item separately by putting it in the water. They then compared their predictions with what they had observed (Table 7). (It was interesting to note that children wrote down their prediction before each item was tested.)

In the following session, they were given a mixture of yellow sand and blue salt to separate. While the groups were thinking, Dr. Rodriguez asked them to pretend that the blue items were sand and the yellow ones were iron filings. Jose said, "*I know, take a magnet. It will get the iron stuff.*" Then Dr. Rodriguez asked, "*What property did you use?* Henry said, "*Iron attracted to the magnet.*" While this discussion was going on, they wanted to talk about the decorative magnets on the refrigerators, and instances where they had used these magnets to grab pins and needles. Dr. Rodriguez encouraged them to have this kind of discussion, where their applications of scientific knowledge were brought into the real world. Again the question of separating a mixture of yellow sand and blue salt was asked. At once, Don said, "*Salt dissolves in water and sand stays.*" When Dr. Rodriguez asked how to get the salt back, Pamela said, "*Put it in the sun, the water will go off.*" After this activity they did chromatography to separate the colors in one single color.

Discussion. From the group responses it is evident that the everyday experiences of children tend to color which properties of the item to be floated or sank they see. The children brought together their knowledge about seeing things float and sink to tie in with what

they've observed in their world. For all the metal items (penny, fork) and rocks, they predicted they would sink. They were given three rocks of different sizes and color. Their prediction for cork and styrofoam was also correct. This example clearly illustrates that if children are given the opportunity, they can bring their ideas and prior experiences together to think forward. They can reflect on their experiences both in and out of the classroom.

The two wooden blocks used in the "sink or float" activity were not painted. They were the same size, and looked exactly the same. All the groups guessed wrong in their predictions, for the denser wooden block. They could not figure out why one wooden block floated and the other one sank. As Edwards and Mercer (1987) pointed out, there are things which children cannot be expected to discover for themselves, such as the principle of density used in floating. Their discoveries may not be matched with the intended theory, and assistance should be provided to help them understand the concept. Dr. Rodriguez knew the difficulty that students had in understanding why only one wooden block sank, and introduced the concept of density to them, using observations that they, themselves, had made. Thus, the process of knowledge they achieved was a socially constructed process. As I

mentioned earlier, Dr. Rodriguez taught science as a craft, or a social process.

Discovery skills

In about half of the activities in the Family Science sessions, such as making bridges, towers, helicopters, race cars from mouse traps, periscopes, and kaleidoscopes, the children had to discover their own methods for doing the activity. Some of these activities were done individually, while for still others collaboration was needed before they could start the activity.

In the activity to improve the speed of moving a bubble of water on wax paper (10/21/93), the children had to discover successful ways to move the water drop to its home. Underneath the wax paper was a maze drawn on white paper. The speed was counted as the time that one took to move the bubble of water from the starting point to its home in the maze. The junior scientists timed the speed of the moving drop of water. They had to start over if they spilled the water or if they could not move along the maze. After they had tried about five times, Dr. Rodriguez asked the groups what techniques they had used to improve their speed:

Anthony: I used the thicker side of the toothpick.
Solomon: Put the drop in the middle.
Pat: Smaller the drop, the quicker you go.
R: You were designing a game. What would you say for your players to make it as fast as possible? This is just a thing that you

> *discover. If you have bigger drops, what is the technique that you use?* (10/21/93).

With the use of different techniques for adding the drop, and with practice, the children improved their speed (Table 8).

Table 8

Time (in seconds) taken to move a bubble of water through a maze

Pat	Sarah	Karena	Anthony	Andrew	Solomon
15	26	30	28	23	20
15	29	20	32	01	15
22	19	35	32	25	22
25	30	35	33	-	27

The discovery skills expected to be used in the activity on microorganisms were different than the same skill used in other activities, because the children had to culture microorganisms for a week to observe whether there were indeed microorganisms in the tested areas. Besides the curiosity and eagerness to use microscopes, to their surprise, the students discovered that microorganisms grew everywhere they had tested.

Discussion. In most of the hands-on science activities, the participants had to figure out which way would work best for them when doing the activity. It

was not a quick process for the activities such as building a tower or making hot air balloons. But their curiosity and enthusiasm led them to keep involved in what they were doing, which apparently made them interested in doing science activities and also in participating in the Family Science sessions.

Data recording skill

Neither the children nor the junior scientists had the habit of recording their data. When they did the first activities like water drops on a penny, Dr. Rodriguez had to repeatedly ask them to record their results. They were given enough pencils and papers on which to do their rough work. At first, in the earlier sessions, the junior scientists recorded data. But gradually the children voluntarily started doing that task. When Pam, Julia and Christina worked as a group doing the second chromatography activity, Pam wanted to do the data recording. "*I'll do the writing today.*" She wrote the colors they had started with and what colors they got after doing the separation. That day she reported to the whole group, as it was easy for her to describe the results. When the children did the activity on sink and float, they wrote their predictions and then while they tested each item, they recorded the results.

Discussion. At the earlier sessions of the Family Science Project, the children did not understand the necessity of data recording. The activities that they did, such as chemical indicators, needed data recording to compare the results of adding indicator to different items to see the color change, and to classify acidic and basic items. When the children realized the importance of keeping records, they wanted to do it themselves. By developing the skill of data recording, they developed an important routine in the scientific process.

Communication Skills

As mentioned earlier in Chapter 3, one objective of the Family Science Project was to develop the communication skills of children. The children worked in groups doing hands-on science activities. The social interaction in these groups led them to develop their thinking skills. For some of the activities, like building bridges, they had to figure out which model worked the best. In the group, each one had to defend her/his idea against the others' ideas in order to find the best design, listen to others, and also defend their own idea with reasons while challenging the others' ideas in order to come to a consensus.

Some of the activities were done individually, such as "water drops on a penny." In that case, each

individual had to share what s/he found with the whole group. When they did any group activity, at first they had to communicate with their groups' members. Generally in a group there was a person to record the students' observations. Although they took turns in reporting, most of the time the person who did the recording, reported the results to the whole group during the discussion at wrap-up time.

Some of the responses given by the children in sharing their findings for the "floating the needle" activity are given below:

> *R: Can I have your attention everybody? What did you learn by floating the needle?*
> *Pamela: I put it sideways.*
> *Jaime: You have to put it very gently to the sides.*
> *Sarah: I failed to do it with the fork. I used my fingers.*
> *Pat: I used the fork and dropped the needle at an angle so that it slides on water.*
> *Anthony: I pulled it by the corner like this, and just dropped it.*
> *R: We heard so many different techniques. All were successful, so there is no one method to float the needle. Karena, what method are you going to use again?*
> *Karena: I like Pat's method. It might work all the time* (10/21/93).

Discussion. I noticed that within groups, while they were doing the activities, they were showing each other when they were successful. At the post interviews, when I asked them about their group work, many children told me it was beneficial to work in a group because you could learn from one another. Luz said, "*When you go*

wrong some one will guide you. Junior scientists knew how to do it."

Another activity that required sharing of ideas to a greater extent was when they had to build a tower from straws. The problem was, "How high can you build a single straw structure?" They were given straws, pins, scotch tape/masking tape and yarn to be used in any amounts. They worked in four groups, and shared their ideas on building the tower. Some ideas failed, and some were successful. The groups tried to figure out why some ideas were successful and the others had failed.

In the preceding section, I described how children had developed different skills. The data shows development of the children's skills in the following areas as a result of the Family Science Project: manipulative, observation, prediction, estimation, classification, discovery, data recording, and communication. The following section shows how children changed their perceptions and developed positive attitudes toward science and scientists, which made them develop self-esteem and high aspirations about their future plans. The following section will discuss what changes were observed in the children's perceptions about science and scientists, and their future aspirations.

Assertion 5

The Family Science Project helped the children envision new possibilities for their future.

At the first Family Science session of the second year of the Project in October of 1993, the participants were asked to draw a scientist and write what that scientist was doing. Most of them were hesitant to do it. Dr. Rodriguez noticed this and said:

> *We are not giving you a star or a grade. Come on* (Jose)*, just draw a scientist. Nobody will see your drawing except Sunethra and me* (10/14/93).

Except for one child, all the others drew males as scientists. The only child who drew a female scientist was Sarah, and that was in her third year of participation in the Project. She drew Dr. Rodriguez as her scientist, because she thought that Dr. Rodriguez was a scientist. She further said that, "*Scientists are younger women. They can be anybody. They are nice. They help people with stuff like* (Dr. Rodriguez.)" Sarah showed her scientist to Dr. Rodriguez and said, "*I don't like my picture. This is you Dr. Rodriguez.*" She wanted to be a scientist in the future.

Dr. Rodriguez asked the class whether they had ever seen a scientist. Nobody responded by saying "yes." Their silence and surprised faces made me think that they assumed that they could not see a scientist, so

that there is a distance between them and a scientist, so that they would not be able to be scientists. It was a great surprise for them when Dr. Rodriguez said that she would bring scientists to the community lectures, and asked them to bring their parents. One had the question, "*Are you talking about real, real scientists?*"

Participation in the activities in doing hands-on science activities helped the children as well as the parents build confidence in their ability to learn science. Many children wanted to be a junior scientist. For Julia, becoming a junior scientist was a stepping stone to reach the scientist stage. They respected the junior scientists, and liked to put on a white lab coat like them. In addition, they believed that the junior scientists were smart, because they knew what they were doing in the activities. Having junior scientists in the sessions had a positive effect for the children to build high aspirations about themselves:

> *Sarah: I like to wear one (lab coat). It helps get out of chemicals. Lab coats help us to know junior scientists* (4/29/93).
>
> *Luz: White coats look like they are scientists.* (Dr. Rodriguez) *told me I can wear one when I go to the seventh grade* (5/3/93).
>
> *Rita: It shows that they are junior scientist. I like to wear one because it gives a better look, excitement* (5/3/93).
>
> *Julia; I want to be a junior scientist, and a scientist to do things* (5/25/93).
>
> *Lucinda: It is fun to wear them. They look like real scientists. I like to wear it one day* (5/3/93).

As I described earlier (Assertion 2) they liked to do things, rather than just listening or writing. They were curious about what they were doing. They felt that what they were doing everyday was science. At the post interviews their response to the question, "*What do you think about scientists?*" was different than the answer they gave at the beginning of the Project. Some of the responses of the elementary students were:

> *Kate: They explore a lot. They find new things. Probably they have lot of fun* (5/11/93).
>
> *Sarah: Nice people. Old and young people* (4/29/93).
>
> *Luz: I think they really great. Because they got more brain than normal persons. They could be both women and men* (5/3/93).
>
> *Rita: They discover things. They try to find cures for illnesses* (5/3/93).
>
> *Julia: Really neat what they make up. They have coats like our junior scientists. They sit in the lab trying to figure out new things* (5/25/93).
>
> *Lucinda: Very interesting. They put on a coat like junior scientists* (5/3/93).

Because they said some positive things about scientists, I wanted to learn what they wanted to be in the future to get an understanding of whether they want to continue learning science. Following are their responses:

> *Kate: I want to be a scientist* (5/11/93).
>
> *Sarah: I want to be a teacher* (4/29/93).

Luz: I want to be a teacher, a brain surgeon 5/3/93).

Rita: I want to be a lawyer (5/3/93).

Julia: I want to be a scientist (5/25/93).

Lucinda: I want to be a scientist 5/3/93).

Of the six students, three wanted to be scientists, and two wanted to be teachers. The three who wanted to become scientists wanted to do things to engage in some kind of activity such as doing observations. The two who wanted to be teachers said that they wanted to teach science. This shows that the younger children could be motivated to learn science by providing them with positive role models. For further verification of what kind of perception they had about scientists, I asked them whether any one could become a scientist. Their answers were:

Kate: Yes, anybody can be a scientist (5/11/93).

Sarah: Yes, because they could be smart enough (4/29/93).

Luz: Yes, because even though scientists have more brain, but people have brains too, and there is little room for fun (5/3/93).

Rita: Yes, it is easy if you are interested (5/3/93).

Julia: Yes, if they listen (5/25/93).

Lucinda: Yes, because they don't have to be smart (5/3/93).

Although all six children said that anyone could be a scientist, the last person's response was different

from that of the others. When I tried to get some explanation, the child repeatedly said, "*Because it is easy.*" Lucinda was a first grader, and from what she said, I was not sure what kind of an image she had received about scientists. I was not clear if she thought that it is very easy to become a scientist or what other notions she had picked up.

They were asked to draw a scientist at the post interviews (not during the session time). Except for one student, all of them drew female scientists. The only person who drew a male scientist was a boy. Many drew their scientists with white lab coats on. This made me think that their perception of a scientist had been influenced by the junior scientists' behavior and the white lab coats that they wore. I also had a hunch that the people who conducted the sessions had had an impact on how they viewed themselves, because the Project Director, myself, the teacher who brought the junior scientists, the instructor in the evening session, and the undergraduate who came to assist in the evening were all females. In the 1994 fall semester, a male graduate student from the Biochemistry Department volunteered to help the children and junior scientists in doing the hands-on science activities.



Figure 13 A scientist

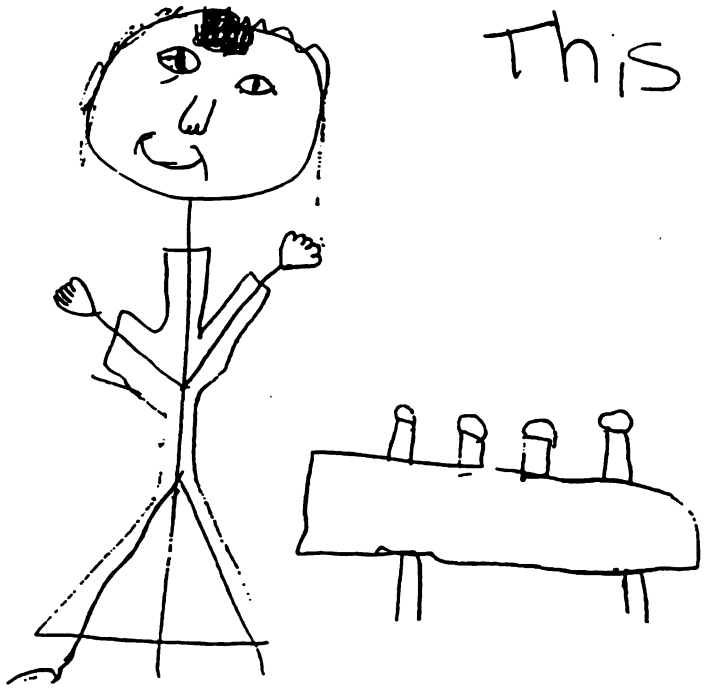


Figure 14 A scientist

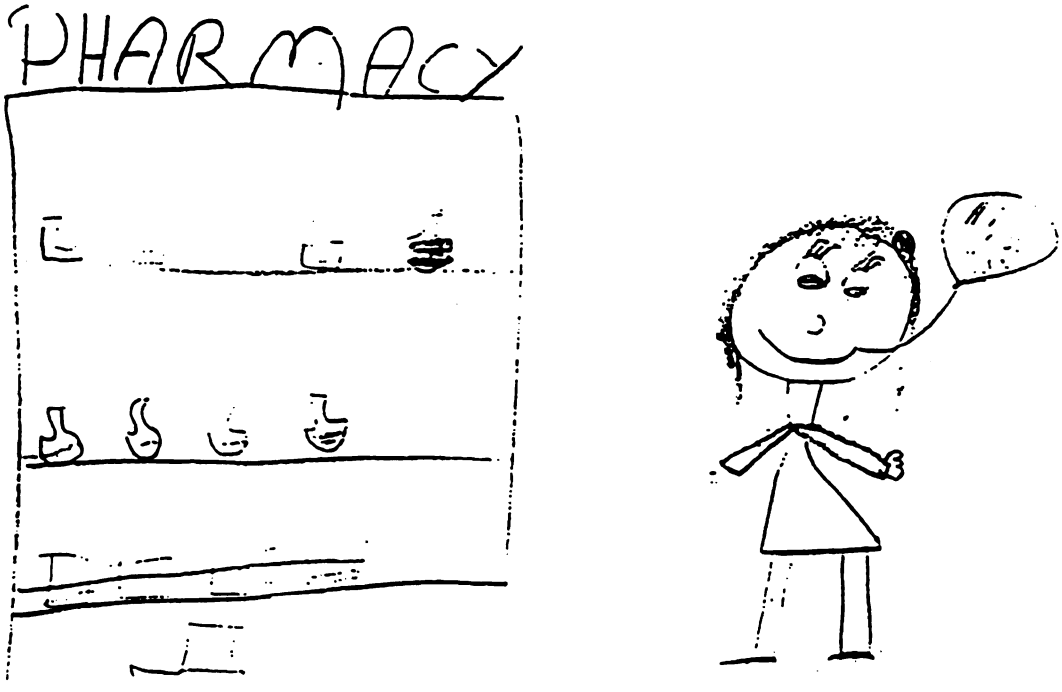


Figure 15 A scientist

Many of them had drawn the scientist holding something. In the interviews, when I asked, "*What is your scientist doing*?" most of them told me that the scientist was mixing chemicals. To them a scientist was a person who worked with chemicals and found new things. Even at the post-interview stage they wrote something about chemicals when drawing their scientists (Figures 7,8 & 13-15). It was not clear what made them think that scientists worked with chemicals. Although the activities in the Family Science Project required some materials from the kitchen and home, still for most activities the participants had to use test tubes, reagent bottles, and things like filter papers. These materials might have had an influence on them to think that scientists used chemicals. They did activities on heat (air pressure, conductivity, etc.), light (mirrors, periscopes, kaleidoscopes, etc.), and biology (microorganisms). For all of these activities some kind of science equipment was used. For the activities on acidity, indicators, and chromatography they used more chemicals and equipment than in the other activities.

For some children, scientists were people who invented new things. When I asked them, "*What kind of new things*?" most of them could not specify any. Andrew showed his drawing and said, "*He is designing a roller coaster.*" At the pre-interview (9/28/92), Steve told me that he wanted to be a pilot. I was with the community

liaison, and she asked Steve to tell something more about what he is planning to do when he is a pilot. His response was to describe fixing the pilot lamp in the gas stove. During that time he was a third grader. At the post-interview stage (4/29/93), he wanted to be a scientist. I observed that in all the children, the image of a scientist had started to change since they joining the Family Science Project.

Discussion

It was evident that the children's behavior had changed since they started attending Family Science sessions. The children who could not believe that they could see a scientist now wanted to be a scientist. Doing hands-on science activities motivated them to think that they could learn science, and are capable of becoming scientists. They had also changed their attitudes toward science and scientists. Realizing their potential to learn science and develop positive attitudes toward science helped them to build their self-confidence and high self-esteem, which apparently led them to think about their future goals.

Analysis

David and Palincsar (1991), and Anderson (1994) discussed how group members develop their understanding through collaborative efforts. As with their findings,

the students' engagement in the hands-on science activities of the Family Science Project enabled the participants to develop manipulative skills, and improved their predicting, observing, estimating, classifying, and discovering skills. In addition to the science process skills that the children developed, they also developed communication skills through reporting their findings, and sharing their ideas among the group members and the whole group. When one can understand a concept, then s/he develops the capability to use that knowledge, share it with others and apply what s/he learned. Doing science activities helped the students understand science concepts, along with developing the necessary skills. Through both questioning and answering the students increased their knowledge by reflecting on their existing knowledge.

In addition to developing scientific understanding, the interactions within the group enabled the children to develop positive attitudes toward science. Kunjufu (1984), referring to Freire's "banking model" in education, discussed that in a traditional classroom setting, minority children passively receive, store and deposit information, thus perpetuating the oppression of the minority group. He suggests that we adopt a mode of pedagogy which transforms the oppressive relationships of minority groups in the classroom. The environment of the Family Science Project was conducive for learning by

minority students (Hispanics) due to several reasons.

1) Children had a secure feeling for engaging in doing science activities, because they had a junior scientist or a parent to help;

2) They were able to talk and move around while doing the activity;

3) Dialogue among the group members was encouraged; and

4) They worked with a Hispanic professor who knew their culture.

As Sheriff and others (1965) said, the nonformal setting with peers helped them in developing positive attitudes by sharing values. This study also supports Slavin's (1990) thesis that cooperative learning affects children by developing high self-esteem. Having a higher self-esteem, they were easily motivated to engage in doing more and more science activities and to develop skills, attitudes and knowledge.

MICHIGAN STATE UNIV. LIBRARIES
31293014112928

MICHIGAN STATE UNIVERSITY LIBRARIES
3 1293 01411 2936

THESIS
5

LIBRARY
Michigan State
University

PLACE IN RETURN BOX to remove this checkout from your record.
TO AVOID FINES return on or before date due.

DATE DUE	DATE DUE	DATE DUE
SEP 2 2 [illegible]		

MSU Is An Affirmative Action/Equal Opportunity Institution
c:\circ\datedue.pm3-p.1

FAMILY SCIENCE: COLLABORATION, PEER INTERACTION, AND PARENTAL INVOLVEMENT TO BUILD HISPANIC CHILDREN'S INTEREST IN LEARNING SCIENCE

VOLUME II

By

Sunethra Karunaratne

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements for the
degree of

DOCTOR OF PHILOSOPHY

Department of Teacher Education

1995

CHAPTER VI

WHAT DID JUNIOR SCIENTISTS LEARN FROM THE FAMILY SCIENCE PROJECT?

This chapter first describes who the junior scientists were, how they were selected for the Project, and then what they learned, which fall under four assertions; namely:

1. The recognition given to "Junior Scientists" in the Family Science Project helped at-risk students develop high self-esteem and envision their potential to study and understand science.
2. Family Science sessions fostered comprehension of goals and directions among the junior scientists that had not developed as a result of their interactions in the school or community. This resulted in improved self-confidence and achievement.
3. Junior scientists believed that the qualities that they developed, such as patience and temper control, enabled them to keep the children on task.
4. Junior scientists provided role models for younger children to learn science.

Who Were the Junior Scientists?

As mentioned in Chapter 2, it was the Project Director's idea to have middle school students as adult peers or surrogate parents to help the younger children, because of the difficulty of getting parents to participate in the Project. She wanted to call the Project's middle school student helpers "Junior Scientists" to give them a status symbol. Mrs. Lopez was a friend of the Project Director and started teaching in a middle school close to Michigan State University. Upon the request of the Project Director, Mrs. Lopez agreed to participate in the Project on a voluntary basis, and to bring some Hispanic students from the middle school to the elementary school to assist the younger children in doing hands-on science activities.

Mrs. Lopez started teaching in this middle school during the first year of the Project. Because of this, she did not know much about the students or the school ethos. Although she agreed to bring students from her school, she was not certain how to do the selection, and so she asked for support from the teaching faculty and the principal of the school. Mrs. Lopez described to me the way she performed the selection:

> *I basically went to the science teachers and asked them to recommend students--Hispanic high-risk students-that they felt would benefit or be interested in participating in the Family Science Program. A number of teachers gave me a list of*

> *names. I didn't know them. Then I showed the list to* (Dr. Garcia), *the principal. He helped me go through and select children, from single-parent homes as much as possible, who needed extra help in education* (7/7/93).

The group of junior scientists in the first year of the Project were a mix of seventh and eighth graders, who were selected by Mrs. Lopez with the assistance of the principal. In the first year of the Project, Mrs. Lopez did not teach science. She taught only math, but was planning to teach science in her second year. She expected that she would understand the strategies used by the Project Director in conducting the Family Science sessions, and felt that these would be helpful in her teaching during the following year.

Except for two parents, all other first year junior scientists' parents were not educated beyond high school. The fathers were semi-skilled laborers, such as a baker, plumber, motor mechanic repairman, or a car mechanic (Table 9). Most of the mothers did baby sitting as a way of earning an income. Two families came to the United States two years prior, and were still trying to adapt to the new environment. These mothers took English classes at Lansing Community College. Two junior scientists came from single-parent homes, and one child's parents were separated. All the junior scientists received free lunch in the school.

Table 9

Background of first year junior scientists

Name	Grade	Age	Mother's Employment	Race	Father's Employment	Race	SES	Marital status of parents
Andrea	8	13	Social worker	Hispanic	Not Applicable (NA)	NA	Low	Single parent
Belinda	7	12	---	Hispanic	---	Hispanic	Low	Married
Dorothy	6	11	---	Hispanic	---	Hispanic	Low	Married
Myra	7	12	Student nurse	Hispanic	Not Applicable (NA)	NA	Low	Married
Otila	8	13	Working in an automobile company	Hispanic	Working in a garage	Hispanic	Low	Single parent
Sarita	7	12	---	Hispanic	---	Hispanic	Low	Married
John	8	13	---	Hispanic	Motor mechanic	Anglo	Low	Married
Rafael	7	12	---	Hispanic	---	Hispanic	Low	Father's 2nd marriage
Ramiro	8	13	---	Hispanic	Baker	Hispanic	Low	Married
Ricky	7	12	---	Hispanic	Plumber	Hispanic	Low	Separated

Table 10

Background of second year junior scientists

Name	Grade	Age	Mother's Employment	Race	Father's Employment	Race	SES	Marital status of parents
Christina	7	13	---	Hispanic	Auto repairman	Hispanic	Low	Married
Demetria	7	13	---	Hispanic	---	Hispanic	Low	Separated
Dorothy	7	12	---	Hispanic	---	Hispanic	Low	Married
Kasey	7	12	---	Hispanic	---	Hispanic	Low	Married
Nora	7	12	Student	Hispanic	---	---	Low	Single parent
Alberto	7	12	Secretarial assistant	Hispanic	---	Hispanic	Low	Married
Marcelo	7	12	---	Hispanic	Auto mechanic	Hispanic	Low	Married
Rene'	7	12	Working in a cafe	Hispanic	---	---	Low	Single parent
Ricardo	7	12	Sale woman	Hispanic	---	Hispanic	Low	Married
Rumaldo	7	12	---	Hispanic	Technician	Hispanic	Low	Married

When Mrs. Lopez selected the junior scientists for the second year of the Project, she selected seventh grade Hispanic students from her science classes. Among those junior scientists, two came from single-parent homes and one child's parents were separated. None of the parents had permanent employment (Table 10). All the junior scientists received free lunch.

The Project Director knew about the "*at-risk students*" category in the school. It was her intention to provide some kind of support to their academic success through after school programs. She believed that those students who were identified as at-risk students by the school staff could be motivated for school work if they participated in the Family Science Project, which would give them recognition that they had never previously in school.

Assertion 1

The recognition given to "junior scientists" in the Family Science Project helped at-risk students develop high self-esteem and to envision their potential to study and understand science.

All the junior scientists who participated in the Project were of Hispanic origin. In addition, they were labeled as at-risk students by the school staff, due to the teachers' perceptions of school grades and behavior.

In the Family Science sessions, junior scientists assisted the students in doing hands-on science activities in a very nonformal environment. Prior to the regular Family Science sessions they were given training on how to do the science activities (described in Chapter 4).

In the second year of the Project, the first session for the junior scientists (10/12/93) was conducted in the middle school before the regular Family Science sessions started for the 1993 fall semester. At this session they were asked to introduce themselves, stating their name, grade, age, what interests they had and what they wanted to be in the future. There were five girls and five boys. At first, none of the five girls, except for one, could say anything. Some did not want to stand up. Even the people who stood up did not stand erect. Four girls wanted to get good grades in the school. One wanted to graduate, the other four said that they were not sure what they wanted to be. Two boys said that they did not know what they wanted to be. Then Dr. Rodriguez started saying what her interests and ambitions were, when she got her doctoral degree, and what she did. Even after that, the junior scientists said that they wanted to improve their grades in class. None of them said what they wanted to be in the future by mentioning a profession, they were only considering their present status in school (to improve grades).

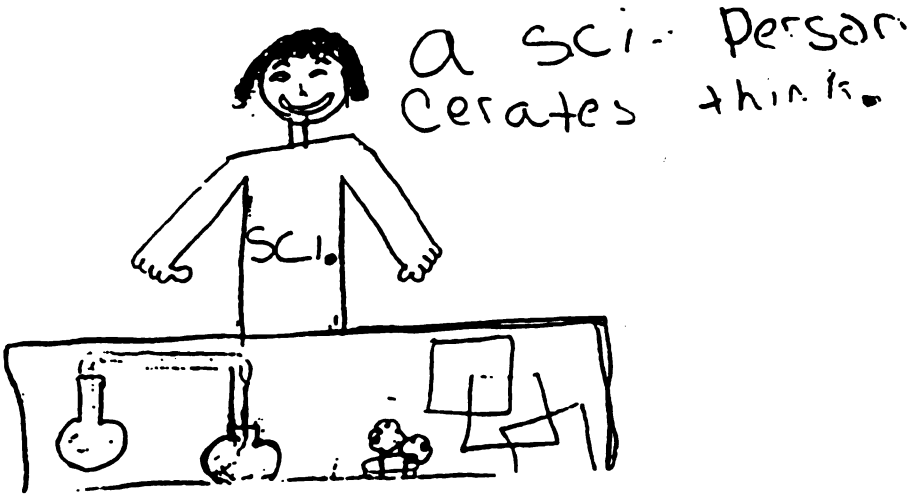
At the first training session they were also asked to draw a scientist and to write what their scientists were doing. They were also asked to write what things they liked and disliked about science.

a) Perceptions of Scientists. Of the five female junior scientists, one female had drawn a female scientist, all the others had drawn male scientists. Their scientists were wearing glasses and except for three scientists, all of them were working with chemicals. One worked with animals. The other two did not specify what they were doing. All five male junior scientists drew male scientists. To get to know more about their attitudes when I did my pre-interviews, I asked, "*Tell me what kind of persons they are.*" All of them said something to try and impress me about scientists being crazy people. Further elaborating about "*craziness*" meant, they said that scientists spend their lives in the laboratories and do not spend time with their families or have any personal life or interests.

Table 11

Likes/Dislikes about science expressed by the second year junior scientists

Name	Like in science	Dislike in science
Christina	Because it is fun and you can always learn something different	Because some parts are boring and seem to be real long
Demetria	You get to work with plants and animals	It always or sometimes takes too much time
Dorothy	You get to have hands-on experiments that are really fun and it's one of my favorite subjects	Because of some of the disgusting things like dissecting mice and cute things
Kasey	We get to do lots of fun things and we get to create things	We have to talk a lot and we have to sit down
Nora	I like to experiment	I hate to dissect something
Alberto	Because it is fun	It can get boring
Marcelo	You can do alot of things	You have to go to school a long time to learn it
Rene'	It is real fun and you can create a lot of neat things	Because you have to do almost every thing
Ricardo	You find out things that you never knew before	If something goes wrong you've got to keep on doing it until it goes right.
Rumaldo	Working in labs	Working with dangerous acids



At the pre-interview stage

At the post-interview stage

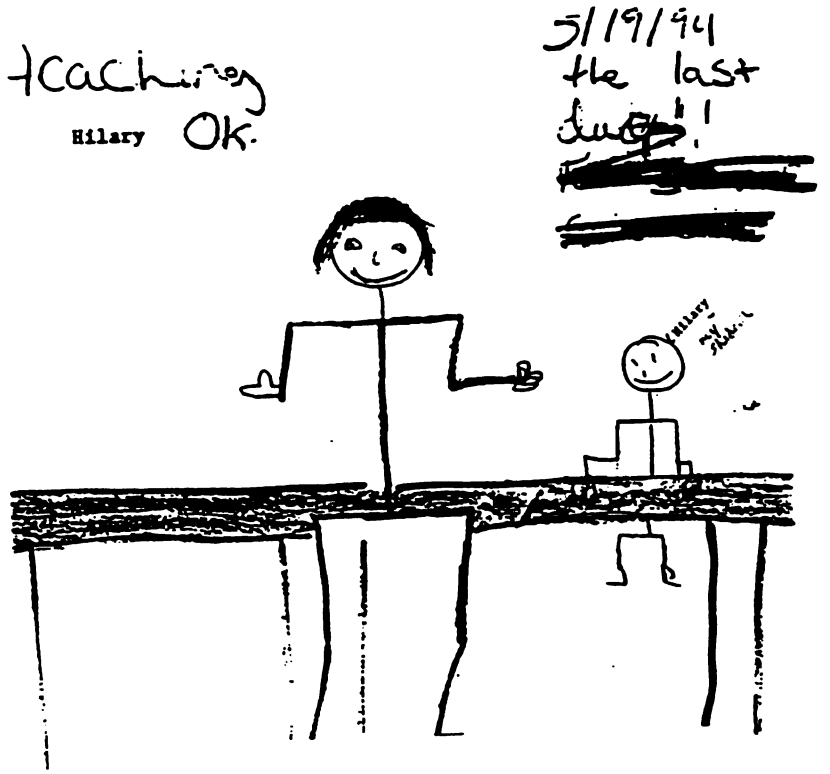


Figure 16 Kasey's scientist

At the time I did the post interviews, I asked them to again draw a picture of a scientist. It was amazing to see how all the junior scientists then drew themselves as scientists. One female junior scientist--Kasey--always worked with a kindergartner--Hilary--because Hilary used to sit beside Kasey all the time. (This kindergartner came to the sessions with her third grade sister, Jean, and both of them pleaded for permission for Hilary to participate in the sessions, because Hilary was not a third or a fourth grader.) Kasey drew herself as the scientist, and as her student, the kindergartner, with the caption, "*Teaching* (Hilary) *O.K.*" and "(Hilary) *my student*" (Figure 16).

b) Likes/Dislikes about Science. The Table 11 summarizes the likes and dislikes about science that were stated by the second-year junior scientists. Except for three, the others liked science and said it was fun. Most of the time in the interviews the children, as well as the junior scientists, used the word "*fun.*" I had to analyze what they really meant by "*fun.*" In this context, fun meant being involved in hands-on science activities which were interesting, not boring, and learning something. Even the junior scientists who did not say that science is fun, liked science, because their definition of science matched

their interests to work with animals and plants, or to work in a laboratory.

Some of their explanations during their post interview that showed how science was be fun are given below:

> *Dorothy: Fun, you do something that you like.*
> *Christina: You are really doing something, like we did with mirrors. Sometimes it is hard, but interesting.*
> *Kasey: You don't have to write, and no one grades you, so you can have fun* (5/20/94).

The most important thing embedded in their interests was the involvement in the Family Science sessions, which allowed them to do activities and compelled them to keep trying.

They also loved the Project because of some self-defeating attitudes. As one junior scientist said, *"You don't have to write, and no one grades you, so you can have fun."* Their participation in the science activities was not graded. This gave them a very relaxed, comfortable environment in which they could work at their own pace, unlike in school. They did not like to write, even at the end of the year. Once I asked Kasey, Christina, and Ricardo to write something about themselves since they had joined the Project. I told them that I needed only few sentences or a paragraph about their experiences in the Project. They never did it. They preferred to be interviewed, so that they did not have to write. Mrs. Lopez was the homeroom

teacher for four of them, and science teacher for all of them in the second year of the Project. She said that most of them were behind in their writing classes.

Their responses for what they did not like about science shows that, although they liked science, they had some fear continuing in science. To them, learning science and continue to do it brought out fears that it might be an obstacle to them graduating from the high school. This was also related to how they were treated in the school. According to the junior scientists I interviewed, they believed that there was a privileged group of Hispanic children in school, but that they did not belong to that group of "gifted" Hispanics.

They believed that they would not get a place even for the extra curricular activities because of the prejudices that the teachers had. They believed that the minority groups, in this particular case, the majority of the Hispanic children, would not be recognized by the school staff for any academic or non-academic activities. This belief made them have low self-esteem. They told me at their post interview that they did not have any programs in which that they could participate in the school. Christina expressed her surprise when she received the opportunity to participate in the Family Science Project:

> *Well, Hispanics, we don't have anything for Hispanics. If we do, it's for the eighth graders, and for the special group of Hispanics. Best graders, for the ones that they know. We know what kids they'll ask. When* (Mrs. Lopez) *asked us, we thought, "She asked us?"* (5/20/94)

After a discussion with Christina, I learned that there were not many extracurricular programs for the minority groups. She and her friends believed that even if there was something which required participation of minority children, school authorities would not have selected them because there was a privileged group of Hispanic children in the school. It was an unbelievable thing for these Hispanic children, who had an inferiority complex about not belonging to the privileged group, that Mrs. Lopez requested that *they* participate in the Family Science Project as "junior scientists." That's why Christina said that she thought, "*She* (Mrs. Lopez) *asked us*?" It was a self-fulfillment and a recognition for them. Still, they were uncertain as to whether it would last, due to two reasons. One, according to two junior scientists, Christina and Kasey, Mrs. Lopez was a new teacher in the school, and they assumed that she was not aware of school politics. Because of that, her selection of the students would not last for a long period, and they might have to discontinue working in the Project. Second, they wondered whether they would be able to perform the role of "junior scientists," due to their

assumption that they were not smart enough or not good enough in science.

At the time the junior scientists enrolled in the Project, they were not definite about they were going to do, and whether they could do it. At the post-interview stage, Rafael, who was a first-year junior scientist, said:

> *I thought it would be hard learning that stuff. It was pretty easy and fun, because we had a lot to do that I didn't even know* (5/25/93).

Regular participation in the Project helped them build an interest in science and also develop communication skills. About six months after they began to participate in the Project, two of the second-year, female junior scientists, Christina and Kasey, presented speeches about their experience as junior scientists at a workshop in March of 1994 for Family Science project coordinators in Ann Arbor, Michigan. They responded without hesitation to questions that were asked by the participants. These were the same girls who could not stand up and introduce themselves at the first training session. One was a thirteen-year-old seventh grader who did not like science. The other who was also a thirteen-year-old seventh grader who thought some parts of science were boring. She said:

> *I never thought that I could talk to people. But now I feel that I have the confidence. I'd like to take some speech classes. I am planning to take one next year* (5/20/94).

This junior scientist wanted to be a psychologist and run a day care center, because she loved to work with children and thought that she could work with the children. At their post-interview, everyone mentioned a future oriented goal and said what they wanted to be. These included an orthodontist, surgeon, teacher, computer engineer, and a chemist. One wanted to be a science teacher.

The middle school students who worked as junior scientists needed recognition in order to be motivated to do things. This was evident from what Christina said:

> *We were really happy when people appreciated our work at that meeting, and to listen to what they were doing. One asked us whether we could work with him in his summer project with the elementary graders* (5/20/94).

When I asked her more about that, she said that the person who asked about the summer project was a participant at the workshop held in Ann Arbor. When he made that request, she felt that people considered her to be a responsible person. Appreciation of their work by others made them feel that there were people who recognized what they did, which made them think that they were not neglected and so they were motivated to do more.

White lab coats also gave the junior scientists an attitude of self-respect. When I interviewed them, most of them said that they did not like the white lab coat,

because they were hot when wearing it, but their behavior noticeably changed when they had one on. They walked more erect and acted more responsibly when they wore it. Some had put a prefix of Dr. or Mr. on their name tags.

One Saturday towards the end of the fall semester (12/12/92), Dr. Rodriguez took the first-year junior scientists to the biochemistry laboratory at Michigan State University to give them an opportunity to see some scientific endeavors. She had arranged for a biochemistry professor to conduct a session wher they could analyze their own saliva. Each one had a sample of their own saliva, added water, and then separated it in a separating column. For most of them it was the first time they had used a Pasteur pipette and a burette, and to see a separating column. After the discussion they were shown the structure of DNA, and how people used DNA testing to analyze different proteins in the blood. The sophisticated equipment that they used to see the DNA motivated most of the junior scientists, especially the boys. Two male junior scientists, Ramiro and John, wanted to work with modern equipment in a laboratory like that in the future.

Myra was a junior scientist during the first year of the Project who came from Puerto Rico. She was behind in school because she believed that the Anglo American children were better than she was. She was

able to change her attitude when she started working in the Family Science Project:

> *When we do group work for science in school, I direct the others. I didn't do it before, I was thinking I came from Puerto Rico* (4/27/93).

Myra had thought her classmates were doing better than her. She felt that she was alienated because she came to the United States from Puerto Rico. Her peers gave her a low achiever label, and so she had a low self-image. The experience gained in the Family Science sessions helped her develop higher self-esteem so that she could work as a leader with her classmates in group activities. Myra came from a single-parent home. She had a sister in high school. She used to tell her mother and sister what she did in the sessions, and showed them the things that she made. Myra's mother said:

> *She has told me a lot of things, about kaleidoscopes, mirrors, and what you did with colors. She is always telling me about the project. She talks about MSU and she feels that she learns* (4/27/93).

Myra's mother also said that her daughter wanted to study at MSU (Michigan State University) and be a surgeon like her uncle. She further said that Myra started talking about studying at MSU ever since she went to the laboratory at the university.

Discussion

The changes junior scientists made in their drawings of the scientists, from old, wierd males to themselves, suggests that they had realized their potential to be scientists. This realization occurred through involvement in the scientific process in a very friendly environment, as a social activity where they were able to freely bring their ideas without any fear. Solving a given problem by doing hands-on science activities involved the members of the groups in a scientific process. This will be further discussed under Assertion 2 on group work. All members of the group had the right to come up with probable ideas to solve the problem, and the students exchanged ideas and came to a consensus through accepting and rejecting conjectures. The trial and error methods, careful observations, hypothesizing, and inferring enabled them to solve the problems. The involvement in this scientific process helped the junior scientists to change their perception of a scientist being a person who is crazy and does amazing things. They were able to see that *they* had the potential to be scientists, and also that anybody who can engage in the process of scientific inquiry has the potential to be a scientist. Christina, who said that scientists were weird people, who spent their time in laboratories trying out experiments, with no time for their family, had changed

her perception about scientists at the post-interview stage. She said:

> *Scientists can be anybody. They do not always wear white coats, not all the scientists. It depends on what you do. Some work in the labs, chemistry, biology. They are normal people. Sometimes they are happy* (5/20/94).

Christina's response of saying, "*Scientists can be anybody,*" expresses her understanding of scientists, by indicating that every person has the potential to be a scientist. It was impressive to observe the changes in their perceptions, such as realizing within the short period of about fifteen weeks in two semesters that they had their potential to be scientists. This could be considered a great achievement, and a success of the Project. I feel that this change in their perception of scientists was a big change in terms of their future aspirations, to realize the importance of their education and appreciate what other people do. All the junior scientists said that if they would not have participated in the Family Science Project, they would have spent the time with friends watching television or playing. According to Christina, her involvement in the Project was an educational endeavor. "*We enjoyed and spent our time in a good thing, learning.*" Participaton in the Family Science Project helped the junior scientists to change their negative attitudes toward science.

Junior scientists' personal views of science at the pre-interview stage, such as "*science is hard to understand,*" "*science is boring,*" and "*it takes a long time to learn science,*" made them keep a distance from science. From the informal conversations I had with them, I learned that they felt that it would be a risky situation to take science in high school. This is evident from what two junior scientists (Christina & Alberto, in Table 11) said about their likes/dislikes about science. Christina liked science because it was fun to do new things. At the same time she did not like science because she felt that some parts of science were boring. What she meant by, "*seems to be real long*" was the trying of different methods in order to succeed when doing a science experiment. (This was the same explanation given by Ricardo.) At the post-interview stage, Christina had the attitude that anyone could do science, and that it is not hard to understand scientific concepts or do the experiments.

The above examples show not only that the junior scientists changed their attitudes toward science, but that they also perceived themselves to be responsible persons and future leaders. Although we noticed their positive changes in attitudes and behaviors, they were still reluctant to do writing, and they were scared about their grades. Many of them had incompletes in their school work. As a remedy, Dr. Rodriguez arranged

for an undergraduate volunteer to help them in their home work. The community liaison also conducted a mentoring program, using her son and his friends, to help the junior scientists in their homework. It seems that they needed people to motivate them in their academic work or else to have programs that would supplement their formal education.

These junior scientists were the children who had been categorized as at-risk students by the school staff, and who had low self-esteem. Junior scientists were able to perform their role and help these children. This will be discussed in detail under Assertion 4 on role models. As with Anyon (1981), these children carried the label given to them, and they added labels to themselves, such as saying that they did not belong to the privileged group. The involvement of the junior scientists in the Family Science Project questions the validity of the "at-risk" label given to these middle school students.

Generally the label "at-risk" has been used in association with a deficit (Frymier & Gansneder, 1989; Donmoyer & Kos, 1993; Valencia & Pearl, 1994), such as failing courses in school, receiving bad grades, accumulating incompletes, and dropping out of school; or in life in using drugs, attempting suicide, or being sexually abused.

Richardson et al. (1989) described two models of at-risk students--the epidemiological model and the interactive model. The former refers to children who display school-related behaviors, such as low grades, suspension, absenteeism, and so forth. The latter refers to children in relation to a specific social context, the interaction between the characteristics of the child and the nature of the classroom and the school. According to this model, a child who is at-risk in one classroom may not be an at-risk student in another classroom due to the different perceptions that teachers have of children.

Richardson et al. (1989) modified the interactive model by adding another concentric circle--school district (Figure 17). They believe that, although the school district does not directly affect the classroom, it may be quite powerful in the lives of these students due to the decisions made by district personnel on matters such as the organization of such programs as bilingual and special education. When the child enters the social setting of a classroom, consisting of a number of students, a teacher, and a set of materials and equipment, the child tries to adapt to the norms of that setting. The norms in a classroom are shaped by the teacher's beliefs about learning, student behavior, and the way s/he operates the classroom. If the child is successful in adapting, s/he will behave as a normal

child in the school, but if the child fails, usually s/he is categorized as an at-risk student by the school staff.

The difficulty in adapting to a setting which a student does not like, such as the classroom, leads them to behave in an unacceptable way according to the adults, which thus creates a counter culture; for example the "*lads*" in Willis's (1981) study. Treuba (1991) suggests that this lack of fit should be understood not as an individual failure, but as a failure of the system to develop a context for cultural congruency and meaningful social exchanges.

It is clear that if there is someone to motivate the at-risk children and get them involved in some kind of activities, like hands-on science activities, to build their interest and develop skills and knowledge, then the children will respond not only by doing science well, but also by understanding and enjoying it. This involvement thus enables them to develop self-confidence and motivation in educational activities, helps them to give up self-defeating attitudes, and to get a vision of what is possible.

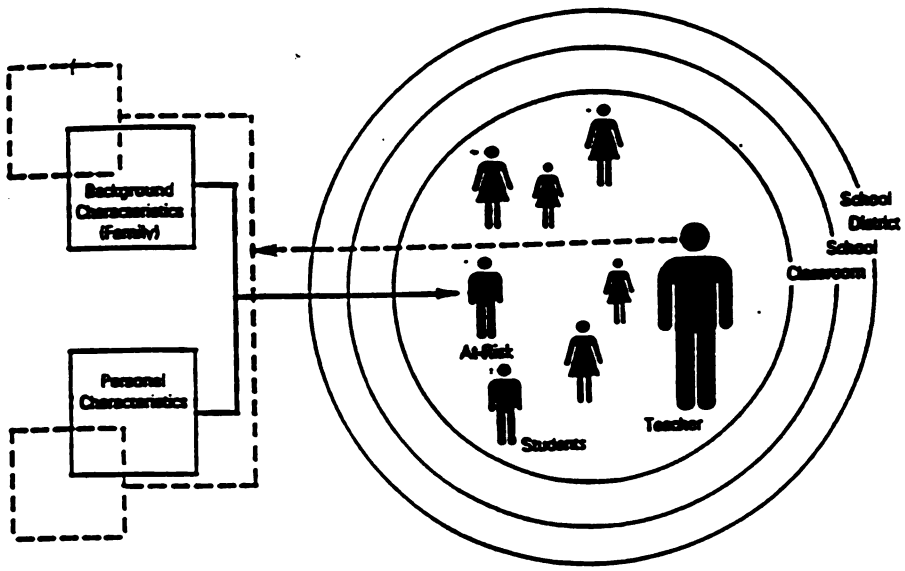


Figure 17 At-risk Model

Assertion 2

Family Science sessions fostered comprehension of goals and directions among the junior scientists that had not developed as a result of their interactions in the school or community. This resulted in improved self-confidence and achievement.

Learning science in school was different from learning science in the Family Science Project. This was mainly due to the activities that the junior scientists did in the Family Science sessions where they used things found in their homes, especially things from the kitchen. Learning was also different because in the Family Science sessions they first did the activities, which were enjoyable. According to the junior scientists, they did not do hands-on science activities at school. Doing science activities was fun to them. The experience of doing the activity helped them to build meaning in the activity due to their observations. This process helped them understand scientific concepts and then to transfer that knowledge so they could do science at school.

In one of the training sessions, junior scientists were given the problem of separating a mixture of yellow sand and blue salt. The problem was how to separate the

sand and salt separately. Dr. Rodriguez allowed them to think, and as a clue, she asked them to think about the property that they had used in order to separate iron filings and sand. After the junior scientists mentioned the magnetic property of iron filings, she asked them to think of a property of sand or salt which would help them separate the mixture. People gave different ideas. Otila's suggestion is given below:

Otila: You get a piece of filter paper, and a funnel. Put the sand and salt mixture into a funnel. Pour water. The salt will go with water.
R: What property did you use then?
Otila: Salt dissolves in water, and sand stays.
R: How can I get salt back?
Sarita: Boil it. The water will go off (10/13/92).

Dr. Rodriguez carried on a discussion of how to separate the colors in ink. She asked the group about the primary colors. No one gave an answer. Dr. Rodriguez showed them a black marker and asked:

R: Is there only black or is black composed of different colors?
Rafael: Many colors
R: What are the primary colors? (No one gave an answer.) *Red, yellow and blue.*
R: How will you separate the colors in this black marker?
Otila: If black dissolves in water (10/13/92).

Then Dr. Rodriguez gave them an instruction sheet on "chromatography" to read first in order to understand how to separate the colors using filter paper. She had to work with the junior scientists to train them to add colors and to then hang the filter paper strips so that

they could assist the children in hanging their strips to get the colors separated. After separating the colors of different colored markers using water, they separated the colors of permanent markers using alcohol. Then they were given tee-shirt material to try drawing on different designs using alcohol.

Most of the students liked the tee-shirt chromatography activity. The goal of this activity was to show that science and art can interface by making a permanent design on a tee-shirt. After questioning the junior scientists about examples where chromatography is used in art, Dr. Rodriguez mentioned that tie-dying is an application of chromatography. Chromatography activities were done in three sessions. Each child was given a coffee can with a lid (the lid was cut leaving only the peripheral part so that it could close on the can), a reagent bottle of alcohol, and a large piece of tee-shirt material. Dr. Rodriguez brought old tee-shirts from home so that the children could try whatever the design they wanted before trying a new tee-shirt. They were given permanent markers of different colors to try the different designs that they wanted. Rene' and Christina were the junior scientists who worked with Jean, Pat and Pam in one group. They tried different designs that would look good on their tee-shirts. Rene' noticed that Christina was drawing something pretty :

Rene': Look. What is this? That's nice.
Christina: What is nice?
Rene': Look at that rose. Pretty.
Rene': Why don't you do the Mexican flag?
Christina: I am bad at doing that.
Rene': What do you mean? Do you speak Spanish?
Christina: I am not Mexican. I was born at Sparrow hospital, not in Texas.
Christina: Look, this is the Mexican flag.
Rene': Rose in the middle and an eagle?
Christina: I am not going to do the eagle (11/11/93).

Dr. Rodriguez came to see how they were doing, and said, "*Very good, very pretty, that's nice.*"

Rene' was able to speak Spanish well. He appreciated it when people talked to him in Spanish. He believed that all Hispanics should be able to talk Spanish and respect the Mexican flag. Because of his appreciation of Mexican things, he always tried to connect what he was doing to Mexican culture. For him, the Family Science sessions allowed him to have informal conversations, something he could not do in school. Once Alberto felt ashamed of himself because he could not speak Spanish like Rene'. But these conversations helped them to know each other well.

When the junior scientists worked in groups they sometimes carried on informal conversations in order to become friendly with the children and their parents. Everyone in the group appreciated Christina's rose. Jean and Pat also drew roses on their tee-shirts. As Rene' did not help Pat and Jean in doing their drawing,

he wanted to appreciate their work and what they had drawn:

> *Rene': Who did this rose?*
> *Pat: I did it in pencil first*
> *Rene': How old is she?* (pointing to the kindergartner, Hilary)
> *Jean: Five, she is a kindergartner.*
> *Rene': How old are you Jean?*
> *Jean: Nine*
> *Rene': Do you have to take care of your sister?*
> *Jean: Nope*
> *Christina: You are lucky, I have to take care of my little sister* (11/11/93).

Kasey knew that Christina did bubble letters, and sent Hilary to her to make MSU (Michigan State University) in bubble letters for Hilary's tee-shirt. When Hilary came to their group, Christina was involved in an informal conversation, and did not hear what Hilary said. Little Hilary was impatiently looking at Christina, for her help. When Christina noticed Hilary's presence, she asked Hilary:

> *Christina: What do you want* (Hilary)*?*
> *Hilary: I said MSU.*
> *Christina: Would you like MSU on your tee-shirt?*
> *Hilary: Yes*
> *Christina: I like U of M* (University of Michigan). Christina did bubble letters for Hilary after this conversation (11/11/93).

Some of the junior scientists wanted to try what they had learned at the session at home to show their parents, sisters and brothers. Rafael (first-year junior scientist) was a good example. He came from a big family. He had four sisters, one brother, two step sisters and two step brothers. He said:

> *Sometimes whatever I learn over there, I felt like teaching over here* (at home). *Because most of the things that they do is household stuff and it's easier to do. I remember what my sister said, when I did that food coloring thing. She said that she never believed that it could happen* (5/25/93).

Mrs. Lopez also validated what Rafael told me:

> *Rafael loves science and worked very well in the group helping the kids. I can remember he borrowed stuff to try at home, like food coloring when he needed. He wanted to show it to his sisters and brothers. It's good that they could try and do them at home. Family Science motivated them to think* (7/7/93).

Rafael was not the only student who did this activity at home. Many junior scientists and children did this activity at home to show their family members how surprising it was. The experiment required only milk and four colors of food coloring. Rumaldo (second-year junior scientist) also thought about his mother while doing the activity and said, "*Look at it, it's going. My g-o-s-h! Isn't that c-o-o-l? Magic. I would like to show my mom.*"

The parents of the junior scientists were also impressed with what their children learned from the Project. Although they did not participate in the Project, during the interviews they too tried to compare what science they had studied in school with what their children had. I present some of the interview data of the junior scientist parents to show their thoughts about their own schooling and what they expected from

their children. (Sarita, Belinda, Dorothy, Ramiro, Rafael and Andrea were the first-year junior scientists.)

Sarita's mother, Mrs. Garcia had been raised on a farm in Texas, and also went to school there. She came to Lansing after her marriage. She could not continue her schooling after the ninth grade, due to some family problems. Mrs. Garcia preferred to have the interview in Spanish, because she could not comfortably speak English. The community liaison from the Julian Samora Research Institute did the interpreting. Mr. Garcia also joined in the conversation. When I talked to Mrs. Garcia, she was attending school to take some English classes, which she enjoyed very much. Both Mr. and Mrs. Garcia spoke very highly of their daughter--Sarita--who was the second in the family. They believed that younger children follow the older ones. They spoke of the need to have control and discipline for their children. Mrs. Garcia said that Sarita was more focused in her school work since her participation in the Family Science Project:

> *[She feels more confident now. She can learn something and teach it. It boosts her confidence. She is smart, but now she feels that she can achieve a lot of stuff. I think now she tries to behave as an adult.*
>
> *She will be a great leader. I would like to see her as a lawyer or a computer specialist.]* (Spanish translation, 4/26/93).

Mrs. Gonzalez wanted her daughter, Belinda, to do well in her education, because she and her husband could not continue their education. She felt that Belinda was learning and enjoyed participating in the Project:

> *She talks about what they do in the class. She is interested in it. I kept her out one week because she had fallen behind in her school work. She really enjoyed the science class* (Family Science sessions). *She tells me that she helps other kids. She wouldn't have continued if she did not like it. I can see that she has matured to handle difficult jobs. I am happy that she is involved in it.*
>
> *Me and my husband, we did not continue after high school. We keep telling her that education is the most important, because we did not have it* (4/27/93).

Dorothy was a junior scientist who started working in the Project when she was in the sixth grade. Unlike the other junior scientists, she was in the Project for two years. Even when she started Family Science, her mother was happy with Dorothy's involvement in the Project and felt that Dorothy enjoyed what she did:

> *Dorothy is interested. Not only does she help the kids, she also learns at the same time. I come from a big family. I dropped out of school. I didn't enjoy school. My parents didn't feel that education is important, especially because I was a girl. Science is far away. I didn't have it, but she needs it, and enjoys it.*
>
> *We had nine boys in our class. All of them graduated from high school. But none of the four girls in the class did* (10/16/92).

Ramiro did not like working with some of the children and parents. He wanted to do experiments. He liked the activity they had done at MSU to analyze their

saliva. His father was pleased about his participation in the Family Science Project, thinking that it would benefit him later on in school:

> *I think it's great. Anything that improves education is great. He is there to learn. Otherwise he would have been playing basketball. That's his main goal. Sometimes he says it* (Family Science) *is fun. Sometimes he says the kids gave him headache. They go on Tuesdays for practice, and Thursdays to teach kids. We encourage him to participate in any project which involves education, or anything that has to do with school. He continues it* (Family Science) *because he likes it and learns something. I like him to be in it because it would help him in school* (4/26/93).

This parent was a baker in a public hospital. He spoke very proudly about his son's participation in basketball and about his friends. He believed that Ramiro was going in the right direction. He further said that Ramiro had good habits and did what they asked him to do. As an example, he said that Ramiro usually went to bed at 10:00 P.M., and only once in a while did they need to tell him twice. He wanted Ramiro to learn to put things in order. For example he showed us the sign by the stairs for Ramiro to hang his hat up in the proper place. There was a rack of about twenty basketball hats with different letters on them. Ramiro's father said that he did not go to college, but he wanted his son to continue his education. He believed that in addition to what their children learned in school, there should be programs like Family Science to direct their future goals. According to Ramiro's

father, Ramiro's involvement in the Family Science Project was helping Ramiro do better in his school work.

Andrea was the only child in her family. Her mother and father never got married. Her father was a teacher who had graduated from school in Cuba. He did not live with Andrea or her mother, who was a social worker. Andrea's grand parents (mother's parents) also lived with them. Both her father and mother participated in the open house held at the middle school one evening (11/13/92). On that day, her parents also did some of the science activities. The junior scientists demonstrated what they did with the children for their parents. The parents were all very pleased. I could not interview Andrea's father because he was out of town most of the time. Her mother said:

> *She showed me the kaleidoscope that she made. She said that she never thought that she could make one with three mirrors. She showed it to her cousins. One is three years, and the other is four years old.*
>
> *I encourage her to go, because programs like these are special. I think she is doing better in science and math than last year. I want her to learn more. I met her teacher at the open house. I liked what they did on that day. I want her to go further than me. Science is very important now* (5/6/93).

Although the parents of the junior scientists appreciated their children's involvement in the Family Science Project, there was one parent who tried to take his son away from the Project, something the son enjoyed very much, and later the father regretted that he had

done that. Rafael used to consistently attend the Family Science sessions, and he enjoyed helping the younger children. Later on he dropped out of the Project, because of the punishment given by his father. According to his father, he knew the interest that Rafael had in Family Science, and suspected that if he kept Rafael at home, suspended from the Family Science sessions, then he would use that time to finish his incomplete school work:

> *I know that Rafael used to like Family Science very much. He always wanted to be in it. He showed some of the stuff that he had made in Family Science--water, food coloring and a lot of stuff, hot air balloons, and I can't remember.*
>
> *When he started falling behind the school work, I figured he would use Family Science time to do things in school. I needed him to dedicate more time to school work.*
>
> *I would have let him to continue Family Science* (5/25/93).

Rafael's father told me about the hardships he was having. He did not have a job. He started several, but could not continue any of them. When his first wife (Rafael's mother) left him, he married his second wife. He lost one of his sons to leukemia during the time that Rafael was attending Family Science sessions. His life was very unsettled. He tried to do different things, and finally had to totally depend on welfare. According to him, his wife's efforts in supporting the children's education did not work:

> *I never dedicated myself to school. I had my fantasies to be a policeman. Never finished school. I never learned science. I want my children to get some education. They are nice kids, sometimes we got frustrated with them. Once I spanked my kid. The protective services wanted reasons for it. Spanking is against the law even for my children.*
>
> *I have a real bad feeling toward school. The step mother used to work with the kids. She got frustrated when they brought incomplete work home. Homework was never done. If they don't do homework, and not receive things from school, what should I do?* (Rafael) *can get nasty with my little boys, when they touch his things* (5/25/93).

Most of the children and junior scientists told me it was easier to ask for something from the parents than from a teacher. But Rafael said, "*I am not sure whether it's easy to ask things from parents. Because most of the time I ask teachers. My dad, he hardly talks to teachers.*" It is understandable from what Rafael's father said that his frustrations had an affect on Rafael's participation in the Family Science Project. But he believed that Rafael learned from the Project, and would not have stopped his participation. He started telling me about all the frustrations he had had in his life, and he cried when he finished the conversation. He realized that he had not done the right thing when he stopped Rafael from continuing to go to the Project.

Discussion

Because of the way that the Family Science sessions were structured, junior scientists at first did the activities. Then their interest was to do the activity. Then they allowed to make sense of the activity, to think of explanations for the outcome they had gotten. For the junior scientists this was a difficult task at the beginning, and they used to keep quiet. But Dr. Rodriguez's questioning, sometimes with the clues she provided, helped them think a little further than the way they used to think. When they had confusion about some of the results, she asked them to do the activity again to see the discrepancies. This kind of learning was not possible in the school due to the large numbers of students, and the fact that the teachers were more concerned about doing things (curricular activities) in order to meet dead lines.

They learned from their own observations and solved their own problems, which helped them understand the science concepts underlying the hands-on science activities. The junior scientists disseminated their skills and understanding, from what they had learned on Tuesdays, to the third and fourth graders on Thursdays. This also reinforced their understanding of the concepts. Furthermore, as Mulkay and Gilbert (1982) noted, the junior scientists realized that making errors when they did the activities helped them learn more, and

that it was not wrong to make mistakes or repeat what they had done. For example, Myra said, "*If I do wrong, to try again.*"

All the parents of the junior scientists felt that the time that their children spent in Family Science was a valuable experience for them to learn science, and further, they said that they wanted their children to do better in school than what they had done. Mr. and Mrs. Garcia, and Ramiro's father related their discipline at home to their success in school and to shaping their children's future. From what the parents said, they believed that their children learned from the Project. For example, Andrea's mother was impressed with Andrea's participation in the Project, and with how Andrea had shared with the other children when making kaleidoscopes. All of the parents had high aspirations for their children, and said that they wanted their children to do better in school than what they had done.

Assertion 3

The Junior scientists believed that the qualities that they developed, such as patience and temper control, enabled them to keep the children on task.

The role that the junior scientists played in the Family Science sessions was to help the children hands-

on science activities. The Project Director repeatedly told them at the training sessions, "*Your job is to help them learn, not to do things for them.*" In a group, generally, there were one to two children, a parent and a junior scientist. Junior scientists had to bring the things needed for the activity from the resource table to the work area. Sometimes they asked the children to help by getting things like paper towels.

There were times that some of the children strayed from the task at hand very easily. Junior scientists had to be patient with them and keep them on task. The following excerpt reveals an example of an instance when a younger child--Anthony--went off task, and the junior scientist--Rumaldo (2nd year junior scientist)--had to keep him on task, when they did the activity to float a needle:

> *Dr. R: Kids, everybody, you have a bowl of water and a needle. Try to float the needle using the fork.*
> *A: This thing floats?* (10/21/93)

The task that the younger children had to do was float the needle using the fork. Dr. Rodriguez gave them the problem without doing any demonstration. The children had to figure out a way to float the needle by trial and error. Anthony did not have any clue as to how to float the needle. That's why he asked Dr. Rodriguez, "*This thing floats*?" He started playing with the needle, pinching, moving it around, and looking

around to see what the other people were doing. Anthony wanted to grab something which was not required for the activity from the resource table. Rumaldo had to ask Anthony to try to float the needle:

> *Rumaldo: No, not that one. Come on Anthony, don't play around. Come on, behave. I am not playing around....Anthony, what are you doing?* (10/21/93)

Dr. Rodriguez noticed Anthony's behavior, and the effort that Rumaldo was taking to keep Anthony on task, came to him and asked Anthony to put the bowl of water in front of him.

> *R: Anthony, put the bowl in front of you. You got a needle. Here's your needle. Get a fork. Try to float the needle. Try any way you want* (10/21/93).

When Dr. Rodriguez walked out, Anthony, with a puzzled expression, looked at the other groups and continued playing with the needle. Rumaldo had to keep him on task, and decided to show how *he* would try:

> *JS: Anthony, it's easy. Try anyway you want. Try to float it. Come on.*
> *JS: I am going to show you.*
> *A: I am going to do it.*
> *JS: I am going to show you how to do it.*
> *A: O.K., show me how to do this* (10/21/93)

Rumaldo put the needle on the fork and very gently slanted it to the side of the bowl, and put it in the water. He demonstrated it about three times and then asked Anthony to try. Anthony noticed that the needle was floating. He assumed that the junior scientists had

mastered the skill needed to float the needle at their training session on Tuesday, and that there was a secret to floating the needle which Rumaldo had not shared with him:

> *Rumaldo: Now try it.*
> *A: O.K., see it floats. What did you do?*
> *Rumaldo: Anthony, do it.*
> *A: Rumaldo, look at my fork. See, looks like you have made it....What's the secret?*
> *Rumaldo: Let me help you. This is the very last time.*
> *A: You guys float it before.*
> *Rumaldo: Yes, but you could do it too. Try again.*
> *A: Man, ooh, I did it.*
> *Rumaldo: Do it again.*
> *A: See I can't do it again....Let's go get a snack.*
> *Rumaldo: No, we can't. No snack at this time* (10/21/93).

After Rumaldo's demonstrations, Anthony was able to float the needle after several attempts. But he got bored with it, and wanted to leave and have a snack. Rumaldo wanted Anthony to try it one more time. At the same time, Rumaldo reminded Anthony that it was not correct to have a snack while doing the activities. Anthony held the needle in his two fingers and told the needle:

> *Thank you stupid needle. You gave me bad luck. I don't like you. I should get a snack and sit down by the partner* (10/21/93).

Anthony's words to the needle reflect that he had become bored with the activity, and that there was some bad luck which prevented him from doing the right thing in order to float the needle and so kept him struggling.

He preferred to sit and have a snack rather than to try the activity, because of his failure when he attempted to float the needle.

Dr. Rodriguez used snack time at the junior scientists' training sessions to discuss the things which had happened on the previous Thursday so that they could do better on the coming Thursday. She noticed how Rumaldo worked with Anthony, who did not have an attention span of even a minute:

> *R: I am glad you came today. Rumaldo, you have very good skills. Your skills get even better. You did not lose your temper. Turn around and try to be positive. It is very important that they should get positive reactions* (10/19/93).

Sometimes there were complaints from the junior scientists about their group members. The following was a discussion at the junior scientists' training after the first session of Family Science with the kids:

> *Ricardo: I don't want* (Steve).
> *Rumaldo: I don't want the same kid.*
> *R: If you did something, does your teacher say that teacher doesn't want you? Let me answer your question. We are going to have some children who give trouble....*
>
> *I want your suggestions. All of you worked very well with the kids. I don't want one person to have the most troublesome kid. But it's different, if you don't like them, because they don't behave the way you want. It's a challenge for you. If you are the teacher what do you do?*
> *Think about it.*
> *Rumaldo: I suspend him.*
> *Christina: Everyone should get* (she did not finish what she wanted to tell).
> *Alberto: How about let them pick you?*
> *Christina: Let the kids select us.*

R: But sometimes people get left out. Let's see how we divide.
Kasey: If everybody picks (Jaime), because he is very good?--
R: Get them talking and try to share with them what they do. What can do is, see how we divide up naturally. Let's see how it divides naturally. But if I give you a signal for you to move to another table, you have to go. You can talk to me later. Little boys always want to work with boys. Thursday I may pair up ...(10/19/93).

An instance where the junior scientists' patience was essential in performing their role was when they had to work with hyper active children. Steve was a third grader who had a mental disability and a very low attention span. (I did not know that he had a disability until his mother told me this at the post interview stage.) Steve always wanted to finish the activities very quickly, and made careless mistakes (as described earlier with the activity on hot air balloons in Chapter 4.) He did not have the patience to wait even when the others were reading the instructions. He liked to work with a male junior scientist. Rafael was good at working with him. Rafael worked with Steve when doing the activity of making hot air balloons, which took a long time to do, since the panels had to be cut and glued. After making the panels, one was torn by Steve due to his impatience and carelessness. Even at this moment, when the other members of the group got annoyed with Steve, Rafael assigned them some other work and then started repairing the panel with Steve, trying

to cool down Steve's temper. He tried to calm down the others, too. When Rafael asked Steve to hold the panel for him, he started teasing Rafael. In spite of his teasing, Rafael tried to keep Steve on task by assigning him the new task of gluing without carrying on the earlier conversation:

> *Rafael: We managed to fix the panels.* (To Dr. Rodriguez, when one panel was got torn.)
> *Rafael: Now you hold it* (Steve).
> *Mom: Right in the middle* (Steve).
> *Rafael: Yes, that's right.*
> *Steve: R a a a a* (Rafael) *got everything.*
> *Rafael:* (Steve) *got everything.*
> *Steve: No,* (Rafael) *does.*
> *Rafael: I am a nice person.*
> *Steve: No, you are not.*
> *Rafael: I am a nice person. Yes, I am. Yes, I am.*
> *Steve:* (Rafael) *you are stupid.*
> *Rafael: Oh,* (Steve), *look here, we need to glue* (2/11/93).

Many junior scientists thought that they had developed their patience while working in the Family Science Project. Myra (1st year junior scientist) was a junior scientist who came to the United States with her sister to see her uncle. They stayed with him until their mother came. Then they started living in a house close to her uncle. When I asked her how she felt about participating in the Project, her response was:

> *I thought it would be fun. I learned to be more patient with the kids, and to take time in what you do, especially in doing observations. If I do wrong, to try again* (4/27/93).

When Kasey (2nd year junior scientist) joined the Project, she thought she does not know how to work with

younger children, because she always had problems with her younger brother. But working with the kids in the Project, and doing hands-on science activities with them, enabled her to work better with her younger brother:

> *I have one younger brother. I used to be really mean to him. Since I started working in the Project with the little kids, I gradually tried to listen to him, and to work with him. After all, he is my brother* (5/20/94).

There was one junior scientist--Ramiro--whose behavior was different from the others. Ramiro was a seventh grader when he joined the Family Science Project. He felt that some parents were "*mouthy*," and said that he did not like some of the students. What he meant by "*mouthy*" was that the parents talked a lot. To him, sometimes children acted like "*brats*." Later at one point in the interview, he said that he had learned how to get along with the younger children. He never missed even one session. He walked from school to the site and was there on time, all the time. He liked to wear clothes that were different from those of the other students. He had an earring of a marihuana plant on one of his ears, a golden watch, and a black cloth bag with an embroidered motif-- "*La-raza*." He also had temporary tattoos on his hands. When I asked him about the earring, he said that it showed he was special. It impressed me that he was very proud to have these special things. He said that he did not want to put on

a white lab coat. However, he told me that when he did put it on, he could see that the children respected him more. He further said that even when he drew a scientist, he drew himself with the lab coat on, with baggy pants with the word "DAMAGED" on them (Figure 18). I felt that he wanted to show that he was more special than the others. I believe that his misdirection, too, will gradually be changed with his involvement in the Family Science Program. So, I could have more information about his behavior, I asked Mrs. Lopez her perception of him. Mrs. Lopez's perception was similar to mine:

> *Ramiro is negative for everything, but he was there all the time.*
>
> *He gets up and walks around sometime for nothing, maybe to show off.*
>
> *He probably would be super negative. He needs to be pushed* (7/7/93).

Ramiro's consistent attendance and punctuality proved his interest in the Project, and he was able to work well with the children. Later on, he liked to work with Steve.

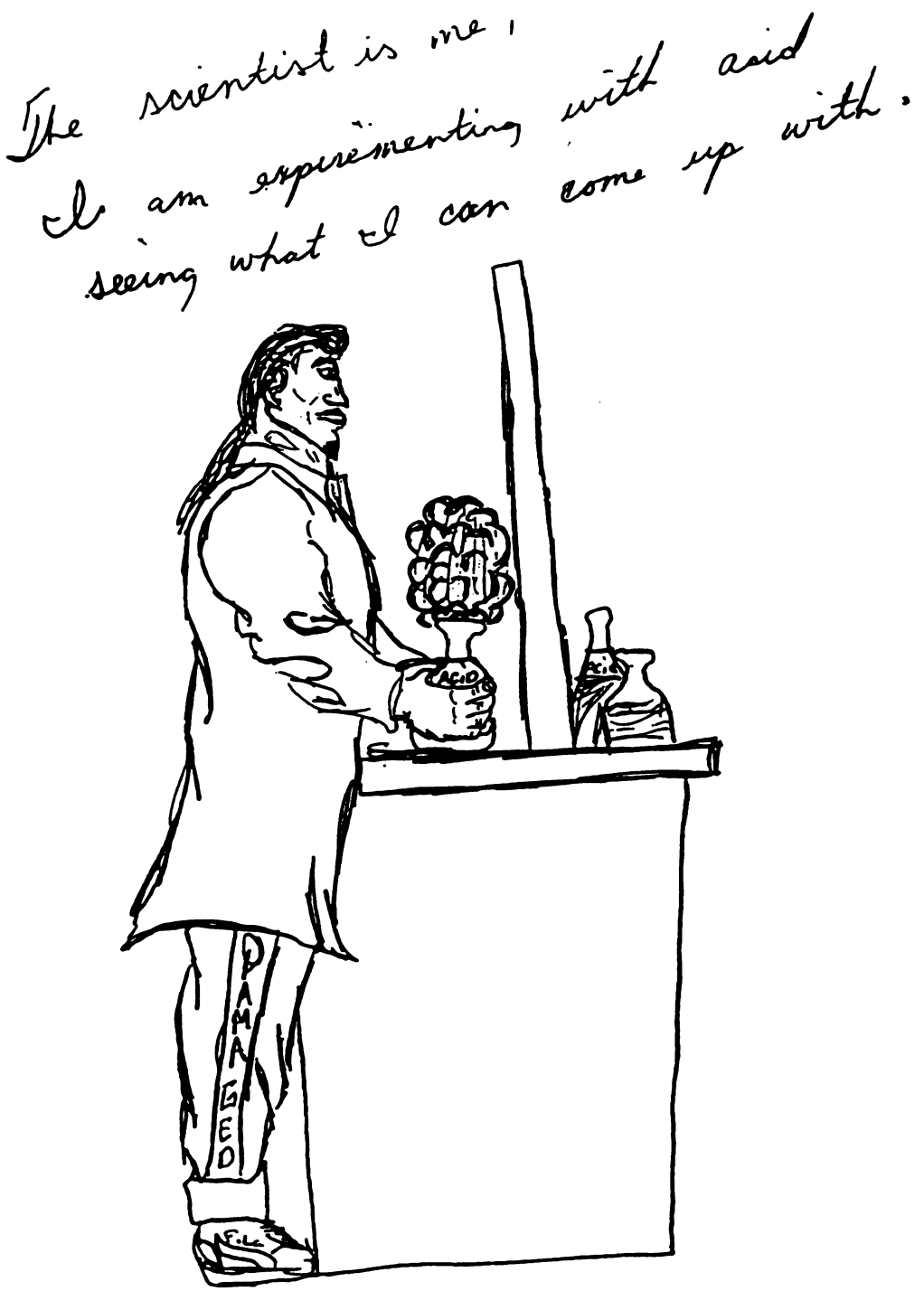


Figure 18 Ramiro's scientist

Discussion

In the Family Science sessions the role of the junior scientists was to assist the younger children in doing hands-on science activities. At the beginning, junior scientists had problems in helping the younger children, but gradually they developed the necessary skills by developing their patience and temper control. Ramiro is a good example of this. The training sessions helped them discuss their problems. In the first two training sessions, the junior scientists wanted to describe how hard it was to undertake the discipline of the "uncontrolled" children in the groups, for example, Anthony in Rumaldo's group, and Steve in Ramiro's group. But later on, their discussions were more focused on problems related to the activities. As Kasey and Christina mentioned, their experience in the Family Science Project helped them relate better with their younger brothers and sisters.

Doing activities engaged the junior scientists in a process where they considered more than just their own enjoyment. However, it was enjoyable only when they were able to work cooperatively with the children. Although there were some problems in keeping the children on task at the beginning, the junior scientists managed to do this by realizing the importance of being patient, and not loosing their temper. Then it was an enjoyble activity.

Assertion 4

Junior scientists provided role models for younger children to learn science.

The third and fourth graders of Highland Elementary School who participated in the Family Science Project worked with the junior scientists in doing hands-on science activities. Most of the time a parent also worked with them in their small groups. Many children told me that their favorite activity was the one where they made race cars from mouse traps. Hence, I chose to describe what happened in some of the groups when they made race cars (4/22/93). Each child got a mouse trap to work with which to work. They made axles from cut dress hangers to put on the wheels. For the wheels they used bottle stoppers, and removed the white undercover. At the beginning of the session, the Project Director introduced the activity by asking the children to make their own design:

> *This is your design. See how far it goes, how fast it goes? At the rear axle you have to have some tape. Small wheels in the front and big wheels in the back, or the same size wheels, or any combination. This is only a prototype* (4/22/93).

The first thing that they had to do was remove some parts from the mouse trap. The junior scientists had made their race cars on the previous Tuesday. Otila (1st year junior scientist) worked with two children--Reyena and Rita. Rita tried to remove the hooks in the

mouse trap just by pulling on them. Otila noticed it and showed her how to pull by tightly holding the other parts. Reyena observed what Otila did and tried to do it by herself. It worked for her, and she told Otila, "*I got mine out.*" The next task they had to do was glue two popsicle sticks to the sides of the mouse trap (Figure 19). Before gluing the sticks, they had to mark where the holes had to be drilled to insert the axles. Reyena was not sure where to put on the wheels. She first asked Rita. Rita told her to glue the sides first, and then she went to get her popsicle sticks glued. Dr. Rodriguez did the gluing, as she had only one glue gun and she did not want the children to use the hot glue gun. Reyena asked Otila, "*Would you tell me where to put the wheels?*" Otila responded by asking her another question:

> *Have you decided what wheels to use? You may use big wheels and small wheels. Look, if you want to use these big wheels you can't put them here. There is no space to rotate the wheel, maybe you need to move them a little* (4/22/93).

Reyena asked Rita what wheels she wanted to use. Both of them wanted to have the same type of wheels on the front and the back. Reyena asked Rita to hold the popsicle sticks to mark the place for the wheels. When Reyena wanted to help Rita, Rita said that she had already glued the sticks to the sides just like Otila had done.

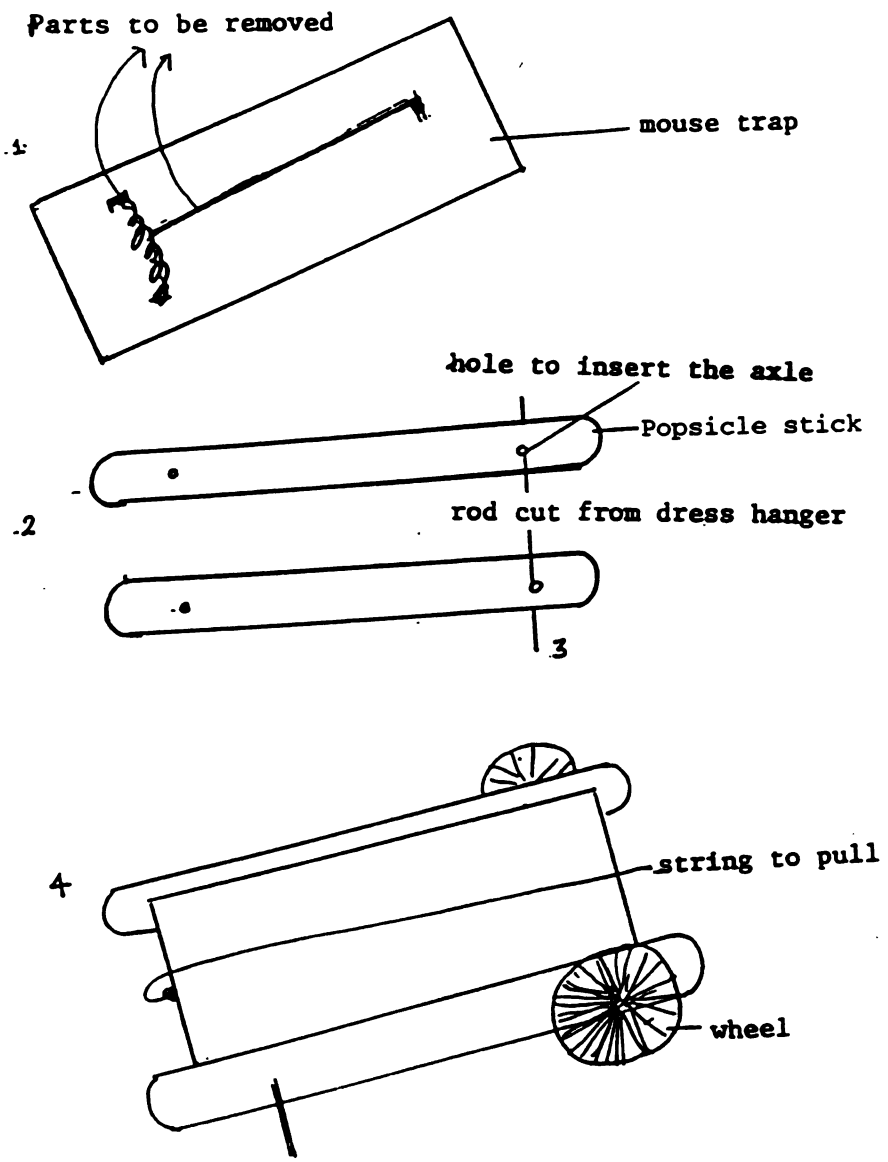


Figure 19 Steps in making race cars

Inserting the axles and fixing the wheels was a hard job for most of the children. The junior scientists had to work with everyone. Andrea worked with Lucinda. Lucinda requested that Andrea put on the wheels for her:

> *Lucinda: I got to put my wheels on.*
> *Andrea: See those.* (Andrea showed Bob's construction to Lucinda.)

> Lucinda put the front wheels on first. She was not happy with what she had done and told Andrea that her wheels were not aligned.

> *Lucinda: My wheels are really crooked.*
> *Andrea: This doesn't look crooked.* (pointing to a wheel)
> *Lucinda: It is crooked, I am still trying to put these wheels on.*

> Andrea tried to find out what was wrong with Lucinda's construction. She found that the sticks were not holding the mouse trap tightly enough.

> *Andrea: How come it doesn't stay? Maybe we didn't dry it enough. Let's do it again. I'll help you* (4/22/93).

Andrea had to work with Lucinda to align holes. I noticed that in all the groups children could not do the aligning without help from someone. The children who forgot to make holes in the sticks had to remove the sticks from the mouse traps to make holes. Rita was one example. She got angry with her car and did not want to continue. Otila had to convince her that she can do it with patience and started to undo the sticks. Her mother Mrs. Arizmendi observed this incident, and tried to work with Rita.

Even after gluing and putting the axles and fixing wheels, some cars didn't move. They asked junior scientists to see what was wrong with their construction. Junior scientists tried to figure out what was wrong with the cars by working with the children, for example, Andrea and Otila.

Julia also had problems in her car. Belinda assisted Julia to make her car run. As the two holes did not align, wheels on the opposite sides were not on the same line. Belinda noticed that if they would make another hole to adjust alignment then the new hole and the old one connect and axle would not stay firmly:

Belinda: Look, we can't make another hole here.

Belinda removed the back wheels and tried to fix the front wheels.

Julia: You mess it.
Belinda: This thing doesn't work. Make another one.
Julia: No, I want to make it straight.
Belinda: No, look at this....

Belinda started making a new car. She asked Julia to do it by showing her how to drill the hole, and then to put the axle in.

Belinda: Could you put this one in?
Julia: Hm, hm, hm
Belinda: Now do this one.
Belinda: Oh! you did it.
Belinda: Now do this one.
Belinda: You are doing great! (4/22/93)

The above dialogue shows how Belinda's support helped Julia to make her car. Dr. Rodriguez walked around to see how children were working. Whenever she saw something to be corrected, she stopped in and helped

them. While walking around observing what the groups were doing, Dr. Rodriguez paid special attention to how junior scientists were assisting the children. She said quietly to one of the junior scientist who was doing it all, "*Ramiro you can't do it like that. That's not helping.*" Following her advise Ramiro showed Jose to tie the string to the mouse trap. When Jose was tying the string Ramiro helped him by holding it. Then he asked Jose to let it go. Jose's car worked. It went for a distance of about ten feet.

All the parents who attended that day also made racing cars. They also helped the children while they were learning to make their own cars. But as they did not have an earlier experience, they also requested junior scientists assistance to make their cars. At the end of the day, there was a race to see whose car went fast? The discussion after the race helped people to understand why some cars went fast and why some cars went slow or did not run at all.

As the following excerpt reveals, Belinda felt that she worked as a teacher with the children:

> *I enjoy kids. There is lot of fun to be with them, to teach things that they don't know and couldn't do. I feel like I am a teacher to them* (4/27/93).

Whenever the junior scientists noticed good work of children, they commended. When they did the activity on water drops on a penny, one girl (Karena) did excellent in adding drops very patiently. She was able to add

forty drops of water at the first trial. Kasey--junior scientist noticed it and told the middle school teacher, "*Mrs.* (Lopez), *they did better than us.*"

During a session when they had a discussion on what is in milk, children gave some responses which were not given by the junior scientists at the training session:

> *R: What is in milk?*
> *Solomon: Protein*
> *Jaime: Vitamin B*
>
> At this time all the children started talking together.
>
> *R: We have to listen to what other people say. What makes strong bones?*
> *Pam: Cow's milk*
> *Jaime: Calcium*
> *Rumaldo: Great! I told you that they are doing better.* (to Dr. Rodriguez, 10/21/93).

Rumaldo surprised with those responses. None of them mentioned about calcium at the training session. While doing the activities, they encouraged children and appreciated any good suggestions.

Belinda joined the Project two weeks later than other junior scientists. But she was able to keep up with other junior scientists, and worked coperatively with children. She always asked children's ideas to do the activities. She said:

> *I like working with other people. I really enjoy it. It is fun.*
> *I like working in science, doing things in science. I made a lot of things. Worked with other people. Learned not to argue with them, but to listen to them and help them.... We made decisions together.... I think we developed problem solving and teaching skills* (4/27/93).

The elementary graders liked working with the junior scientists. Some children always wanted to sit in a group with the same junior scientist. Hilary was a nice example. As soon as she finished signing-in the Venn diagram and doing estimation looked around to find where Kasey seated. If during the snack time the groups changed, then she went to Kasey and asked her to work with them. Steve and Solomon liked to work with male junior scientists. Pat and Jean liked to work with female junior scientists, but they did not have a preference to what junior scientist.

Students' interviews revealed that junior scientists helped the elementary children a lot with hands-on activities and directing them what to do. Some of the responses given by children were:

> *Sarah: They help you a lot. Its kind of fun. When we did that thing on moving water drop on the wax paper, they help you count, and ask us to slow down when necessary* (4/29/93).
>
> *Luz: Its good to work with them because they know what to do. Parents also know what it is* (5/3/93).
>
> *Rita: They help me. They show how to do the activities. ... Andrea helped me to put the mirrors when we did kaleidoscope* (5/3/93).
>
> *Julia: They talk to us nicely. Learn more in science, different things. The tower we made, I never thought it will stand erect. Before you do it you feel that it won't work, but when they show us it works* (5/25/93).
>
> *Lucinda: They help a lot. Sarita helps a lot. Ramiro also helps, but I prefer Sarita, because Ramiro doesn't help that much. Sarita helped me to put the things to make the periscope* (5/3/93).

The above statements of children reveal that they appreciated the assistance given by junior scientists. Some had preferences over another.

The responses given by children about wearing white coats in doing hands-on science activities were different from the junior scientists. They impressed me that they wanted to be junior scientists to put a coat on (Chapter 5, Assertion 5).

Most of the junior scientists thought it was better to have a parent in a group. Belinda had observed that parents had better skills to work with children than them:

> *I like working with parents. They can understand the kids better. Sometimes when we asked something kids did not answer. But if a parent asks they say something. May be the way they are asking* (4/27/93).

There were instances where the junior scientists thought that they learned from the children. Rafael said:

> *When we were doing straw things, we all had different ideas, except most of the things did not work. Kids have good ideas. Some of those were better than mine. When we were doing hot air balloons, (Steve) figured out a way to glue the panels in a fast way* (5/25/93).

Kasey said that she always noticed how Karena was doing the activities with lots of patience, and she also had tried to behave like that.

Mrs. Briones and Mrs. Smith attended all the Family Science sessions. Mrs. Briones was happy with the junior scientists interaction with the kids. She said:

> *They interact with the kids fairly well. I liked the way Rafael used to work with Steve. He tried to keep him on task. Steve is little bit behind than the others because of his disability. He used to be hyper very easily. He and Sarah are twins. Sarah is one class in advance. Sarah likes to work with Sarita, but she works with anybody. I think Sarita gives enough time to think* (4/29/93).

Mrs. Smith who was a student nurse, and attended the sessions, believed that junior scientists helped the children and also provided role models. She also helped in the school in the mornings in some of the classrooms. Mrs. Smith said that she liked her children to join the project, because it helped them to do science. Her son, Solomon was a third grader, and the daughter Pamela was a fourth grader. They were talkative than the other children, and asked questions and requested things to receive attention. Mrs. Smith felt that junior scientists patiently worked with the children:

> *Pamela works with any body in any group. But Solomon doesn't want to stay in one place. He asks questions, questions. I like when male junior scientists working with him. He stays little longer with boys, because he likes their responses, and they know what to tell him to convince* (5/10/94).

Mrs. Smith, herself enjoyed working in the sessions, and did not miss sessions.

According to Mrs. Lopez (middle school teacher), Family Science also helped junior scientists to be more

assertive as leaders. Some of the science teachers in the school told her that the junior scientists had taken a lead in doing most of the activities in the class saying that they had done something similar to the class activity in the Family Science Project.

The principal of the Highland elementary school came to the Family Science sessions several times to see how children were working. He was very pleased with junior scientists assistance to elementary children:

> *I think excellently prepared those middle school kids. A lot of those middle school kids had come to (Highland). They are our ex-students. So I thought it was an excellent thing to tie that in, and have them as mentors closer to their peers.* (3/8/94)

Discussion

The elementary children's responses show us that junior scientists were able to do science activities with enthusiasm, and assisted them in doing activities. Children believed that junior scientists know the techniques to be used in activities. Children had no idea of relating the activity to knowledge. What happened in the Family Science sessions was the junior scientists directed children to figure out doing the activity. In order to do the activity, children had to pay careful observation on what junior scientists were doing, to model their techniques. Junior scientists helped them to understand what they did. They tried to provide explanations whenever it was necessary. This

was supported by parents and also by Mrs. Lopez. According to her junior scientists' assisting children helped junior scientists to work as leaders. The principal of the elementary school also had a positive view about junior scientists' work in the Family Science sessions.

Rafael was a junior scientist who thought that he could not do science and work with children. But later he found that it was fun and educational too. He enjoyed working with the younger students and with the parents. Children liked to work with him. But Dr. Rodriguez let him worked with Steve, because Rafael had better skills than the other junior scientists to keep Steve at work. Steve was disappointed to hear when Rafael quit coming to Family Science sessions.

Summary

Children as well as parents of children appreciated assistance given by junior scientists in doing hands-on science activities. It was observed that junior scientists had developed the skills to work with students by developing patience and listening to children's ideas. This shows that junior scientists were able to perform their role of assisting children in doing hands-on science activities. While performing their duties as junior scientists, they developed not only science process skills, but also social skills and

positive attitudes toward science. They were the students who were given a at-risk label in the school.

Participation in the Family Science Project also helped junior scientists to do better in school work. All the parents of junior scientists wanted their children to have a good education, which they had not had. They believed that junior scientists learned from Family Science sessions, and wanted them to continue it, except Rafael's father. Even Rafael's father realized that he made a mistake by keeping his son from participaing as a junior scientist, and he said he would have let Rafael to continue, had he given more thought to his decision.

McPartland and Nettles (1991) in reviewing the RAISE project, where adults were used as mentors and school based advocates for at-risk middle school students, note the increase of student attendance and report card grades. They also point out that mentoring or advocacy did not help the students in eliminating the risks. In the Family Science Project, students who had been labeled "at-risk" were not treated as at-risk students. Assigning them responsibility to work as leaders help them to build up confidence to perform their role, and at the same time to develop high self-esteem.

This study supports the study done by Bridgeman et al. (1985) on relationships of attitude toward science

and family environment. Their results show that if adolescents are provided with a good environment then they develop positive attitudes toward science education. Overall performance as junior scientists helped them developing confidence, high self-esteem and to work as leaders.

CHAPTER VII

WHAT WERE THE PERCEPTIONS OF PARENTS ABOUT THE FAMILY SCIENCE PROJECT?

In this chapter I present the parents' perceptions of the Family Science Project under three assertions; namely:

1. In spite of special efforts to encourage parental involvement in the Family Science Project, attendance of the parents remained problematic due to such factors as work, taking classes, taking care of siblings, and sickness.
2. Parents participated in the Family Science Project to help in their children's education by assisting children in doing hands-on science activities while they were also learning science.
3. The parents who had poor images of themselves and science were able to build up their confidence and develop positive images of themselves and science as a result of their participation in the Family Science Project.

These assertions are described in the next section.

Assertion 1

In spite of special efforts to encourage parental involvement in the Family Science Project, attendance of the parents remained problematic due to such factors as work, taking classes, taking care of siblings, and sickness.

The Family Science Project in Lansing was started after the Project Director, Dr. Rodriguez, had worked at a site in Detroit. That experience made her understand the difficulty in getting the participation of parents:

> *For example, I'm talking here on the recruiting. The problem that I saw here, and that we saw in* (Highland), *that you needed a system by which you got the parents to come or to feel comfortable about coming to begin with, much less staying.... I think once we got them there we could keep them there. It was having them come to begin with* (10/28/93).

As Dr. Rodriguez knew the problem of getting parents to regularly attend due to their work and other commitments, such as taking care of siblings, she wanted to make the Project exciting for parents. At the same time, she was a professor of biochemistry, and not a professor of education, so she really did not want to work with young children because of her inexperience in teaching at the elementary level. Hence, she required support from adults to implement the Project, as the following excerpt reveals:

> *We knew that a lot of parents work. That they're dealing with a lot of situations that middle class families don't deal with. And on top of that, they didn't have a positive experience in school, that they may not necessarily respond to just having a flyer sent home and saying, "Oh, this is a good program, I'm going to go." Because of that knowledge that it was going to be difficult to get parents there and I knew we needed an adult-child ratio that was reasonable, plus my inexperience at working with kids that age, meant that I needed more adult facilitators* (10/28/93).

Since Dr. Rodriguez anticipated the problem of getting the parents involved in her program, she tried to get assistance from other programs. Her first attempt was to get students from the Youth Empowered for Success (YES) program to work with the elementary students as adult facilitators:

> *What happened after that was that the Institute* (Julian Samora Research Institute) *became a reality....At the same time, I got involved with* (Sylvia Hernandez) *and the YES! program, and here was an outlet to actually do Family Science using junior scientists because she wanted some science. She wanted some activities for the middle school kids and I wanted to target elementary. So I said, "Well one of the problems is that the parents won't come and so we need to provide surrogate parents," and so that's when I got the idea of connecting the junior scientists* (10/28/93).

The middle school students who were involved in the YES program were from a nearby middle school. They walked to the elementary school to attend Family Science sessions. By using middle school students, Dr. Rodriguez also wanted to get the reputation in the community for the new program, as the following excerpt reveals:

> *That's why the program was set up that way in* (Highland Elementary) *using junior scientists to kind of address that issue until we were able to: 1) establish our reputation that I was known well enough in the community that the parents would feel comfortable in sending their kids, and 2) that coming was going to be a positive experience for them rather than a negative experience for them. So the junior scientists, while I envisioned it on a long-term basis, was also a way of addressing getting institutionalized and becoming recognized as part of the community and of building that trust* (10/28/93).

From the experiences Dr. Rodriguez had in the pilot year, she wanted to develop close relationships with the parents by talking to them. She thought that her participation in the PTA (Parent Teacher Association) meetings might increase the parents' attendance at the science sessions. She attended PTA meetings, introduced herself, and explained to them what she was planning to do for their children to help and for them:

> *I think the after school programs are the weakest in terms of connecting to the community and involving parents. I think our parent outreach and training is the weakest. So that's being targeted this year. One of the ways we're targeting it is I am working with the PTA* (10/28/93).

While using middle school students, Dr. Rodriguez also tried to get the parents involved by conducting workshops for them on Saturdays. As an incentive to increase parental participation, she gave a calculator and a basic science kit filled with materials for everyone who attended the workshop. This was further revealed from what the elementary school principal told me:

> *I think with* (Dr. Rodriguez) *the important part is she really goes after trying to get these parents involved. In some of the Saturday workshops, she'd give them packets and materials that they could take home. Each child that came, each family that came, got calculators* (3/8/94).

It was evident from what the school principal told me that getting the parents involved had been a real problem in the past. According to him, parents needed to be educated as to how to help in their children's education. He had tried several ways to get the parents to participate. As the following excerpt reveals, he believed that parents helping their children learn would be an asset to their education:

> *Even with* (Dr. Rodriguez), *we've come in and we've done everything to get parents involved. We've had workshops on Sundays. I come back on a Sunday off and my Saturdays off to try to submit a grant for a parent institute. We've tried to reach these parents and provide them with the background and develop some of their skills....And trying to show them that they can be an asset to their kids. A lot of parents don't have the parenting skills, perhaps, but that doesn't mean that they don't want the best for their kids, just because they don't know how to go about getting them* (3/8/94).

Dr. Rodriguez, herself sent flyers home with the elementary students, and made announcements on the school intercom system on the days Family Science sessions were held. She was always concerned about getting the parents to participate, and said:

> *I'm satisfied, but not in the parent participation, and even the parents getting their children to participate, and I think it has more to do that we need more personal contact with the parents in the 3rd and 4th grade* (10/28/93).

The community liaison of the Julian Samora Research Institute sent flyers to the children's homes, and made calls to contact the parents. She also visited the homes to talk personally with the parents. As I did not know the community, she went with me to interview the students and their parents, and translated for me what they sometimes said in Spanish. There was no community liaison during the second year of the Project. Hence, there was nobody to continue the frequent contacts with the community. Dr. Rodriguez felt that it was a loss to all outreach projects:

> *The teacher has been recruiting with the kids so we need to figure out ways to be sure that the message gets to the parents and the parents understand the importance of participating, or their children at least participating. So, I've done a couple of things. One, I've talked to 3rd and 4th grade teachers to identify children and target them and send them. Some of them, especially people like* (Monica Sanchez), *have taken a much more active role in calling the parents. The other thing is, I've talked to the case worker,* (Nancy Richmond), *to identify the Hispanic parents that she could work on to be sure that their kids come. In other words, we're connecting her intervention to the Family Science Program. The major thing is we don't have a community liaison to do that outreach* (10/28/93).

Both the school principal and Dr. Rodriguez felt the need to involve the parents in their children's education. They tried several methods to get parents involved. With all these efforts parents' attendance was inconsistent. Some parents came for just one session. Some came for two sessions and then stopped coming, and again attended at a later date. Some came

regularly for about three sessions and then dropped out. Some came only when they had free time. There was a session on October 29, 1992 when six parents attended. As Table 12 shows, there was an irregular pattern in the parents' attendance.

There were three mothers and one father who consistently attended the Family Science sessions during the first year. They were Mrs. Briones, Mrs. Martinez, Mrs. Arizmendi, and Mr. Parker. Mr. Parker was an Anglo-American who never missed a single session during the pilot and first year of the Project. He attended the evening sessions with his son. However, he moved to South Carolina in the second year of the Project.

The only parent who attended all the Family Science sessions since it started was Mrs. Briones. She was in the Project from the fall of 1991 through the spring of 1994. She did para-professional work in the school. Because of her 100 percent attendance, I asked her about the inconsistent attendance of most of the parents. According to her, it was not negligence, but the other responsibilities that people had which kept them from participating in after school programs or even parent/teacher association meetings. Her response was:

Table 12

Attendance of Parents (Year One-Oct.92-Apr.93)

Name	October				Nov	Dec.		February			March		April			Reasons for absence
	8	15	22	29	19	3	10	11	18	25	11	18	15	22	29	
Mrs. Arizmendi	X	-	X	X	X	X	X	-	X	X	X	-	-	X	X	work overlapped with FS sessions
Mrs. Briones	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Present throughout
Mrs. Hunter	-	X	-	-	X	X	-	-	-	X	-	X	-	-	X	
Mrs. Martinez	X	X	X	-	-	-	X	X	X	X	X	X	X	X	X	sickness and doctors appointments
Mr. Velasquez	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No time to come after work
Mrs. Velasquez	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Overlapping in class schedules
Mrs. White	-	X	X	X	-	-	-	-	X	-	-	-	-	-	-	Dancing lessons overlapped
	Evening Family Science sessions															
Mr. Chavez	-	X	X	-	-	-	-	-	-	-	X	-	-	-	-	Work
Mrs. Chavez	-	X	X	-	-	-	-	-	-	-	X	-	-	-	-	Classes in the college overlapped
Mrs. Knapp	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Present throughout
Mr. Parker	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Present throughout
Mrs. Smith	-	-	-	-	-	-	-	-	X	-	X	X	X	X	X	Classes, but present regularly
Mr. Winters	X	X	-	-	-	-	-	-	-	X	-	-	X	-	-	wife's work & prefer night shifts
Mr. Wooten	-	X	-	X	X	X	-	-	-	-	-	-	-	-	-	rotating shifts in work

> *Not that they really didn't want to come or didn't like it. Some of the parents have to work. Some kids do not get interested. Lots of times many parents are not encouraging the after school programs, talking to other people. They are scared to send the children alone in the evenings, especially in the winter. Not because they don't like the program, they won't show up even for PTA meetings* (6/1/93).

She further said that some parents did not have the time to spend with their children, and she had observed that those children did not have long attention spans in the classrooms and they were behaved as trouble makers.

Work. For most of the parents, their work schedule overlapped with Family Science time (Mr. Chavez, Mr. Velasquez, and Mr. Winter). In spite of this overlap Mrs. Arizmendi tried to attend the sessions. In the afternoons that Mrs. Arizmendi had off from work, she attended the Family Science sessions to do science and help her child. She was very interested in the Project, despite the experience that she had on the first day of the sessions (10/8/92,) which was held when she was home and waiting for the strike in her work place to be over. Mrs. Arizmendi asked me, "*If I go back to work, can I come at about a little after 4:00?*" My response was, "*You can come at any time whenever you can.*" As her daughter Rita was in the school, Rita had no problem coming to the sessions right after school. But when her mother could not come, she walked home with Mrs. Martinez.

Rotating shifts in work. Some parents had rotating work shifts. Mr. Wooten worked both the day and night shifts. When he had daytime shifts, he attended evening Family Science sessions. According to him, he could not attend the afternoon sessions because his night shifts started at 5:00 P.M. When he was absent for the evening sessions, his son attended these two sessions with his uncle. Mr. Winters preferred to work at night, to take care of his infant while his wife was at work. Mr. Velasquez came to Family Science only once. He said that he liked the Project very much, but he could not make it after work.

Child care. Mrs. Hunter had an infant at home. When she could find a baby sitter for her child, she came to the sessions with her two older children. She also did baby sitting as a source of income, and when those parents could not find another baby sitter to replace her, Mrs. Hunter did the baby sitting for them, because she felt that it was necessary to have a good relationship with the parents for whom she did baby sitting.

Taking classes. Being a student nurse, Mrs. Smith had to take classes and keep up with her work. In spite of this, she volunteered to do some para-professional work

in the school, and attended Family Science sessions to help in education of her children. She joined the Project in the spring of the first year, and attended evening sessions with her children--Pamela and Solomon. In the second year she was able to go to the hospital for her nursing apprenticeship in the mornings, and so had free time in the afternoons. She and her husband were Anglo-Americans. Although the Project was started for Hispanics, it was later opened to other minorities and also to whites.

For Mrs. Chavez and Mrs. Velasquez, they could not fit Family Science sessions into their class schedules. Mrs. Chavez was studying at college during that time. Mrs. Velasquez took classes at the community college, and she could not fit Family Science sessions into her schedule either.

Mrs. White attended four Family Science sessions during the first year of the Project. In response to a question asked toward the end of the 1993 spring semester regarding her inconsistent attendance, she said that she could not change the schedule of her dance lessons. Further, Mrs. White repeatedly said that she liked the Project and wanted her children to be in it. Upon her request, and to get the participation of more parents, we tried to change the Family Science sessions to Wednesdays. But it did not work, because the junior scientists could not come on Wednesday afternoons.

Sickness. Mrs. Martinez had some disability and suffered from arthritis, but came to the sessions with her daughters, Luz and Lucinda, quite consistently. She had to miss sessions when she had medical appointments. Despite her disabilities, she took responsibility for bringing other children (Julia, Rita, and two other children who came twice) to the sessions.

I met Mrs. Martinez at the Thanksgiving dinner served at the community center. When I finished helping serve dinner, I went and sat in the same circle where Mrs. Martinez was. After giving me a description of her sickness and problems, she said she did not feel like continuing to come to Family Science sessions because she had already missed so many sessions. (Although she felt that she had missed a number of sessions, she actually missed only two sessions.) In the month of November, Family Science sessions were not regularly held due to another overlapping responsibility with Dr. Rodriguez's work. She was convinced that she could continue without any problem, even with missing a whole month, because of the variability of each session's activities. Mrs. Martinez attended the session that was held after the Thanksgiving, and has attended regularly since then.

Discussion

There is a growing body of literature referring to the importance of parental involvement in their children's education (Delgado-Gaitan, 1991; Lareau, 1989). As with Treuba (1994), schools require parent participation for school activities. Although parental involvement supports children's education, several studies had difficulty in getting the parents to participate (Bridgeman, Oliver & Simpson, 1985; Bronfenbrenner, 1978). Through her experience in working with the Family Science Project as the Director, Dr. Rodriguez was frustrated by the inconsistent attendance of the parents. She realized that it was necessary to get teachers' input, as well as input from other people who worked for the school, in order to increase parent participation:

> *It's not that I'm dissatisfied, it's that we really haven't hit upon all that we have to do to connect the parents in a more positive way to the school and to the fact that they can do the science. So, I think that's a major, major problem. Without the teachers being involved, without the case worker being involved to connect the parents and say to the parent, "We need your child to come to this and it will be very good," without that one-to-one with the parents, we're not going to get participation* (10/28/93).

Chapa and Valencia (1993), and Lareau (1989) point out that families living in poor socio-economic conditions often face sustained isolation from the school culture, which might lead to miscommunication

between the school and parents. This miscommunication affects the children's education because of their parents resentment and apathy. This could be understood, even in the Family Science Project, because the children in Highland Elementary School came from low socio-economic status families, with predominant minorities of blacks and Hispanics. As Mrs. Martinez indicated, it is necessary to build trust between the school and the community in order to get more and more parent participation in school work.

Treuba (1994) reports that the parents of disadvantaged groups and minorities have minimal participation in school activities due to disjunction between the cultures of school personnel, the children they serve, and their parents. The majority of the Highland staff were Anglo-American, middle-class workers. As McCaleb (1994) says, the large institutional structure of schools and schooling intimidates minority parents.

Some parents had regular attendance. Those who did not have regular attendance were absent not because they disliked the Project, but for many other reasons. So, it is questionable whether the parents' absenteeism was due to the social incongruency of the school and the community or to other factors. However, it appears that the low level of parental involvement is a great obstacle in community outreach programs.

Another finding of the Family Science sessions was that the majority of parents who attended were mothers. Except for Mr. Parker, the fathers' attendance at Family Science sessions was minimal. The only times that Mr. Velasquez attended Family Science sessions, he came with his wife. In the evening sessions, Mr. Chavez was there only when Mrs. Chavez was present. Although Mrs. Briones attended all the Family Science sessions, her husband, Mr. Briones, never attended Family Science sessions, because he worked at night. During the day time he was home sleeping. I met him once, when I went to interview Mrs. Briones one morning, but he was all ready to go to bed. He said that he had assigned his wife the responsibility of educating their children.

As reported by the Highland school principal, even the parents who came to the PTA meetings were mostly mothers. Experiences during the Family Science Project raise a question: What contributed to the minimal participation of the fathers? Although parental involvement is beneficial in a child's education, due to other involvements and cultural differences, parents do not feel comfortable in participating in school activities. A major unanswered question was: "How can a higher level of parental participation be achieved in schools?"

Assertion 2

Parents participated in the Family Science Project to help in their children's education by assisting children in doing hands-on science activities while they were also learning science.

Most of the activities that participants did during the Family Science sessions were able to be done at home using items available in the kitchen. This was an advantage, because the children could practice some of the things they had learned at home, and share with other family members. This opportunity provided those people who did not do the activities in the sessions with enjoyable experiences in science. As mentioned earlier in Chapters 5 and 6, there were instances where the children, as well as junior scientists, demonstrated some activities to their family members. Parents assisted children in doing activities by helping them develop manipulative skills such as pouring, folding, cutting, and so forth.

Making race cars provides a strong example of the parents' engagement in doing the science activities (4/22/93). In making race cars from mouse traps, the participants had to take out some parts of the mouse trap and make wheels using bottle caps (Figure 19). Junior scientists and parents helped the children remove

the unnecessary parts and put on wheels, difficult tasks for the children.

The following excerpt gives one instance where Mrs. Arizmendi helped Rita when they were making race cars:

> *Rita: I need help.*
> *Mom: What do you want me to do?*
>
> Dr. Rodriguez came to their group at the same time and asked, *"What kind of help?"*
>
> *Rita: I need another wheel.*
> *Mom: Let's do it together. You can help me put on the wheels.*
> *Dr. R.: You need a string to pull.*
>
> Mrs. Arizmendi was able to make the wheels align each other on her race car. Rita observed her mother put on the wheels.
>
> *Rita: Mommy, how do you do that? Mine is ugly. Please help me put on the wheels* (4/22/93).

Rita needed support to put the two wheels on in a straight line. One wheel was a little bit away from the other. It was easy to align the wheels when two people worked together. Even tying on the string to pull the car with, one had to have the correct tension in order to move the parts. While Mrs. Arizmendi was helping her daughter, the junior scientist in the group helped another child. When Rita finished her car, she wanted to do another one, but her mother let Rita realize that it was not correct to use another mouse trap for her:

> *Rita: Mom, are you going to make another one?*
> *Mom: We already put the things together for you.*
> *Rita: I want to do another one.*
> *Mom: I don't think it's fair if you use another mouse trap. I think she had brought one for each one. You can do one with your brother at home* (4/22/93).

There were instances when the child helped her/his mother, as the following excerpt reveals:

Mom: I can't get this thing out of here.
Lucinda: I'll show you how to do it, mom. Come on, you have to wait....
Lucinda: Now pull it out. (Mom tried to pull, but failed.)
Lucinda: I'll pull it out for you.
Mom: Ha, ha (laughing).
Lucinda: Do it mom. (Mom tried it again.)
Lucinda: You are doing it wrong.
Mom: That's alright.
Lucinda: No it's not. (Finally mother succeeded.)
Mom: Good, that's hard.
Lucinda: I want to see how it works (4/22/93).

When all of them finished making their race cars, they took them to the hallway to start the race. Some cars went for awhile and then stopped. Some did not move more than a foot. Mrs. Martinez's car went beyond Lucinda's. Lucinda showed it to her mother with enthusiasm. Some cars went for about twenty feet at high speed. When they saw the high speed cars, they cheered and clapped without thinking about who had made them. I heard people saying, "*It's fun, though it's hard.*"

While learning and assisting their children, parents also considered discipline in the sessions. There were times when children misbehaved. Mrs. Briones knew all the children and their parents because she volunteered to work in some of the classrooms in the morning, and all the children came from the same neighborhood. (Because I had seen her in school often,

I made the assumption that she was a teacher's aide until I interviewed her for the first time.) One day Mrs. Briones (B) noticed that Solomon and Andrew were doing something that they shouldn't have been doing, and she tried to keep them on task:

> *B: Solomon, have you got yourself done?*
> No answer from Solomon.
> *B: Andrew, Solomon, I would see....If you want to stay you'd better be polite.* (Dr. Rodriguez) *would have you leave. I got to wait and see (Dr. Rodriguez) see it.*
> *Andrew: (R-o-d-r-i-g-u-e-z)*
> *B: See, you are not supposed to play with alcohol.*
> Steve also wanted to join them.
> *B: You leave them alone for now* (11/8/93).

Mrs. Briones was able to get Andrew help him the letters in his tee-shirt. Solomon took his tee-shirt to the window to get more ventilation so it would dry quickly.

All the parents who attended Family Science on a regular basis expressed their what they had expected from the program at the post interviews.

In the following section, I present profiles of four parents to give an overview of their background and interests, and also how they felt about Family Science sessions.

1. <u>Mr. Parker</u>

Mr. Parker lived one block away from the school. Compared to other homes that were in the neighborhood,

his home looked different, in the way things had been organized. He had a collection of trophies and souvenirs from places where he had traveled.

Mr. Parker was an Anglo-American who participated in evening sessions of the Family Science Project, with his son Henry, for two years without being absent, until he left for South Carolina in the summer of 1993. He worked as a draftsman, and had graduated from college. According to him he had background knowledge in physics, but not in biology.

For his first post-interview appointment scheduled, Mr. Parker could not come home on time due to an accident on the freeway. Instead, his wife was interviewed on that day (5/25/93). She said that both her husband and her son showed her what they did in the sessions. She was delighted to see Henry's involvement in the Project, because Henry was under medication for some kind of disability, and at times she could not control him. She was not employed, but did baby sitting. Mrs. Parker had an acute asthmatic condition, and that was the main reason for them moving to a warmer and drier place than Michigan.

During the post interview, Mr. Parker said that his main concern in joining the Family Science sessions were to support his son's science education. He also expressed his interest in Family Science, and how it had helped him, and his unforgettable experience in doing

hands-on activities. He felt that his move was going to affect Henry, who wanted to be a junior scientist, as well as himself, in continuing the sessions:

> *I went there to support* (Henry,) *but I learned a lot. On Thursdays I make it a point to come home after work to attend science class.*
> *I will never forget what I observed for microorganisms. Henry will be in the fifth grade next year. He had plans to be a junior scientist. I hope he will get something over there* (new school in South Carolina.) I am going to miss Family Science (6/1/93).

2. Mrs. Briones

The only parent who attended all the Family Science sessions since it started was Mrs. Briones. She was born and raised in Michigan. She was proud to say that she had connections to Michigan State University (MSU) from her childhood. Her father was employed at MSU, and her mother had done some waitress work in the dormitories. Mrs. Briones had attended in school in the Okemos school district. She was a high school graduate. She felt that she did not do well in school. She did not have a permanent job, but occasionally she did baby sitting. She was an Anglo-American woman, who was married to a Hispanic man. Their house indicated of humble life to me, from both the exterior and the interior. However, things were pretty well-organized inside the house.

Besides the flyer that Mrs. Briones received, she came to know about Family Science because she went to the school almost everyday. Her house was in front of

the school. She felt that she should send her children--Sarah (a 3rd grader) and Steve (a 2nd grader in the first year of the Project)--and at the same time she could also be there to learn science. Mrs. Briones was glad to send her children to the Family Science sessions, as the following excerpt reveals:

> *(Sarah) is interested in Family Science. Family Science would help further her interests. I thought it would be fun, and a little extra would help them in their education. They enjoyed it, and wanted to continue it. I hope they learn something. Family Science would be an extension of what they learn in school. Teachers have you read chapters. Some teachers have them do more. Family Science is more relaxed* (4/29/93).

At the time Mrs. Briones started attending Family Science sessions, she had negative attitudes toward science. As the following excerpt reveals, Family Science helped her develop positive attitudes toward science:

> *I participate because I didn't like science in school, and this will help me enjoy science and to help my kids in their education. We learned how to try and try again. If one way doesn't work then we try another....*
>
> *When I was in high school, science was mainly working with chemicals, doing book work. None of my teachers really pushed me in that direction. We had to memorize a lot, like biology part dissecting I didn't like either* (9/28/92).

On Thursdays, as soon as Mrs. Briones got back home from Family Science, she had to serve dinner quickly so that her husband could leave for work. According to Mrs. Briones, dinner time was the time that her children

talked to her husband, because of his work shifts, *"They talked to dad and showed what they had made and told him what they learned."*

Mrs. Briones felt that her children were more interested in the Project than she was, and reminded her on Thursdays about Family Science. *"They are excited about going. They remind me on Thursdays that it is Family Science day."* She further said that she always paid careful attention to what they did in school and the homework that they had to do. *"We usually talk everyday about what they study. I go through the children's worksheets."*

Mrs. Briones had had science in school, but she did not enjoy it. She came to participate in the Project to help her children in their education and to learn science. She felt that the session's group work helped her learn science and assist her children. She did not have experience in working in groups when she was in school. She worked not only with her children, but also with other children, too. As her son had a disability, she always paid careful attention to his behavior. She said:

> *It is easier to learn in a group. Every one is learning from each other, and not just one person. I like to encourage all the children* (2/24/94).

Since Mrs. Briones was so much involved in the activities of the school, and Mr. Briones worked the

night shifts, he put the burden on Mrs. Brones of taking responsibility for educating their children.

3. Mrs. Arizmendi

Mrs. Arizmendi moved to the school neighborhood, about three months before her pre-interview (10/8/92), when she decided to separate from her husband. During her pre-interview, she was remodeling her house. She worked in a pharmacy. The pharmacy where she had worked had had a general strike and closed, she was home, and she used that time for remodeling. She did the remodeling by herself and with the help of her son, who was a ninth grader.

Mrs. Arizmendi had three children. The oldest was a daughter. She was not happy with her, because she had given up on school and started living with a man. This had an impact on her when she considered the education of her other two children. When she received the flyer on Family Science, she wanted to go to it with her daughter, Rita, so that Rita could learn science. She did not want Rita and her brother to drop out of school:

> *I read the flyer and asked her to go to it. She said, "yes," and both of us went. She could learn more about science by going there.*
>
> *I failed with my first one. I don't want these two to fail* (10/8/92).

As Mrs. Arizmendi was not successful in science, she wanted to learn it, and help her daughter. She felt

that she had not received support from her home to do science or continue her education. Before she separated from her husband, she had started going to the community college and realized the importance of reading:

> *I took science in the high school, but it was very hard for me.*
>
> *My mom and dad spoke only Spanish. They couldn't help me. My dad always thought that girls should not go to school or to college. He never encouraged me.*
>
> *When I went to college only I knew that I have a reading problem. If you can't read, you can't get good grades. If a parent can't read, then she cannot help her children in education* (10/8/92).

Rita was a fourth grader who did not have science in school. Mrs. Arizmendi wanted Rita to have an exposure to science. Over all, Mrs. Arizmendi liked the Project, because she felt that it enabled her to learn some science:

> *I feel that it is interesting for me to give (Rita) support, so that she can do something to help her in the long run. I learned a lot, to do prediction, discovery. I didn't know the reason why hot air balloons go up ...*(5/8/93).

Rita's participation in the Project gave Mrs. Arizmendi satisfaction. She believed that Rita's participation made her work with other people and not totally depend on her mother. According to her:

> *She enjoys going. She's always bugging me, saying, "We got to go to science project." Now she knows about hot air. We took pictures. She likes the project and the things that she had done. This year she seems to be outgoing. Last year she was a cry baby* (that is, she used to depend on her for

> everything). *In the long run she will feel good about herself* (5/8/93).

Mrs. Arizmendi had to go to work when the strike was over. Because of her work schedule, she came to participate in the activities about fifteen minutes to half hour late.

4. Mrs. Velasquez

Mrs. Velasquez came to Family Science sessions only once with her husband. They attended the evening session, and their children came to the afternoon session. According to Mrs. Velasquez, she took classes at the community college and when she returned home, it was too late to go to the Family Science sessions. Otherwise, she was very interested to do some experiments and learn some science. When I went to interview them, I received a very warm welcome, and both Mr. and Mrs. Velasquez wanted to talk to me. They said that both daughters liked the Project very much, and brought out the things that they experimented with in the sessions:

> *They like, always are excited about what they learn. Come home, do homework and play. They show us what they do in school. Usually while we are eating we tell each other what we did. (Ofelia and Reyena) are interested in experiments. They brought the stuff that they did for science* (Family Science) *to show us. They are excited and interested. It is great....I want them to learn. I never got to learn science* (5/11/93).

Parents wanted their children to be in the Project. One day a parent who attended Family Science sessions, could not come to one of the sessions. But she did not want her children to miss it, and sent a letter to Dr. Rodriguez (Original, Appendix 6), asking permission for them to attend the session in her absence:

> *Dear* (Dr. Rodriguez),
> *I came down with a migraine headache yesterday and even though I have medication for it, for some reason it has not kicked in this time. Right now my right eye is useless and I am unable to attend class. I thought maybe a junior scientist would not mind helping my kids anyway. They really want to be there. ,If, for any reason, you feel that it won't work out, then please send them home. I expect them to be on their best behavior. If not, please let me know the next time I see you.*
> *Thank you* (3/11/93).

This mother was an Anglo American who complained at first, thinking that the Project was offered only to Hispanics. Although Dr. Rodriguez is a Hispanic, and she wanted to have Hispanic children in at the beginning of the Project, it was offered to anyone who was interested.

Even the parents who could not participate were happy to have their children involved in the Family Science Project. Three children from the Hernandez family came to the Family Science sessions in the pilot year of the Project. At first only the third grader came, and then she brought her siblings, sister and the brother twins. When I went to interview their mother,

they ran to me and welcomed me by giving me hugs, and told the mother, "*She is our science teacher.*"

According to their mother they developed good habits of sharing what they had done in school since they started participating in the Family Science Project:

> *Before the program they never told us what they did. But now, when they come home, they tell us more about the things that they did. Mom, this is what we experimented with today....I didn't like science. Now my kids have a chance to learn science* (6/11/92).

Mr. and Mrs. Hernandez were not happy with the environment in which they lived, because of all the gun shots. They did not want to raise their children in such an environment, and so they decided to leave and go to Texas, where they had relatives and friends.

Discussion

Most of the parents wanted to participate in the Family Science Project to improve their child's education. They further revealed that they enjoyed doing activities with the children, and they were happy with what they learned in the science lessons.

After the first day of the sessions, the participants got used to follow a routine. These routines helped them behave as part of the community by organizing the participants and having them follow methodical procedures. Children, as well as the

parents, signed in the Venn diagram as they walked into the room. After hanging up their coats, they did estimation, and hung their estimates on the line plot. Then they had the snack time, where socializing such as, inquiring about the home front and school occurred. Those things generally took a total of fifteen minutes. Snack time was over when Dr. Rodriguez started introducing the activities. During the activity time they did hands-on science activities individually or in groups. However, they always sat in mixed groups, and recorded data. In the Family Science sessions, the work groups contained three different age groups-elementary children, middle school students, and parents. Because of this mixed ability and mixed age groups, ideas that the participants brought, the questions they asked, and the way they proceeded were different. Generally one person represented the whole group when reporting the methods they had followed and their findings. After finishing the activities they were ready for the discussion time, and they then cleaned the work areas.

Another benefit of having a mixed group was that the three groups could be involved in three different subordinate tasks to achieve the final outcome. The children usually got bored when they were involved in doing the same thing for more than five minutes. Parents had more patience than the children and junior scientists, and helped the others to wait for things

like gluing and drying. This collaboration helped in their exploration. It was a very relaxed atmosphere, which encouraged all the participants to be involved in the dialogue and do the hands-on science activities. The participants respected everyone's different views, and could readily eliminate non-working ideas and explore ways to do the activity better.

Within the small groups, too, they followed some routines. First they discussed what they had to do, so that they completely understand the task. Then they discussed how to do the task. While they were involved in doing the activity or performing the task, they had to be involved in a dialogue among the group members. The set rules for the dialogue were to give each member a chance to bring her/his idea, and to respect each one's idea. In a classroom situation, however, the same child might initiate the dialogue and continue without giving enough time for the others. Parents and junior scientists monitored the dialogues so that everyone in the group had a chance to talk. The participants developed the skill to explain their ideas to the group so that they could understand what s/he was presenting. Group members had the right to accept or refute one's idea with evidence. Accepting or refuting an idea was based on the responses to the questions asked by the group members and on the type of evidence provided.

Again, the questioning was to understand the idea better and not to harass the one who presented an idea.

From the very beginning of the sessions the participants were informed that they had to be cooperative in what they did. The first thing that they were asked was to respect the kindergarten teacher's participation, since she provided the room for the Family Science Project. Dr. Rodriguez asked the children to not touch kindergartners' things, and to not play with anything that did not belong to the Project. Another important item that was mentioned in the sessions was to think about own safety and the safety of others . The children had to remind from time to time about safety and property of the kindergarten classroom.

The hands-on activities, the way the sessions were structured, and the social norms that they followed in group activities were appreciated by the parents. It was revealed by all the parents that they thought their child had learned a lot and were motivated to do science because of the Family Science sessions. A common view point of all the parents who were interviewed was that they wanted their children to have a better education than they had received. The parents of the junior scientists also had the same kind of expectation. As an example, Belinda's mother said:

> *My husband and I push them to do their homework, not to watch TV. Both of us graduated, but did not continue. She* (Belinda) *really enjoys going to the*

> *Project, it will help her in school. I want her to continue her education* (4/27/93).

Dr. Rodriguez felt happy with the changes she observed in those parents who attended. She said:

> *I think one of the changes that we've actually seen in the parents is that the parents are probably more excited about doing the activities than the kids. And in fact, they finally connected what they were taught in school years before. "Oh, this is what this was." Now they understand what it is. So, it's as much almost a learning curve for the parents, just basic skills. And also, I think, the parents are developing self esteem, and saying, "Oh, I can do this"* (10/28/93).

Since the parents had high expectations for their children, they wanted to send them to any program which would help in their education. They preferred the nonformal environment of the Project in doing science activities, rather than the formal environment of the school, where their assistance was neither recognized nor appreciated.

Assertion 3

The parents who had poor images of themselves and science were able to build up their confidence and develop positive images of themselves and science as a result of their participation in the Family Science Project.

The parents who participated in the Family Science Project were mostly mothers, not fathers (Table 12).

These mothers recalled unpleasant memories when discussing their experiences in science while they were in school. All the mothers said that they did not have the opportunities to continue their education, especially education in science. It was a common view that they wanted their children to have more science in school so they could lead a better life. Stories of two mothers follow:

Mrs. Martinez. The activities in the Family Science sessions encouraged Mrs. Martinez to be in the Project and send her children. She enjoyed working with the children and the junior scientists.

She felt that the way the Family Science sessions were structured and the hands-on activities that they did helped people develop their learning, and that teachers should use a similar method of doing hands-on science activities in the school to help children in their learning:

> *The things you do even a first grader could grasp. A young child can really have the learning capability. That learning capability is higher than I thought. I thought science was for middle, junior and high school, but not for elementary. Teachers in the school should also teach with hands-on things.*
>
> *There is a big difference when you say something, and reading a book, or by doing a thing. I really like science. Science to me is a strong point. I didn't take science in school.*
>
> *I learned things I didn't know* (5/3/93).

Mrs. Martinez further said that, being a woman who had not learned science, the Family Science Project provided her with opportunities to do some science and think about continuing her education. The following excerpt reveals what Mrs. Martinez thought about the program, and what changes she had in developing her self-esteem:

> *The program being offered free. I learned a lot. Science that I know is from a newspaper or a book. Now I see different aspects. We do hands-on activities. When we received the flyer saying "Family Science class" I had the question, "Are we smart enough to learn science?"*
>
> *Now I feel that if I had the opportunity, I would have learned science. There was no one to push me. I didn't have science in school. I thought you needed high SAT scores to do science* (5/3/93).

Mrs. Martinez was able to develop positive attitudes toward science and confidence in herself to do science. Because of her interest in learning more science, she decided to take a science class at the community college:

> *I am planning to take a science class at the community college. Motivation is important. I realized that I have the capability. I felt that I wouldn't be able to do it. But now I have the attitude. I read a book about how to do experiments in science using inexpensive things* (5/3/93).

Considering the changes that Mrs. Martinez observed in the elementary school classrooms, she felt that schooling now has changed:

> *Nowadays they make it so exciting. Students come from MSU. Our children like to see those*

> *university students. Even I feel highly motivated. When I go to school, I do see children motivated. Sometimes they ask questions that even I do not comprehend. I am happy with those changes* (5/3/93).

Mrs. Martinez was able to develop positive attitudes toward science, and confidence in herself to learn science. She believes that she has the confidence to learn more, and has started reading more about science. The groupwork and the assistance given by the junior scientists were appreciated by Mrs. Martinez, *"One parent is enough for a table. Junior scientists help the children. They do things which I can't do. Some of them worked very hard."*

Mrs. Martinez explained to me the barriers that had existed when she was a child. Her parents did not let her continue going to high school, and wanted her to marry at a very early age. She further said that at the time she did her schooling, there was no place for women and especially for minorities. The common belief was, women should produce children, and stay at home looking after the children. She had six children. Two children went to elementary school, and four went to middle school.

Mrs. Briones. Mrs. Briones felt that her involvement not only encouraged her children, but had an impact on her also. *"If I enjoy Family Science, it not only helps my children, but it might also encourage me. We do more*

things at home, while I cook." The following excerpt reveals her interest to learn science, and how she tried to integrate that at home:

> *I like the osmosis class. It helped me in my cooking. I know that if you add salt in your salad first, the water in the leaves comes out and gives the wilty look. When I wash sand from parsley I think about separating mixtures. So it's good for me. I try to think. Whenever I see something that I could apply at home I asked the kids too, and tell them what I think. Even when I organize my things, especially when I wanted to put things in the jars, I think about the estimation we do over there. It is helpful* (4/29/93).

In a discussion about parental issues, Dr. Rodriguez pointed out the necessity of making the parents realize their potential in learning and helping. She said:

> *The problem really addresses the spectrum of families that live in the neighborhood. I think that the parents can learn that there is a lot of things they can do to enhance science skills with the things they have at home. And in many ways they know a lot more science than they think they know. I think the objective of the program was also to give the parents the self-confidence that they do know a lot of science and they are capable of helping their child in science....and that science is not just for nerds or it's not to be done just with sophisticated equipment* (10/28/93).

Discussion

The profile of Mrs. Martinez provides many theories about which features are necessary in order to have a successful program in science. To her, it is most important to build up the children's courage. As reported earlier, she said, "*Now I feel that if I had*

the opportunity I would have learned science. There was no one to push me. I didn't have science in school."

Mrs. Martinez thought that she would have learned science if there had been someone to encourage her. As more evidence, she said that her father wanted her to stay home. She also presented a commonly held attitude by saying that her father thought that the role of a woman was to produce children.

Mrs. Martinez liked the activities because everyone was able to do those activities. *"The things you do even a first grader could grasp."* Her involvement in doing the hands-on science activities kept her motivated to learn science, and also build up positive attitudes toward science. *"Motivation is important. I realized that I have the capability. I felt that I wouldn't be able to do it. But now I have the attitude."* Mrs. Martinez felt that even in the school, if there were activities that the children had to do, it would motivate them to continue learning science. She thought that a child could understand scientific concepts better by doing something than by listening to the teacher. *"There is a big difference when you say something and reading a book, or by doing a thing."* This perception of parents supports Millar's (1987,) and Driver's (1989) studies of science by doing.

As Driver (1989) said, from their early days in school, children's ways of doing things, and seeing the

world are being shaped by the parents. A parent's involvement and the interrelationships in working in a group help them build a learning community. The descriptions in earlier chapters (3, 5, & 6) indicate how different the environment is in the Family Science Project compared to the environment in schools. The Project's nonformal environment made the participants learn with joy, without the pressure of thinking that they had to learn.

The environment in the Family Science Project was very democratic. Although Dr. Rodriguez conducted the sessions, the power and authority experienced in the sessions were quite different from that of a classroom situation. All the participants worked collaboratively (Anderson, 1994) to solve the given problem by using different techniques.

As David and Palincsar (1991) suggested, this collaboration helped in their exploration. As described earlier in the Chapters 5 and 6, all the participants in the Project worked in small groups. They did some hands-on science activities individually, but shared their findings with the small group at first, and then reported it to the whole group. The activities such as building a tower (described in chapter 5) and other activities like building bridges, chromatography, and making hot air balloons, required a lot of dialogue among the participants in order to figure out a design

that worked. All the participants were involved in the discussion to build a stabilized structure. There were both right and wrong decisions that they made, but careful observation and thinking helped them disregard the wrong decisions, and directed them in making useful suggestions. The observations made during these activities enabled them to come up with new conjectures, which helped them finish the task. When they had to perform complex tasks, such as constructing a tower, the suggestions that came from the children were different than those suggested by parents. Parents had a lot of experience in the real world and the things that they had seen. Mrs. Briones compared the tower that they were making to the tower that she saw at the radio station, in order to focus on a model that would help stabilize their tower. Group discussion enabled them to come up with ideas that closely match the problem they encountered.

Walker and Rakow (1985) report that males have more positive attitudes toward science than females do. This supports the perception that science is a field for males. But the contradiction is this: Why then was their minimal attendance of the fathers at Family Science? Was it because a female scientist conducted the Project? The parents who participated in the Family Science sessions were mostly mothers, and not fathers (Table 12). This was contradictory with the findings of

the project, "Active Participation of Parents," in Sri Lanka (Kularatna & Karunaratne, 1988).

Most mothers who attended the Project had a fear about science (Karunaratne, 1994), but they wanted their children to learn more science in order to lead a better life. Mrs. Martinez expressed a commonly-held attitude, when she said that only smart people can learn science. These findings show us the necessity of changing the negative attitudes of parents regarding studying science.

Although I took the examples from Mrs. Martinez's profile, the data showed that all the parents thought that their children grew in science knowledge, and were motivated to learn more science because of the Family Science sessions.

The mothers' responses provided two reasons why they could not learn science. One was the unequal treatment for minorities in the schools. The other was because they were women--there was a gender discrimination. To provide equal education opportunities, public schools should serve as places where teachers and students are encouraged to inquire, invent, and experiment, even at the risk of failure (Holmes Group, 1990). These qualities will only emerge if the school and its classrooms function as learning communities, where all students work together as equals, and are exposed to similar problem situations without

putting labels on the students or providing different treatments according to those labels.

It is clear from what the parents demonstrated that they had many skills to impart to their children's education. They also demonstrated that they were learning science that they had done many years ago, and that their self-esteem had risen. (Figure 20 gives a summary of families who attended the Family Science Project.)

Summary

The things that happened in the Family Science sessions, such as working together, sharing, reporting, learning from each other, and building new knowledge, helped the participants to work as a community. Their collaborative efforts helped them develop a variety of new skills and knowledge, and also develop positive attitudes toward science. These features are somewhat comparable to a scientific learning community, where the participants use scientific knowledge, construct new knowledge, and reflect on scientific knowledge (Anderson, 1994). The acquisition and sharing of knowledge can impel them to new learning. New learning can then lead to developing new knowledge, are of which all characteristics of a learning community. The participants in the family Science Project tended to behave as a research community.

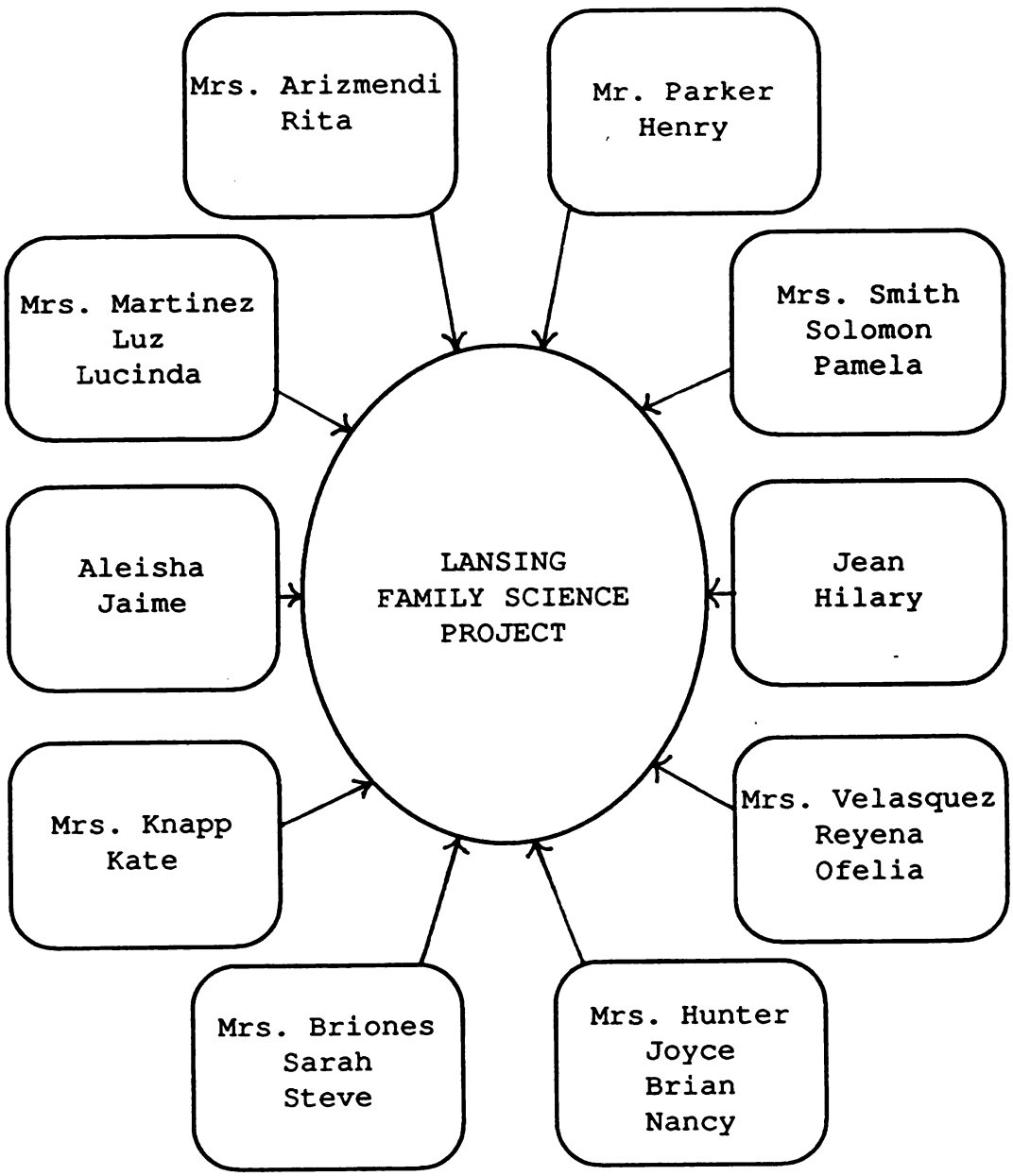


Figure 20 Families attended in the Family Science Project

CHAPTER VIII

HOW DID LEADERSHIP AFFECT THE FAMILY SCIENCE PROJECT?

The Family Science Project Director's Involvement in Outreach Activities

> *This experience so enraged me that I have continued to remain enraged at the fact that if this was happening to my kid, and I had the education and the money to intervene, what was happening to poor children whose parents were not educated and didn't have the money to intervene?*
>
> *I was already committed to assuring equal educational opportunities for women and minorities in science. But this experience strengthened my resolve and made me refocus at the early grade levels so that we could intervene prior to children falling behind.*

This chapter discusses the leadership role played by the Project Director, relates her background and interests, and how she herself changed her method of teaching due to the experience gained from the Project. The quote that was presented at the beginning of this study expresses Dr. Rodriguez's concerns about the education of Hispanic children. In addition to her responsibilities as a professor in biochemistry and serving as a consultant to several national committees, she was involved not only in the Family Science Project but also in several other community outreach projects to

promote the education of Hispanics' especially in science.

The science program implemented was embedded in an Institute's community-based education agenda. All the programs listed below were efforts sponsored by the Julian Samora Research Institute (JSRI) under the direction of Dr. Rodriguez, through funds from external resources to link the university and community.

a) Kindergarten Scientist in Residence Project. This was an in-school program started for kindergartners. Dr. Tamaza Palacio, a chemist working for the Avian Disease and Oncology Laboratory, conducted this program. These students who participated in this program wanted to have Dr. Palacio for their science teacher. Because of Dr. Palacio's interest in improving Hispanic education, she continued with the same group of children for three years, while still working with the new kindergartners.

b) Playtime Is Science. This was an in-school program developed to encourage children and their parents to work together (in school and at home) on fun activities that would help elementary children develop science skills. The materials that were used in this project were items available at home, such as empty milk cartons, used toilet paper rolls, food cans, and so

forth. All the materials used in the activities were inexpensive, even if they had to be brought. An Hispanic female graduate student worked with elementary teachers (kindergarten to third grade) in lesson planning and teaching. The objective of the program was to include hands-on science activities so that elementary students would realize that science was fun.

c) Fifth Grade Science with Friends Project. This program was offered to the fifth graders in the Highland Elementary School. These students corresponded with fifth graders in an elementary school in Texas through electronic mail. They discussed through electronic mail the science projects that both classes did . For this project Dr. Rodriguez received assistance from two fifth grade teachers. She also received support from two graduate students at MSU to help in using the computers so that the participants could correspond through electronic mail.

d) La Clase Magica: A Computer Assisted Literacy Program for Neighborhood Children. This was an out-of-school program offered to the elementary children in the Highland Elementary School to improve literacy through the use of computer games. Sessions were conducted in the community center on Tuesdays and Thursdays from 3:00-5:00 P.M. Dr. Maria Vallejo from MSU/JSRI

coordinated the program, with the assistance of graduate and undergraduate students in the Department of Teacher Education at MSU. (A description of this program is given in Chapter 2.)

e) Community Lecture Series. A community science lecture series consisted of both formal lectures for the community at large, and connecting MSU visiting lecturers directly with the schools. The focus of the lectures was on the contributions of Hispanics to science, so that the community community would aware of these contributions.

The lectures were conducted in a middle school in the north Lansing community. Before the lectures started, people participated in a reception where mainly Mexican food was served. The informal discussions during the reception revealed that they were very enthusiastic, as they were asking Dr. Rodriguez to expand the focus of the lectures.

The guest lecturers were Hispanics. They talked about their research work, focusing on science practices involved in Mexican traditions, and the importance of them. For example, one lecture entitled, "Fire medicine: The science of chile," was about the medicinal properties of the hot chilies used in Mexican food. The presenter discussed his research findings to show the importance of using chilies in their food. In addition to the formal presentations given for the

community, these scientists also talked to students when they visited the schools. The series later expanded to include other minority professionals.

f) Kellogg Biological Station Summer Camp for Migrant Children. This was a program developed by Dr. Rodriguez to help migrant children in learning science, and was done in collaboration with the Julian Samora Research Institute and Michigan State University's Kellogg Biological Station (KBS.) KBS was the summer house of W. B. Kellogg, but was donated to Michigan State University (MSU.) It is located about eighty miles from MSU. This center and the surrounding land is used as a research site for many MSU research programs. The residential facilities and cafeteria at the center provided the people to conduct the workshops and seminars. Migrant children came from the Carruth migrant education program, which is located at a migrant housing facility close to the center.

Background of the Family Science Project Director

The Family Science Project Director, Dr. Rodriguez, was born in a city where there were many Mexican Americans. She did not feel that she belonged to a minority group when she was growing up as revealed by the following excerpt:

> *On the minority issue, my home town was 70% to 90% Mexican-Americans. So, I was in the majority. I*

> *didn't know that we were minorities. And, in fact, growing up I never realized, because I was middle class or above, that Mexicans were discriminated against. I knew there was a class difference and that some poor were treated differently. But my parents never treated people that way so I thought nobody did. So, it took probably really into college to look at minority issues because there had never been any blacks in my home town except in my last year of high school....I think that had a lot to do with the whole idea of community involvement and working with groups* (10/28/93).

Her early education and college were in Catholic schools, but her middle school and high school were in her home town's public schools. Her interest in science developed early. She said:

> *Even as a child I wanted to go into science....I was good in science in school. I did well academically in the school. By the time I was in high school I had already decided that I wanted to go into biochemistry, and in fact, in my yearbook picture, it said "Future Biochemist." I don't think at that time I knew really what that meant. I always had the idea that with biochemistry I was going to do something that was going to help the world, or help people....I majored in biochemistry ....I went from a research focus to a lot of teaching....I ended up doing very little research and turned more to teaching....I had never really looked at scientists as teachers....But from the beginning I started to become active in issues that dealt with women and minorities in science* (10/28/93).

Dr. Rodriguez earned her doctoral degree in biochemistry, and worked at the post-doctoral level in the Institute of Marine Science in Florida. Then she came to Michigan State University and did two years post-doctoral work in the Department of Animal Science. During this period, she got married and looked for a

job, because her husband was a student at that time. She got a position in the Department of Natural Science, where she taught Astronomy and Geology, for which she did not have the necessary background knowledge. Although her earlier plan was to do more research, the planning and preparation she had to do to teach Astronomy, Biology, and Geology encouraged her to do more teaching than research. This experience also allowed her to think about women and minority issues:

> *I did two years Post-doc in the Animal Science Department. And what that really told me was that Biochemistry could be done under a number of different areas as opposed to just in the Biochemistry Department. Anyway, that's what brought me to Michigan State. It turned out that I got married and my husband was still an undergraduate so I had to look for a job here and the one that was open was in the department of Natural Science which was the department that taught the core curriculum for the non-science majors at Michigan State. So I went from just a research focus to a lot of teaching. And, I had to be teaching in areas in which I had absolutely no training such as Astronomy, and Geology, (even though I had loved Geology, I had never taken a course or really pursued it any further) and, a lot of Biology, and the only Biology course I had was in one six-week summer course when I was in college. So here I was teaching genetics and evolution and I had never been exposed to it. So, I think, the first couple of years, or even three years, I think I was one step ahead of the students. So, what happened was that I ended up doing very little research and turned more to teaching. But all along I started to become to become active in issues that dealt with women and minorities in Science* (10/28/93).

What Motivated Dr. Rodriguez to Become Active in Women and Minority Issues?

There were several reasons why Dr. Rodriguez became involved in Hispanic education. Although she was involved in different activities, her involvement in women and minority issues expanded after attending a conference sponsored by the AAAS--(American Association for the Advancement of Science) in 1975, where the organizers were trying to identify what aspects of women scientists' experiences were positive in their career development. For this conference, twelve blacks, six Hispanics, and six Native Americans were invited. According to Dr. Rodriguez, the conference provided her with many opportunities to advertise her name:

> *That particular conference opened up many of the opportunities that I have been able to take advantage of because then my name became known. I was one of the six Hispanic women who were invited* (10/28/93).

Dr. Rodriguez learned that networking existed among white women, and the conference provided her with opportunities to participate in the activities in which white women were involved:

> *A lot of activity was going on in the circles of white women and they were very well networked, but minority women were not networked....For a whole week you got debriefed on your whole life. Everybody did. This was really the push that forced the white women organization and the majority organizations to include minorities.... So, what happened then was, you get invited to a conference, and you do well and then someone sees you and you get invited to others. So, actually it*

> *balloons out. You know, it's a geometric progression* (10/28/93).

After about two years, she attended SACNAS (Society for the Advancement of Chicanos and Native Americans in Science) conference. This was the first large conference of Chicanos and Native Americans in Science. Dr. Rodriguez felt that this conference provided her the opportunity to meet with other Hispanic scientists:

> *And, in 1976 or 1978, they had the first large conference of Chicanos and Native Americans in Science. Until then, I hadn't really run into other Mexican Americans who were in science, and that particular SACNAS afforded me the opportunity to meet other people from my background, both men and women, who were involved and interested in these issues. So, that started that network. And that network continues. And I became very active, and I am still very active. So, basically, it all goes back to those two conferences* (10/28/93).

By 1985, due to her experience in conducting several projects for ten years, Dr. Rodriguez and a colleague became convinced that, for Hispanics, lack of achievement started earlier in life than what she had originally supposed. This experience helped her to see the weak areas in Hispanic education. One was the need to make changes at the elementary rather than writing until later in the Hispanic child's school career level.

Increased participation in meetings and conferences widened Dr. Rodriguez's knowledge regarding the factors affecting the participation of women and minorities in science. The primary focus of intervention at that time was at the college level, but the focus slowly moved

down to the middle school, where research showed the biggest difference between women and men in their math achievement.

Dr. Rodriguez had no formal training in either gender and minority issues or in education, nor did she have any experience in working with elementary children. But that did not prevent her from working with the elementary graders. She tried to understand the needs of elementary children by working with them in different programs. She also learned by doing reading in the subject area, attending conferences, networking, and by just actually working with this age group. As her involvement increased in this area of education, she and some of her colleagues became convinced that the focus for educating minority children in the area of science should be started at the elementary level:

> *Targeting high school and middle school was not the place for Hispanics. There is some research that shows minority kids fell behind as early as the third and fourth grade. There is something that is either not happening, or is happening, at the K-5 level. So, if you are going to intervene, you better intervene prior to them falling behind....I really had never envisioned working with elementary children because I had no experience, but that has never stopped me in the past from doing something....And what you really need in K-5 is to provide children experiences so they can take advantage of what the education curriculum has to offer* 10/28/93).

Dr. and her colleagues became involved in developing culturally relevant science materials, and then working with teachers to help implement the new

materials. Not only was the dearth of culturally relevant science materials addressed, but also the disconnection that Hispanics experienced with the schools, as well as the overall "science anxiety" of the population in general, which affects more than just minorities and women. Dr. Rodriguez said:

> *The end objective really is, How do we connect the community to the school and the school to the community in a positive way? Well, one of the major problems is that disconnection. The other problem is a science problem, and I chose to address this disconnection through science programming because of the need in science and math. I think my whole reason for getting involved was to address this underrepresentation in science. It was a way to combine my interests with a real problem in our community* (10/28/93).

According to Dr. Rodriguez, many minority scientists are well aware of their underrepresentation and have become agents of change. She thought that their education should return something to their community:

> *Because of the underrepresentation of minorities in science, many minorities find themselves in advocacy positions very early in their academic career. Nothing in the academic training prepares one for this. This expectation is not placed on majority scientists, and in fact it is rare for a majority professor to be involved in this area. Basically it's a sink-or-swim phenomenon. It's learn as you go. You educate yourself (with the help of your established network) and it is basically your desire to return something to your community that keeps you going. Most of the minority scientists I know feel that it is part of their responsibility to give back to their communities, and most are involved in minority issues to some extent* (10/28/93).

Even though Dr. Rodriguez was a professor of Biochemistry, and did not have a background in education, her efforts to improve Hispanics' science education through various programs seemed very unique. But, she did not feel that she was in a unique situation compared to minority scientists:

> *I don't think I am an exception, but I am one of the few Hispanic scientists extending the focus to K-5 and to working with teachers and parents* (10/28/93).

Why did the Project Director Start the Family Science Project?

Dr. Rodriguez, the Project Director of the Family Science Project, worked with her colleagues in programs which all contained the component of improving the education of Hispanics. Her involvement in the Family Science Program specifically began when she and some colleagues were reviewing the test pilot sites for the national Family Science Program. It was evident to them that the pilot sites did not reflect the true spectrum of minority communities in the country, especially not the Hispanic communities.

One of her colleagues, who was an educator, suggested that they run a pilot program. She told them that not only did she not have the time, but also that she had never worked with such young students before. Not daunted by that problem, her colleague persisted, and worked to provide the support for her to do the

project. Thus was born the pilot site program in a predominantly Hispanic elementary school in Detroit, Michigan. Developing this program gave Dr. Rodriguez the opportunity to design a model Hispanic bilingual program which would be reflective of the community's needs. This pilot program provided the impetus for the community-based program that was developed by the Julian Samora Research Institute:

> *Actually the motivation is not just doing more science, it's actually doing better academically. Succeeding academically. And that science could be used as a vehicle. I suppose one could say the objective is to try to get more kids to go into science, but my objective really is to try to get the kids to stay in school and do better academically and not be estranged from an academic environment. I don't think what we're doing is going to necessarily attract more kids into science. I do think it might make them comfortable enough so they're more apt to take more science courses. I think that the major goal is to try to connect the community and the school, so that kids can excel and do well* (10/28/93).

Dr. Rodriguez's objective supports McCaleb's (1994) six broad philosophical principles in transformative education; namely, 1) Teaching and learning occur in a socio-historical context, 2) Education takes place within the context of a community, 3) Teaching begins with student knowledge, 4) Skills and voices develop out of a need to know and act, 5) Teaching and learning are both individual and collaborative processes, and 6) Teaching and learning are transformative processes. In addition to these six principles, I consider the role of leadership to be the

seventh principle. While motivating the children to do science and continue in it, the Family Science Project was conducted also to bring about a transformative education. Dr. Rodriguez wanted to change the way teachers teach science in school:

> *Another objective of the K-5 program is really to change how the teachers teach science. Not only how they teach it, but that they do teach it. You can't see Family Science in isolation, you have to see it in the total context because the objective for the family science program is to get parents working with the kids. Well, if you get parents working with kids and teachers start seeing that the parents are working with kids, they start saying, "Oh, these parents really care that their kids learn," they are more apt to then have a different attitude towards the children in this low-income school, that they have higher expectations* (10/28/93).

The children who participated in the Project recognized that their ideas were respected and considered by the adults. This feeling that someone was listening to them encouraged the children to continue participating in the dialogue and develop knowledge. This was especially the case for the minorities, because the competitive settings in the school often cause these students to lose their motivation for learning (McCaleb, 1994). Dr. Rodriguez was proud to be able to provide an appropriate context for science learning by involving people in a dialogue through the Family Science sessions, although she had some frustrations regarding parental involvement:

> *I always envisioned a comprehensive package because I knew one-shot activities, even if I was there for*

> *three years, were not going to really have any large impact on the behaviors of teachers, behaviors of parents, behaviors of kids. But seen in the total context, and even in the connection up to the middle school, because so many of these children do go to* (Paterson) *Middle School, it also says to the elementary kids, "Well, when I go to junior high, can I be a junior scientist?" A lot of them are aspiring to that* (10/28/93).

In the Family Science sessions, participants were introduced to multiple perspectives and were encouraged to compare, critique, evaluate and use their own experiences to solve the activity's given problem. The activities that were used in the Family Science sessions allowed the participants to use their own knowledge in many different, real world contexts. This design was developed to meet the objective of helping the participants realize their potential to do science and to build an interest in continuing their science education. Dr. Rodriguez believed that to implement this design, input from teachers as well as parents was necessary. In her teaching she tried to articulate the children's ideas, so that the children could construct their own meanings:

> *Science is going to be a critical area that people are going to have to know, so it is important that we start doing it early. You have to do activities which are motivational and fun so that they can start having some successes rather than failures and say, "Oh, I can do this," and "I can do science," and that they have that attitude from the very beginning. Of course, no matter what we do, one bad experience can many times derail children. So it has to be a consistent message that is sent to them by their teachers, that they experience it, and that the parents give them the same message. Unless you have all this positive reinforcement*

> *with our whole psyche about who does science, kids will tend to take that one disappointment as a message that they're not capable* (10/28/93).

As McCaleb's (1994) philosophical principles of the importance of parental involvement demonstrates, the parents involvement in the Family Science sessions enabled the children to be involved in discussions in a non-threatening environment where their parents, as well as other parents, could relate experiences from their past. It also provided a comfortable environment for children to say whatever came to their minds, because what parents told them was somewhat familiar to them and helped them to become involved in a dialogue without any fear. This kind of positive environment, developed for children and parents through the Family Science Project, was reinforced through other projects implemented for teachers, staff, parents, and children. According to Dr. Rodriguez, she felt that the overall program was having a positive impact in the school:

> *Now, the fact that we've been there is beginning to have a positive effect. The other day* (Ms. Hollister) *was saying that the school has to set a focus and they* (Highland's) *are seriously looking at having a science focus school. That wouldn't have occurred three years ago. But, I think being there, and being there on a consistent level, and having them see a long-term commitment to the school by us is even having them look at themselves as really being capable of having a science focus. That has to do as much with Family Science as with any of the programs, but I don't think if we had just done Family Science alone, it would have had the same impact* (10/28/93).

How Did Dr. Rodriguez's Teaching Affect Behaviors?

As Millar (1989) noted, Dr. Rodriguez believed that development of skills was valuable in a child's later life, even for those who did not go into the field of science. She tried her best to select the activities that were enjoyable and would make children and parents curious. She thought that it would help the children to think, and enable her to articulate the children's thinking and conceptions into the discussions. When she noted that some of the activities took too much time, the children were not interested, and there was limited dialogue, she did not include those activities the following year. From her experiences with the fifth grade program at the Boston museum, Dr. Rodriguez knew that teachers were not ready to do science activities very often:

> *I tried a 5th grade program with the Boston Museum of Science, but that didn't work well. I bought a membership to the museum, the Boston Museum of Science would send 5th grade teachers a kit every two months and the whole class would do the activities. I thought that the 5th grade teachers would be capable of doing it, but without a lot of guidance they weren't going to do the activities. I bought kits for them and they didn't use them. This was in '92. See because I was already trying to look at how to structure a K-5 program. So, if I did Family Science for* (Highland) *for grades 3-4, then 5th graders would do the Boston Museum of Science kits and the kids would do activities each week and they would then talk to a scientist about how to do it by letter* (10/28/93).

Because of the failure with the Boston Museum Project, Dr. Rodriguez tried to connect, via electronic

mail, fifth graders to a scientist, and also to connect them with fifth graders in a school in Texas. Fifth graders love to do electronic mailing. In the spring of 1994, she also started teaching science to a fifth grade class. These fifth graders wrote, what they did with Dr. Rodriguez for science to children in Texas through electronic mail.

Dr. Rodriguez learned how happy the children were when she addressed them as a friend. She used this as a strategy to engage students at work. Treating children as friends did not create any disciplinary problems, perhaps because she looked older than their very young teacher who started teaching in the same year, or perhaps because they respected university professors more. Later on toward the end of the 1994 spring semester, the fifth-grade science teacher told me that he had developed enough confidence to be able to assign activities for the children which he thought might not work.

The way that Dr. Rodriguez addressed the children encouraged them to participate in the Family Science sessions with confidence instead of with fear. Her method of teaching encouraged participation in the group activities, which led to building interpersonal relationships (Conceptual framework, Figure 4). An explanation for why the activities' products have taken

place is that they enabled the children to understand the activity's scientific meaning.

Dr. Rodriguez allowed the children to build the context so they could learn the science concepts by asking them to do science activities. As Jane French (1989) considers, Dr. Rodriguez presented science as a craft, that is, as a practical subject. This helped the children to develop manipulative skills, science process skills, and social skills. Her philosophy of considering the social context of the students, as well as their lives at home and in the community, provided a rich learning sourcefor all the participants in the Project. She thought that using parents in her Project might also help the teachers in the school to then use the parents as a resource:

> *In the near future I would expect that you would get more parents feeling comfortable about coming to workshops to learn how to work with their children. If they do that, then I would expect that they may feel confident to start volunteering, or that the teachers can use them as a resource and that the teachers see them as a resource, that's another impact. I don't think teachers see parents as a resource to help them doing science activities now* (10/28/93).

Dr. Rodriguez believed that communication between the parents, the teachers and the children was very important in education. In the Family Science sessions, she allowed the participants to have a lot of interaction. According to Bernstein (1971), science is a subject in which the structure of its knowledge cannot

be understood unless its surface features presented to and accumulated by, children. In the Family Science sessions, Dr. Rodriguez did not interrupt the students to teach science concepts while they were involved in doing science activities. Her major concern was to encourage them to be interested in doing science activities. Hence, she gave the children, and all the participants, time to share their findings and explanations at the end of the day. Using their responses became the starting point for giving them an understanding of the scientific concept underlying the activities performed. For example, after doing the activity on microorganisms, all participants shared with the whole group what they had observed, and began to understand that microorganisms lived everywhere they took samples. Explanations given by Dr. Rodriguez relating to the children's observations helped the children understand some of the features of microorganisms. This understanding occurred due to the interaction of ideas and responses given during the wrap-up session. Without that discussion and sharing, each person would have known only about what s/he observed.

In the activity on making towers, a lot of conversation went on within the small groups to figure out the stabilized structure, based on how to fix the straws, how to glue tape, how many strings to be used,

how the strings should be placed, and so forth. Each step added together enabled the group to arrive at the final product of building an erect tower, and also enabled them to communicate the procedures they had followed to the whole group.

What Kind of a Culture Is Needed to Bring About Successful Changes?

Research evidence shows that learning about the world does not take place without an understanding of occurrences in the real world (Duckworth, 1990; Heath, 1983). When Dr. Rodriguez planned the Family Science sessions, she paid attention to her own personal successes and tried to incorporate those aspects to create a culture that was conducive to the academic growth of both the children and the parents. Her assumption was that providing a Hispanic culture in the sessions affects how the children and parents learn science.

Dr. Rodriguez believed that the neighborhood where the children live affects their growth. A parent, Mrs. Martinez felt that the neighborhood where she lived was not a good, secure place for children to move around. She believed that it would have been better if more parents had attended the sessions with their children:

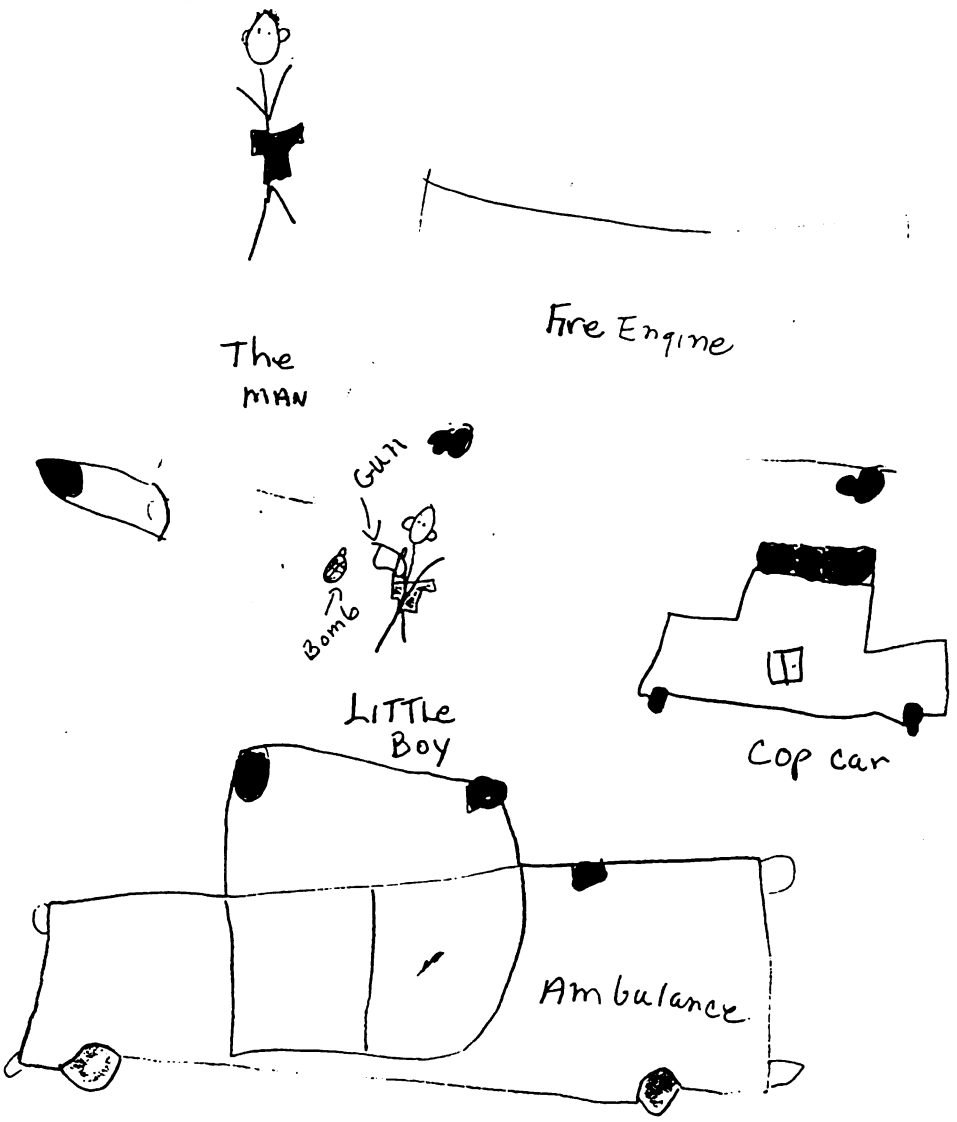


Figure 21 A scientist

> *In this area child goes to school without the guarantee that she would come back. I moved here because of the land contract....I took the responsibility of walking with (Rita), and now with (Julia). This neighborhood is not a safe place for them to walk in the evenings. You need more parents. I told another lady* (5/3/93).

Another family who lived about four blocks from Mrs. Martinez's house was also not happy with the neighborhood and moved to another place. In the first year of the Project three of this family's children came to the sessions. Their mother was interviewed in the spring of 1993. At that time, this family was planning to move to Texas. Both Mr. and Mrs. Hernandez told me that they wanted to move to a place where they could live with their relatives and without fear of gun shots. They showed me the gun shots in their walls and windows. According to them, those shots were the result of some fights between neighborhood children (not their children). They had nine children, but the oldest was only thirteen years old. They had two boys, one seven and the other an infant. This seven-year-old boy came to Family Science with his two sisters. He drew a man with a gun as the scientist (Figure 21). In addition to the ambulance and fire engine, there was another motor vehicle near the scientist. When I asked him about the vehicle, he said, "*That's the police.*" This gives us an example of how the physical environment affects children's perceptions.

When Dr. Rodriguez started the Family Science Project her intention was to get only Hispanic students, but later she opened it up to anybody who was interested in participating in the Project, minority groups as well as whites. She tried to be very close to the children, and acted as a friend, a guide, and a motivator. She spoke to them both in Spanish and English. She had a very pleasing way of approaching students who needed help. It gave children a comfortable feeling to share their difficulties with her. She believed that Hispanic children needed more touching than the others, and so she touched them a lot to show that she appreciated their good work, and also to encourage them while they were working. She brought things for snacks from the Mexican store to show that they were doing things with Mexicans. This did not affect the other children, because they loved to have those Mexican snacks.

Because of Dr. Rodriguez's behavior, the elementary and middle school children respected her and also sought help about their problems from her. There were times that junior scientists requested her advice even for things that had happened at school and at home.

Dr. Rodriguez believed that the success of the program depended on several factors.

a) A majority of the people who were involved in the Family Science Project were Hispanics. The only non-Hispanic person the participants saw in all the sessions

was me. Somehow they did not feel that I was an outsider. Even with the interviews I had with the parents of the junior scientists (who did not participate in the Project), thought that I was a Hispanic. Probably because of my external appearance, they considered me to be one of their group. All the junior scientists and the teacher from the middle school were Hispanics. The community liaison was a Hispanic, and there were also connections with the community center, where the staff was Hispanic. This is in contrast to most minority programs in which the staff is primarily African-American or all whites. The staff of the Family Science Project provided role models to the children as well as to junior scientists.

b) In the Family Science Project, when the participants worked in groups, individual families were encouraged to not sit at the same table so that the participants could communicate with members other than those of their family.

c) The staff was bilingual, not only to be able to work with the children and parents who spoke primarily in Spanish, but also to promote the importance of knowing and retaining a second language.

d) Although the programs were developed to address the needs of the total school area community, special efforts were made to work with Hispanic children and families.

The above-mentioned factors related to Hispanics, and the integration of these factors into the whole context of learning, was a successful innovation. Dr. Rodriguez tried to provide a comfortable environment for Hispanics so that they would feel that it was a program for Hispanics, since an Hispanic professor was working with Hispanic junior scientists to promote education of Hispanic youth:

> *What is unique about this particular model that I've developed here, the model is not just the Family Science, it's the Family Science with the Hispanic focus, with the junior scientist focus, and then it's integrated in a more comprehensive way to where there's an impact for the whole school* (10/28/93).

Discussion

This entire chapter provides a background for considering the successes and failures of the Family Science Project. The most important feature in the Family Science Project is the connection of home, school, and community. The programs I described in Chapter 2 also tried to build connections between school, home and community. As described by Comer, 1986; Rich, 1987; and Rivera, 1988, the incomplete and evolving nature of the research on parental involvement in children's education needs to be recognized.

As with Comer (1986) in his New Haven parental participation program, Dr. Rodriguez considered her background and compared it with the majority of Hispanic students' background, and realized the obstacles that

they encountered in continuing their education. She felt empathy with those people who could not afford to have their children succeed in education. This was triggered when it happened to her own daughter. Even though she was a female Hispanic professor in biochemistry who had worked for the success of Hispanics in education, she still had problems with her own daughter in school. She tried to understand the problem of why teachers tend to put labels on minority students. This bad experience forced her to start outreach programs for disadvantaged groups to learn science. An important consideration of these outreach programs is to see all of them as one whole package. The products of one program cannot be studied separately, because they were all interrelated.

In all the outreach programs of Dr. Rodriguez, emphasis was placed on the students' and parents' culture. Rogoff and Lave (1984) discuss the importance of context in cognitive development. The context or physical environment provided for learners is useful for making connections to their prior knowledge. Culture in the classroom affects the students' learning. Parents bring their culture to the discussions, which helps children to understand and solve problems. Since Dr. Rodriguez felt it was important to have parents participate in group work, she made efforts to get parental involvement through various ways in order to

provide a sound environment in which children can do science.

As discussed in Chapter 3 on the description of the Family Science Project, the Project goal was to build interest in learning science. The strategy used was to build interest in parents so that they could help motivate their children (elementary third and fourth graders) in learning science. This was successful, as observed in the changes that occurred in parents, children, and middle-school students who served as junior scientists.

Driver (1989) warns about the danger that could happen when children tend to follow everything that adults and parents ask them to do without developing critical thinking. This danger was avoided in the Family Science sessions by using a constructivist approach. In the Family Science sessions participants did hands-on science activities and so developed skills and understanding. They had the authority to develop their own knowledge, skills, and attitudes. This was a successful feature in the Project.

As a working mother, the time that Dr. Rodriguez spent in these outreach activities needs to be appreciated. Her devotion to the Family Science Project enabled her to have some successes, and at the same time she had frustrations in getting parental involvement. For Dr, Rodriguez the question what prevented the

parents from participating in the Project remained unsolved during the entire study. Getting parental participation even for PTA meetings has been a problem. This is not unusual, as research evidence shows the difficulties and failures in getting parents to participate in school activities (Bronfenbrenner, 1978; Lareau, 1989; & Delgado-Gaitan, 1991).

The success of most innovative programs depends on the dedicated leaders who had the vision. The Family Science Project is an example of such an innovative program with such a visionary leader. As discussed in this chapter, it is evident that the strong leadership of Dr. Rodriguez helped achieve the successes of the Family Science Project. Strong leadership is required to implement a program successfully; at the same time if there is no person to take over in the absence of the leader, then it will negatively affect the Project. This happened to the Family Science Project when Dr. Rodriguez moved to another state to accept a new position. Since her departure in September 1994, Family Science sessions have not been conducted, mainly because there has not been a person to take responsibility for getting funding and the overall activities. Secondly, the middle school teacher who participated in the sessions underwent surgery, and was absent from school for the entire 1994 fall semester. For a program to continue on a long term basis, there should be roles

performed by several people, so that in the absence of one, the others can keep the program running with a substitute.

As mentioned earlier, Dr. Rodriguez's involvement in the Project helped her gain successes and failures. It appears that implementing a successful program that connects the school and community is a very complicated process, but also a very important one. What accounts for the failures needs to be researched further so that they can be converted to successes.

CHAPTER IX

CONCLUSIONS, RECOMMENDATIONS AND IMPLICATIONS

Summary of the Study

The Project under study was a version of the national Family Science Program modified to build Hispanic students' especially that of girls' interest in learning science. Research evidence shows that the science achievement of Hispanics, especially women is low. The purpose of this study was to examine what the participants of the Family Science Project learned and how they interpreted what they had learned from the Project, while building an interest in science.

The Family Science Project was designed to build interest in science in children through the children's and their parents involvement in science activities in an after-school setting. The sessions were held at Highland Elementary School on Thursday afternoons for about two hours in a series of six to eight sessions in a semester, starting with fall of 1991 through the spring of 1994. The first year was conducted on a pilot basis. An innovation and modification of the national Family Science Program, was the use of middle school students called "Junior Scientists," who would assist

the elementary children with their science activities. On Tuesday afternoons they practiced doing the science activities to be done on Thursdays. Junior Scientists and the Project Director then discussed their activities to build their understanding, so that they could better assist the elementary children.

Qualitative research methods were used to study the interactions among the participants. To examine the behavior of the participants, it was necessary to document what had happened in the science sessions. This required observations of all the program events. I played the role of a participant observer. Attendance of participants was a major criterion in selecting subjects for the study. All the people who had had more than sixty percent attendance in each year of the two years of the study (excluding the pilot year) were selected as subjects for the study. This included twenty children, fifteen junior scientists, and six parents. Each year the participants were different, except for four children, two parents and a junior scientist who participated in the sessions for two years. In addition to the subjects of the study, the parents of the children and junior scientists were also interviewed. All the subjects were interviewed two times, once at the beginning of the year and again at the end of the year. To get a clear picture of what happened because of implementing the Family Science

Project, the Project Director, Mrs. Lopez, and the elementary school principal were also interviewed.

As discussed in Chapters five to eight under several assertions, detailed analysis of the audio-taped interviews, participant observations, and the children's documented work found that the middle school students, as well as the elementary children had developed stronger aspirations to be scientists. The children enjoyed doing hands-on science activities, compared to reading about science in textbooks. At the same time, they had acquired a variety of science-related skills and understood science better through their involvement in a scientific process, which will enable them to succeed at a higher level in school. It was also found that both the children and their parents had developed positive attitudes toward science and recognized their potential to do science, and even aspiring to a scientific career. The parents demonstrated that they were now learning science that they had studied, but not learned, many years ago. Moreover, the experience had a positive affect on all the participants' self-esteem. The parents also demonstrated that they had many skills to impart to their children in education. All three groups together were able to form a learning community.

I summarize the research findings of this study under sub-headings; children (Chapter 5), junior

scientists (Chapter 6), parents (Chapter 7), and leadership and institutionalization (Chapter 8).

Children. Third and fourth grade elementary students participated in the Family Science Project. For some of them this was the only place where they were able to do science activities, because they only read about science in their regular classroom, instead of doing hands-on activities.

1. The children enjoyed the Family Science Project because science was taught in an active, encouraging climate where students received a lot of individual attention, compared with the teacher-directed work done in their school classroom, where the interaction among the students and teacher is very limited.
2. They acquired many new academic skills, such as science process skills (observing, predicting, estimating, inferring, data recording), and social skills, such as the ability to interact and take a leadership role in a group because of their participation in the Family Science Project.
3. The children's engagement in doing science activities, and their conversation in the small groups while doing the activities, and in the whole group discussion motivated and helped them learn the underlying science concepts.

4. Success in doing interesting hands-on science activities made the children think that doing science activities and learning science were not as hard as they had anticipated, which led them to want to do more and more hands-on science activities.

5. The assistance received while doing the hands-on science activities, and the satisfaction with what they did, enabled the children to develop high self-esteem about themselves.

6. Overall, the children gained many benefits through their participation in the Family Science Project. Their involvement in the Project was an enjoyable activity that led them to aspire toward science-related careers. When students are placed in a program that allows them to interact, explore, and do things, they not only learn through that engagement, but they also gain from increased self-esteem and improved aspirations.

Junior Scientists. The middle-school students, seventh and eighth graders who had been identified as at-risk students by the school, participated in the Family Science Project to assist the elementary children in doing the hands-on science activities.

1. By helping the children do hands-on science activities and working with the parents, the junior

scientists developed sophisticated interpersonal skills that enabled them to better work with the children.

2. While playing their role of helping the children, the junior scientists also learned the science concepts underlying the hands-on science activities, especially during the training sessions that they had prior to the regular Family Science sessions. They also became adept at modeling what they had learned for the children.

3. Junior scientists were able to engage in hands-on science activities that they could not do in school, which helped them develop such academic skills as observing, predicting, estimating, inferring, data recording, as well as social skills such as the ability to interact and take a leadership role in a group because of their participation in the Family Science Project.

4. Negative attitudes that the junior scientists had at the time they joined the Project, such as science is a hard subject to learn, were changed as a result of their participation in the Family Science Project.

5. The junior scientists were able to discard their low self-esteem and build high self-esteem through successful interaction with the children while doing hands-on science activities.

6. The junior scientists' participation in the Family Science Project helped them develop self-confidence to

realize that they could do science activities, and to have high aspirations toward science-related careers.

7. Participation in the Family Science Project enabled at-risk, middle-school students to perform a leadership role that they had not performed before, while learning science and developing academic and social skills at the same time.

Parents. The parents who participated in the Family Science Project were parents of the elementary children. Parents of junior scientists were not asked to participation in the Project, although some questioned this during the interviews I had with them.

1. The negative attitudes that the parents had, such as not being intelligent enough to learn science, not being able to do science activities, and not wanting their children to be unsuccessful in learning science, changed to positive attitudes that they could learn science, could do science activities, and that their children could be successful in learning science so they could have a better education than their parents' had.

2. Engagement in hands-on science activities helped the parents motivate their children to learn science.

3. Working in small groups with the elementary children and middle-school junior scientists in the Family Science Project helped the parents develop academic and social skills which in turn helped them develop parenting skills.

4. The encouraging climate in the Family Science Project helped most mothers, who at the beginning were reluctant to participate, to continue doing science activities and to learn science, and also to learn more by taking classes elsewhere (community college) to have further education.

5. Although the parents who participated developed positive perceptions about science and the Family Science Project, most parents did not attend even half of the sessions, in spite of significant efforts by the Project Director and staff to enlist the parents involvement.

Leadership and Institutionalization. The Lansing Family Science Project was possible due to the efforts and devotion of the Project Director, Dr. Rodriguez, to furthering Hispanics' science education.

1. The Lansing Family Science Project was successful when the Project Director was in the Project. Projects that depend heavily on the efforts and concepts of one person tend to have difficulty surviving when the "leader" can no longer provide the service.

2. Although the Lansing Family Science Project was a partnership between the Julian Samora Research Institute of Michigan State University and the elementary school, community center and North Lansing community, it was not

institutionalized. To survive, a project needs to develop a base of institutional support.

Conclusions

The research findings about the Family Science Project, drawn from the assertions in Chapters 5, 6, 7, and 8, are presented under eight headings; namely, context for learning, engagement, enjoyment, building confidence, social norms, junior scientists, parental involvement, leadership, and learning community.

1. Context for Learning. Nonformal school settings provide social contexts for learning which complement formal school settings. It is important to have a friendly, democratic environment so that the children can bring in and discuss their ideas without fear. This then, sets the context for learning.

As Driver (1989) said, children come to classes full of knowledge about their world. For example, when they did the sinking/floating activity, they were able to use their prior experiences about heavy things sinking, and light things floating. Their knowledge worked for them for several items, such as metal and plastic objects. But some plastic objects sunk, and for two wooden cubes of the same size, one sunk and the other floated. In this case, it is the facilitator's duty to connect their knowledge to the scientific

concept studied-in this case, density. Doing science activities is a social activity (Solomon, 1989). Teachers in schools should consider children's ideas in their teaching and learning situations, because children's ideas are built on their own experiences. Further, integrating children's ideas helps in the knowledge construction process, which is socially constructed, and also helps the learners be responsible for their own learning.

In a regular classroom setting, where the teacher exercises her/his power and authority, children, especially the minority children, tend especially the minority children tend to not share what they want to say. In addition to that, learning science in the regular classrooms is an individual process, and not a social process, due to the lack of integrating ideas to construct meanings. This lets the students keep their ideas to themselves and not to interact with the others about their ideas. Hawkins (1989) discussed that this kind of preexisting and unarticulated knowledge was common sense, and which is not described in science textbooks. What is important to consider is that common sense for a third grader is not the same as common sense for an adult learner. When the adults work with young children, they should consider the children's ideas, and integrate them with their common sense to construct meanings.

In a setting where children work with their parents and with people whom the children believe to be helpers, they tend to share what they want to say, and compare their ideas with other childrens' ideas. As Galton and Williamson (1992) propose, it was also an advantage to have a mixed ability group in the Family Science sessions. Children bring ideas from their experiences, and from their prior knowledge. Parents add information from their cultural knowledge. Junior scientists help others with the content knowledge that they have. These ideas are necessary to make connections to the scientific concepts underlying the activities (see Figure 4, conceptual frame work).

2. Engagement. Since there was a good context for learning, the three groups--the children, junior scientists, and parents--worked together, which helped them keep on-task when doing the hands-on science activities. As with Lemke (1990) and Millar (1989), when children are involved in doing something, they do not get bored. According to the children, the Project was interesting to them because of the fun activities. Further, they knew that they could get assistance from the junior scientists and their parents.

As provided in Chapter 5, evidence showed that the children who participated in the Family Science Project felt that science in school was "reading science," and

science in the Project was "doing science." They preferred doing science rather than reading science which they did in school. They neither liked to listen all the time nor read and write. There was one instance that surprised both Dr. Rodriguez and me. What we thought was a chaotic session with lots of noise (the acidity/basicity activity using natural indicators like cabbage juice, 12/1/92) was rated by children and junior scientists as one of the best activities, because they were able to try different combinations. At first they followed the instructions in the given sheet, but afterwards the different colors they got motivated them to try other combinations. They did not like reading the instruction sheet, started doing whatever they felt like doing and showed each other their combinations.

As with Slavin (1990), the cooperative behavior of the participants in the Family Science sessions helped keep them involved in doing, an interesting activity, which made them feel that they were doing something to have "fun" and yet were learning at the same time. Involvement in doing the hands-on science activities not only enabled them to have "fun," they also developed a variety of skills by doing the science activities. While developing skills they also constructed understanding by being involved in a dialogue with the group members, as well as being involved as a whole group when discussing the activities with the Project

Director. For this dialogue, in addition to the standard language they used, they also used their colloquial language.

Vygotsky (1978) argued that language plays an important role in education. He discussed the interconnected roles of thought and language. Based on his ideas, Lansdown (1971) described an instructional model to teach elementary science through investigation and colloquium. As in the Family Science sessions, this model requires children to debate and discuss their ideas, and investigations, and so come to a consensus. It was learned from the interviews that the children and parents learned at least some scientific terminology. They had changed their attitudes toward science and scientists through their participation in the Project.

In many of the school systems, teachers consider themselves to be people in a bureaucratic system where they have to follow orders. They are successful when they are able to complete the given syllabus or textbook on time. But Duckworth (1990) commented that in the textbooks, many events that children consider are not fascinating described. Teachers also do not consider science to be an important part of the elementary curriculum (Easley, 1989). Because of this belief, they do not want to spend the time necessary for children to be involved in hands-on science activities, which are very time consuming. Furthermore, the belief that

elementary teachers think about their lack of confidence to teach science, prevents them from teaching science. They believe that without having a knowledge of science, they cannot give the correct answers to students' questions. It is necessary that both teachers and students know that there may be more than one correct answer to science-based questions. Henriques (1990), a pupil of Jean Piaget, talked about how she was guided by children in her teaching. To her, most teachers have no clear idea about what, how, and why they do what they do. Considering herself, she reports that although she was considered a good student, she felt she was illiterate in scientific fields at the end of high school. Her experience in working with normal children who failed at school and had become very insecure and unhappy made her realize the necessity of creating situations to observe and talk with children while teaching. Learners assimilate new things according to their existing knowledge base. Thus, teachers should be trained to build up their confidence through seminars and workshops where they can practice some of the activities that they can do in their classrooms.

3. Enjoyment. When a child has a good context for learning s/he enjoys what s/he does. Enjoying the activity is really important to keep the children engaged. As with Slavin's (1990) cooperative learning

and collaborative group work done by Anderson, Palincsar and others (1993, 1994), in the Family Science sessions children aged nine to ten who were third and fourth graders were motivated through collaborative work to engage in hands-on science activities. As with Galton and Williamson (1992), children worked with enjoyable activities. This enjoyment was due to three reasons.

First, they were guided and helped. The children felt that they were not alone, that there was somebody to assist them. This secure feeling made them work with enthusiasm. Some felt that it was comfortable because of the presence of a mother, some felt that the presence of an older youth--the junior scientist working with them--was an asset. For most of them, it was motivating that a junior scientist was working with them, because of the belief that the junior scientists knew what they had to do and would direct them in the proper way to do a group activity.

Second, all the members of the group belonged to the same culture where similar values were appreciated. Both the children and junior scientists believed that they were more able to work at their own pace and share their ideas while participating in the Project rather than in the school. They did not hesitate to suggest whatever idea they had. For example, when the children did the activity on hot and cold water, they had to connect the two containers using a rubber tube. A boy

said, "*I know how to do it. That's how we change water in our fish tank.*" He said that he sucks the tube and lets it go, and then the water comes out. The boy was able to connect his experiences to the activity, but at the time he did not know why he was doing it that way. The explanations given enabled him to develop the concept of density.

Third, the language that was used in the small groups was very similar to what they heard at home. Bernstein (1971) and Rogoff (1990, 93) discussed how the language used at home affects children both positively and negatively. The vocabulary of the children who came from educated families was better than that of the children who came from homes with limited vocabularies. Most of the children who participated in the Family Science Project were able to easily communicate with the group members, because the vocabulary that was used in the sessions was not foreign to them. Family Science provided a sound environment to link the language used at home and in the school.

4. Building confidence. The findings of the Family Science Project support some earlier studies. Children, as well as parents, could be motivated to develop self-confidence and self-esteem by being involved in enjoyable activities which required a lot of action (Galton & Williamson, 1992), such as hands-on science

activities. It is essential to build confidence in children in order to develop high self-esteem.

Treuba (1994) and Bronfenbrenner (1978) discussed the fact that minority children do not have the opportunity to develop their confidence while they are in classrooms, due to the lack of social congruency between the school and home. If they work in settings where they can share with each other, especially with parents and adult students, then through the dialogue they engage in they can see the relevance of what they are doing (Rogoff, 1986). In the Family Science Project, the children, parents and junior scientists felt that they were motivated when they knew that there was somebody to listen and share with, which enabled them to realize that they could do science.

Doing the science activities helped them develop skills and understand what they did. As Beane and Lipka (1981) presented, the children's involvement in doing these activities helped them build their self confidence. It was also found that the children, as well as their parents, developed positive attitudes toward science and realized their potential to do science. As described earlier, it was found that middle school students who were labeled as "at-risk" students, as well as the elementary children, developed stronger aspirations to be scientists. Parents who attended the

Project wanted to continue their own education by going to community colleges.

Children enjoyed doing hands-on science activities more than reading science in textbooks (cf. Lemke, 1990). Cooperation (Slavin, 1990) and collaboration in group work (Eichinger, Palincsar and Anderson, 1994) helped them acquire a variety of skills and an understanding of science through their involvement in a scientific process, which will enable them to lead a better life in the future. The parents demonstrated that they had many skills to impart to their children in education. All three groups together were able to form a learning community (Holmes Group, 1990).

There were times that Dr. Rodriguez dropped the junior scientists off at their homes after the sessions. She discussed with me some of their behavior on the way to their homes. They had confidence in her and discussed some personal problems with her in order to get advice. Dr. Rodriguez also did things to please them whenever she could. For example, she had to change the channel of the radio in her car to suit their preference.

Parents need to get motivated to become involved in learning activities to help their children in education. The parents who participated felt that science was not as hard as they had thought, and felt that any one could learn science. The positive attitudes that they

developed helped them continue participating in the Project, and continue their own education.

5. Social Norms. Engagement in the collaborative group work helped develop the social norms set by the Project Director. Eichinger et al. (1993) talked about the tension between academic discovery and colloquial discussion, referring to the social norms followed by children. It was evident that children followed routines in the sessions. As the children walked in, they signed in on the Venn diagram and then did their estimating. After having a snack, they routinely started working in their small groups. While doing those they obeyed and respected the Program Director.

As Palincsar et al. (1993) noted, setting norms at the beginning helped the group members be directed in what they did. Whether the children did individual or group activities, they had to follow the norms set by the Project Director, such as handling and doing things patiently, listening to others, respecting others' ideas, help in building an idea, and coming to a group consensus. Developing these norms in turn helped to promote productive group work in learning.

6. Junior Scientists. Using junior scientists to help the elementary children was a successful innovation. Both the junior scientists and children benefited

because of this innovation. Those junior scientists who worked efficiently in assisting children, were the same ones who had been categorized as at-risk students by the school staff. Labeling the middle school students as "junior scientists" and having them wear white lab coats for the sessions had an impact on their behavior. Assigning leadership roles and respecting their views helped the junior scientists to take responsibilities, develop self-esteem, and develop self-confidence in their ability to work as leaders. They helped the children to acquire the knowledge and skills necessary for doing the hands-on science activities.

7. Parental Involvement. The involvement of parents in the Project added another resource to connect the home environment and cultural knowledge to what was done in the Project. As Treuba (1991), Lareau (1989) and Rogoff and Lave (1984) presented, the contribution of cultural knowledge onto academic activities helps children in their cognitive development by making bridges between the mainstream culture of the school and the children's lives and culture. Children should be able to build their own meanings as they can understand scientific concepts. It was a great opportunity for parents to see what their children were doing for science activities and to work with them while doing the same activities. The parents who participated on a

consistent basis felt that they were also motivated to continue their own education, build positive attitudes towards science, and develop the confidence that they could learn science.

8. Learning Community. Children can form a learning community and behave as a community of learners if they are properly guided (McCaleb, 1994). Formation of a learning community means that the members of the group have succeeded in following routine patterns in order to construct knowledge as a group.

The children, junior scientists, and parents considered the small groups in the after school setting to be a better learning environment than the school setting. Students' verbal and nonverbal interactions during the group work helped them build interpersonal relationships, which promoted better understanding of the diversities found in the small groups as well as in the group as a whole (Figure 4). However, Shapiro (1994) reported that opportunities for the use of language in science learning is vital, and that very few studies have been undertaken to understand how children use language to communicate in small groups.

Recommendations for Further Research

It was revealed from the study's findings research that there are some areas to be considered for further research.

1. Although there are many research studies undertaken to involve parents in their children's education, securing parental participation remains a persistent problem. In spite of all the efforts that Dr. Rodriguez used to enlist the parents' participation, such as conducting Saturday workshops for the parents, giving them some equipment as incentives, trying to contact them through their children's teachers, sending flyers, and attending PTA meetings, the parents did not regularly attend sessions. Although research has been done on the importance of parents' involvement in their children's education, further research is needed to seek ways of securing parental participation in educational programs, and whether to use different techniques with mothers and fathers.

2. Some teachers at the Highland Elementary School had observed that those children who participated in the Project had developed better questioning abilities than the other students. For example, Mrs. Hollister described Luz's questioning behavior in the classroom. She was impressed that Luz was trying to understand in a better way than the others. The question here is how did Luz develop that quality? In all the Family Science

sessions there was a wrapping up time which included discussion of the activity, where Dr. Rodriguez tried to get answers from the children by asking guided questions so as to get at the concept behind the activity. At the same time the children asked questions to clearly understand what they were learning. Even while the children were doing the activities, Dr. Rodriguez asked questions to direct them so they could solve the problem, and group members questioned each other so they could come to a consensus. Working in an atmosphere like that, where adults and children both asked questions, helped Luz develop the questioning ability so she could better understand what they were doing. Further research is necessary to understand what other qualities, which supplement formal learning, help children learn better.

3. Programs which have long-term benefits need to be institutionalized. The Family Science Project came to an abrupt end when the Project Director left Michigan State University to accept a higher position at another university. This left the school and community with no promise of continuing the Family Science Project. Dr. Rodriguez's strong leadership also negatively affected the Project, because there was nobody to undertake the Project in her absence; partly because it was a project developed and modified by Dr. Rodriguez, and partly because no other connecting scientist had the same

commitment, devotion or empathy toward educating Hispanic youth. There were times that sessions had to be canceled because of her other responsibilities. There were two sessions conducted in her absence, one by Mrs. Lopez, and the other by a graduate student in biochemistry. The behavior of the participants was noticeably different in these two sessions in terms of attentiveness and following the established social norms. This has also been evident in some other projects, like the Toledo project (Gallagher, personal interview, 1994), where leadership personnel changes often reduce the potential for a long-lasting change in a serious problem. Researchers need to find out how to institutionalize programs, especially community based programs.

Implications for Practice

1. Nonformal science education projects enable educators and scientists to consider the many influences that impact on a students' ability to learn science, such as the students' interests, motivation by peers and adults, and collaborative learning in group activities.

All groups who are interested in improving their elementary, middle-school, and high-school education could use nonformal school settings which provide an active, encouraging climate, by examining how a nonformal setting helped the Family Science participants

to build an interest in science and in their education as a whole. It was discussed that using a nonformal setting with the parents provided a relaxed environment so that extended dialogues regarding the science activities could be facilitated.

2. Groupwork should be encouraged in regular classrooms to allow children to interact with each other and to explore, invent and think, thus helping children to have a greater understanding of the concepts than they do when only individual work is done.

3. Parents could be used as a resource in the classrooms, especially in the elementary classes, which in turn helps parents develop their parenting skills.

4. More and more programs like the Family Science Project, with it's interesting activities, are needed to to engage children in activities that supplement their formal school education.

5. Strong leadership is required to implement projects that connecting the schools and community.

6. The projects which facilitate school-community relationships need a liaison person in order to make strong connections between the school and community. One task of the community liaison is to visit homes and talk to parents to understand their needs. For this purpose, the community liaison should be able to talk to parents in whatever language allows them get more information and feel more a part of the experience.

7. The findings of the Family Science Project also help teachers and teacher educators to think of ways to build interest in elementary children by engaging them in doing activities and listening to their experiences and stories, and to build interest in middle-school students by assigning them responsibility and leadership roles.
8. For program implementors it is useful to think about training the personnel involved. In the pilot year of the Project, the junior scientists were not trained for their task, and so were not prepared to assist the children in doing the hands-on science activities. The experiences in the pilot year made the Director realized the necessity for training them for their task. During the following years of the Project, the junior scientists did the hands-on activities on Tuesdays that the children were going to do on Thursdays. This enabled them to know the difficulties involved in doing the activity, and also to discuss with Dr. Rodriguez the scientific concept behind the activity. What they did wrong was useful for them in helping the students.

The findings of Family Science Project help children, junior scientists, and parents develop scientific skills, more positive attitudes toward science, and a better understanding of science concepts. In the long run this helps improve science teaching and learning in the formal education system.

BIBLIOGRAPHY

Abi-Nader, J. (1991). Creating a vision of the future: Strategies for motivating minority students. *Phi Delta Kappan, 72,* 546-549.

Anyon, J. (1981). Social class and school knowledge. *Curriculum Inquiry, 11,* 3-42.

Baker, D.P. & Stevenson, D. L. (1986). Mothers' strategies for childrens' school achievement: Managing the transition to high school. *Sociology of Education, 59,* 156-166.

Beane, D. B. (1990). Say YES to a youngster's future: A model for home, school, and community partnership. *Journal of Negro Education, 59,* 360-374.

Beane, J. A.; Lipka, R. P. (1986). *Self-concept, self-concept, and the curriculum.* New York: Teachers College Press.

Beardsley, T. (1992). Teaching real science, *Scientific American,* October, 98-108.

Bernstein, B. (1971). *Class codes and control. Vol. 2. Applied statistics towards a sociology of language.* London: Routledge & Kegan Paul.

Bogdan, R. & Biklen, S. K. (1992) (2nd edition). *Qualitative research for education: An introduction to theory and methods.* Boston: Allyn and Bacon.

Bond, H. M. (1972). *Black American scholars: A study of their beginnings.* Detroit: Balamp Publishing Co.

Bowles, S. & Gintis, H. (1976). *Schooling in capitalist America: Educational reform and the contradictions of economic life.* New York: Basic Books.

Bronfenbrenner, U. (1978). Who needs parent education? *Teachers College Record, 79,* 767-87.

Bronfenbrenner, U. (1986). Alienation and the four worlds of childhood. *Phi Delta Kappan, 67,* 430-436.

Burris, B. K. (1990). *Academic enrichment project for disadvantaged students.* American Association of State Colleges and Universities, Washington D.C., Chicago State University.

Calabrese, R. L. (1990). The public school: A source of alienation of minority parents. *Journal of Negro education, 59,* 148-154.

Chapa, J. & Valencia, R. R. (1993). Latino populaton growth, demographic characteristics, and educational stagnation: An examination of recent trends. *Hispanic Journal of Behavioral Sciences, 15,* 165-187.

Cheek, D. W. (1989). *Science education for urban minority students: Current problems and potential solutions.* PA: Pennsylvania University.

Church, R. L., & Sedlak, M. W. (1976). *Education in the United States: An interpretive history.* New York: Free Press.

Cole, M. (1990). *Capitalizing on diversity: A proposal for a distributed literacy consortium* (Report No. 91-5215). La Jolla, California: Laboratory of Comparative Human Cognition.

Collins, H.M. (1982).Tacit knowledge and scientific networks. In B. Barnes and D. Edge (Eds.), *Science in context: Readings in the sociology of science* (pp.44-64). Cambridge, MA: MIT Press.

Collins, H.M. (1987). Expert systems and the science of knowledge. In W.E. Bijker, T.P. Hughes, & T.J. Pinch (Eds.), *The social construction of technological systems* (pp.327-348). Cambridge, MA: MIT Press.

Comer, J. P. (1980). *School power: Implications of an intervention project.* New York: The Free Press.

Comer, J. P. (1986). Parent participation in the schools. *Phi Delta Kappan, 67,* 442-446.

Crowley, M.F. & Melissa, J. L. (1986). *Women and minorities in science and engineering.* National Science Foundation, Washington D.C.

Cusick, P. (1983). *The egalitarian ideal and the American high school.* New York: Longman.

Davis, D. (1991, January). Schools reaching out: Family, school, and community partnerships for student success. *Phi Delta Kappan,* 376-382.

Delgado-Gaitan, C. (1990). *Literacy for empowerment: The role of parents in their children's education.* London: Falmer.

Delgado-Gaitan, C. (1991). Involving parents in the schools: A process of empowerment. *American Journal of Education, 100,* 20-46.

Delgado-Gaitan, C. & Treuba, H. (1991). *Crossing cultural borders: Education for immigrant families in America.* Bristol, PA: The Falmer Press.

Donmoyer, R. & Kos, R. (Eds.) (1993). *At-risk students: Portraits, policies, programs, and practices.* Albany: State University of New York Press.

Dornbusch, S. & Wood, K. D. (1989). Family processes and educational achievement. In W. J. Weston (Ed.) *Education and the American family: A research synthesis, 66-95.* New York: New York University Press.

Driver, R. (1989). *The construction of scientific knowledge in classrooms.* In R. Millar (Ed.) *Doing science: Images of science in science education.* Milton Keynes: The Open University Press.

Driver, R. (1983). *The pupil ,as scientist?* Milton Keynes: The Open University Press.

Driver, R.; Guesne, E., & Tiberghien, A. (1985). *Children's ideas in science.* Milton Keynes: The Open University Press.

Duckworth, E. (1990). *Opening the world* In E. Duckworth,; Easley, J.; Hawkins, D. & Henriques, A. (1990) *Sciene education: A minds-on approach for the elementary years.* New Jersey: Lawrence Earlbaum Associates, Publishers.

Duckworth, E.; Easley, J.; Hawkins, D. & Henriques, A. (1990). *Sciene education: A minds-on approach for the elementary years.* New Jersey: Lawrence Earlbaum Associates, Publishers.

Easley, J. (1990). *Stressing dialogic skill.* In E. Duckworth,; Easley, J.; Hawkins, D. & Henriques, A. (1990) *Sciene education: A minds-on approach for the elementary years.* New Jersey: Lawrence Earlbaum Associates, Publishers.

Easley, J., & Sekita, K. (1989). *A follow-up study of peer-group dialogue.* Champaigne, IL: CIRCE. University of Illinois at Urbana Champaigne.

Edwards, A. D. (1976). Speech codes and speech variants: Social class and task differences in children's speech. *Journal of Child Language, 3,* 247-265.

Edwards, D. & Mercer, N. (1987). *Common knowledge: The development of understanding in the classroom.* London: Methuen.

Eichinger, D. C.; Anderson, C. W.; Palincsar, A. S. & David, Y. M. (1991). *An illustration of the roles of content knowledge, scientific argument, and social norms in collaborative problem solving.* Paper presented at the annual meeting of the American Educational Research Association, Chicago, Illinois.

EQUALS. (1994). *Family Science.* Northwest EQUALS, Portland, Oregon: Portland State University

ERIC. (1981). *Hispanics, engineering and the sciences: A counselling guide.* ERIC clearing house on rural education and small schools. Las Cruces, N. M.

Erickson, F. (1986). *Qualitative methods in research in teaching.* In *Handbook of research on teaching.* 3rd Edition, Merlin, C., Wittrock (Ed.) New York: Macmillan Publishing Company.

Fantini, M. D., Weinstein, G. (1968). *The disadvantaged. Challenge to education.* New York: Harper & Row Publishers.

Fehrmann, P. G.; Keith, T. Z. & Reimers, T. M. (1987). Home influence on school learning: Direct and indirect effects pf parental involvement on high school grades. *Journal of Educational Rsearch, 80,* 330-337.

Fitz-Gibbon, C.T. (1988). Peer tutoring as a teaching strategy. *Educational Management and Administration, 16* (3), 217-29.

Freire, P. (1970). *Pedagogy of the oppressed.* New York: Continuum.

French, J. (1989). R. Millar, (Ed.) *Doing science: Images od science in science education.* New York: Falmer.

Frymier, J & Gansneder, B. (1989). The Phi Delta Kappan study of students at risk. *Phi Delta Kappan, 71.* 142-151.

Galton, M. & Williamson, J. (1992) *Group work in the primary classroom.* London: Routledge.

Gartner, A., Kohler, M., & Riessman, F. (1971). *Children teach children: Learning by teaching.* New York: Harper & Row Publishers.

Gee, J. P. (1991). What is literacy? In C. Mitchell and K. Weiler (Eds.), *Rewriting literacy: Culture and the discourse of the other.* New York: Bergin & Garvey, 3-12.

Galton, M. & Williamson, J. (1992) *Group work in the primary classroom.* London: Routledge.

Gee, J. P. (1991). What is literacy? In C. Mitchell and K. Weiler (Eds.), *Rewriting literacy: Culture and the discourse of the other.* New York: Bergin & Garvey, 3-12.

Gorneck, V. (1983). *Women in science: Portraits from a world in transition.* New York: Simon and Schuster.

Giroux, H. (1983). Theories of reproduction and resistance in the new sociology of education. *Harvard Educational Review, 52,* 257-93.

Glick, L. B. (1971). The right to equal opportunity. In J. Samora (Ed.) *La Raza: Forgotten Americans.* Notre Dame: University of Notre dame Press.

Hamm, M. & Adams, D. (1992). *The collaborative dimensions of learning.* Norwood, New Jersey: Ablex publishing corporation.

Hawkins, D. (1990). *Defining and bridging the gap.* In E. Duckworth,; Easley, J.; Hawkins, D. & Henriques, A. (1990) *Sciene education: A minds-on approach for the elementary years.* New Jersey: Lawrence Earlbaum Associates, Publishers.

Heath, S.B. (1983). *Ways with words: Language, life, and work in communities and classrooms.* Cambridge: Cambridge University Press.

Henderson, A. T. (Ed.) (1987). *The evidence continues to grow: Parent involvement improves student achievement.* Columbia, MD: National Committee for Citizens in Education.

Holland, D.; Anderson, C. W. & Palincsar, A. S. (1994, March). *Appropriating scientific discourse in a sixth grade classroom: The case of Juan.* Paper presented at the annual meeting of the National Association for Research in Science Teaching, Walnut Grove, California.

Holmes group (1990). *Tomorrow schools.* A report of the Holmes group. Michigan State University, East lansing.

Illich, I. (1970). *Deschooling society.* New York: Harper.

Iverson, B. A. & Walberg, H. J. (1982). Home environment and school learning: A quantitative synthesis. *Journal of Experimental Education, 22,* 148-51.

Harris, J. & Aldridge, J. (1983 a). 3 for me is better than 2. *Academic Therapy*, January

Harris, J. & Aldridge, J. (1983 b). Ten reasons why peer tutoring won't work. *Academic Therapy*, September

Jensen, A.R. (1981). *Straight talk about mental tests.* New York: The Free Press.

Johnson, D.W.& F. Johnson. (1994). *Joining together: Group theory and group skills* (5th Ed.) Needham Heights, Mass.: Allyn & Bacon.

Katzenbach, J. & D. Smith. (1993). *The wisdom of teams.* Cambridge, Mass.: Harvard Buiseness School Press.

Kaestle, C.F (1983). The ideology of antebellum common-school reform. In Kaestle, *Pillars of the republic: Common schools and American society,* 1780-1860, pp.75-103. New York: Hill and Wang.

Kozol, J. (1991). *Savage Inequalities: Children in America's schools.* New York: Crown Publishers Inc.

Kunjufu, J. (1984). *Developing positive self-images and discipline in Black children.* Chicago, Illinois: African-American Images.

Labaree, D.F. (1988). Politics, markets, and the compromised curriculum. *Harvard Educational review, 57,* 483-495.

Labaree, D.F. (1989). *The making of an American high school.* New Haven: Yale University Press.

Lacey, R. A. (1991). "I have a dream" for dropout prevention. *The education Digest, 56,* 20-23.

Lambourne, K. & Baca Zinn, M. (1993). *Education, race and family: Issues for the 1990s.* Working Paper, 16, East Lansing, MI: Julian Samora Research Institute.

Lancy, D.F. (1992). *Qualitative research in education: An introduction to the major traditions.* New York: Longman.

Lansdown, B.; Blackwood, P. E., & Brandwein, P. F. (1971). *Teaching elementary science through onvestigatiion and colloquium.* New York: Harcourt Brace Javonovich.

Lareau, A. (1989). *Home advantage: Social and parental intervention in elementary education.* London: The Falmer Press

Lemke, J. (1990). *Talking science: Language learning, and values.* Norwood, N.J.: Ablex.

Lightfoot, S. L. (1978). *World apart: Relationships between families and schools.* New York: Basic Books.

Linn, E. (1994). Science and equity: Why this issue is important? *Programs for Educational Opportunity, Equality Coalition, III, 2,* 3-5.

McCaleb, S. P. (1994). *Building communities of learning.* New York: St. Martin Press.

McPartland, J. M. & Nettles, S. M. (1991). Using community adults as advocates or mentors for at-risk middle school students; A two year evaluation

of project RAISE. *American Journal of Education, 99,* 568-586.

National Research Council, Task force on women, minorities and the handicapped in science and technology. (1989). *Changing America: The new face of science and engineering.* Washington D.C. (NSF)

Mc Diarmid, W. (1989). *What teachers need to know about cultural diversity? Restoring subject matter to the picture* National Center for Research on Teacher Education, Conference series 89-1, Michigan State University, MI: East Lansing.

Millar, R. (1989). *The relation between theory and experiment in science education.* In R. Millar (ED.) *Doing science: Images od science in science education.* New York: Falmer.

Mimms, E. M. (1994). Race equity and science education: An interview with Charles Payne *Programs for Educational Opportunity, Equality Coalition, III, 2,* 5-9.

Mulkay, M. & Gilbert, N. (1982). Accounting for error: How scientists construct their social world when they account for correct and incorrect belief. *Sociology, 16,* 2, 165-83.

Mullis, I.V.S. & Jenkins, L.B. (1988). *The science report card: Elements of risk and recovery.* Princeton, NJ: Educational Testing Service.

National Assessment of Educational Progress. (1991). *The seventh national science assessment: Results, trends and issues.* Denver, CO: Education Commission of the States.

National Research Council, Task force on women, minorities and the handicapped in science and technology. (1989). *Changing America: The new face of science and engineering.* Washington D.C. (NSF)

National Science Foundation Directorate for Science Education. (1980, 1982). *Science education databook.* Washington: National Science Foundation.

National Science Foundation. (1981). Minority institutions science improvement project (MISIP): A brief history 1972-1980, National Science Foundation, Washington D.C.

Oakes, J. (1985). *Keeping track: How schools structure inequality.* New Haven: Yale University Press.

Ogbu, J. U. (1978). *Minority education and caste: The American System in cross-cultural perspective.* New York: Academic Press.

Ogbu, J. U. (1985). Cultural-ecological influences on minority school learning. *Language Arts, 62* (8), 860-69.

Ogbu, J. U. (1986). The consequences of the American caste system. *The School Achievement of Minority Children-New Perspectives* (Ed.). Ulric Neisser, Hillsdale, N.J.: Lawrence Eribaum Association Publishers.

Ogbu, J. U. (1991). *Minority status and schooling: A comparative study of immigrant and involuntary minorities.* New York: Garland.

Okawa, G.Y. (1988). *Peer tutoring in a multi-cultural setting.* Paper presented at the Annual Meeting of the conference on College Composition and Communication, 39th, St. Louis, MO:

Palincsar, A. S.; Anderson, C. W.; & David, Y. M. (1993). Pursuing scientific literacy in the middle grades through collaborative problem solving. *The Elementary School Journal*, 93 (5), 643-658.

Passow, A. H. (1986). *Educational programs for minority/disadvantaged gifted students.* A paper presented in the distinguished lecturer series of the San Diego Unified School

Perez, S. M. & De la Rosa Salazar, D. (1993). Economic, labor force, and social implications of Latino educational and population trends. *Hispanic Journal of Behavioral Sciences, 15*, 188-229.

Postman, N. (1982). *The disappearance of childhood.* New York, New York: Delacorte Press.

Rakow, S. J. (1985). Minority students in science perspectives from 1981-82 National assessment in Science. *Urban Education, 20* (1), 103-113.

Rashke, D. and others. (1988). Cross-age tutorials and attitudes of kindergarteners toward older students. *Teacher Educator, 23* (4), 10-18.

Research Triangle Institute. (1985). *Report of the 1985-86 national surveys of science and math education.* Research Trianle Park, North Carolina.

Rich, D. (1987). *Schools and families: Issues and actions.* Washington D.C.: National Education Richardson,V.; Casanova, U.; Placier,P. & Guilfoyle,K. (1989). *School children at-risk.* Philadelphia, PA: The Falmer Press.

Riche, M. F. (1991). We're all minorities now. *American Demographics, 13, 10,* 26-31.

Rist, R.C. (1970). Student social class and teacher expectations: The self-fulfilling prophecy in ghetto education. *Harvard Educational review, 40,* 411-451.

Rivera, R. (1988). *Latino parental invovement in the Boston Public schools: Preliminary notes from the field.* Boston: William Monroe Trotter Institute.

Rogoff, B. (1990). *Apprenticeship in thinking: Cognitive development in social context.* New York: Oxford University Press.

Rogoff, B. (1993). *Guided participation in cultural activity by toddlers and care givers.* Chicago, IL: University of Chicago.

Rogoff, B. & Lave, J. (1984). *Everyday conition: Its development in social context.* Cambridge: Harvard University Press.

Ronda, M. A. & Valencia R. R. (1994). "At-Risk" Chicano students: The institutional and Communicative life of a category. *Hispanic Journal of Behavioral Sciences,* 16 (4), 363-395.

Roth, K. J. (1986). *Conceptual-change learning and student processing of science texts* (Rseach Series No. 167). East Lansing: Michigan State University, Institute for Research on Teaching.

Roth, W.-M. (1994, March). *The diffusion of knowledge in a grade 4/5 classroom during a unit on civil engineering: An analysis of a classroom community in terms of its changing resources and practices.* Paper presented at the annual meeting of the National Association for Research in Science Teaching, Anaheim, California.

Samora, J. (Ed.) (1966). *La Raza: Forgotten Americans*. Notre Dame: University of Notre Dame Press.

Scarpitti, F. R. & Andersen, M. L. (1992). *Social Problems*. New York: Harper Collins.

Shapiro, B. (1994). *What children bring to light: A constructivist perspective on children's learning science*. New York: Teachers College Press.

Sheriff, C. W., Sheriff, M. & Neberqall, R. E. (1965). *Attitude and attitude change*. Philadelphia and London: Saunders Co.

Slavin, R. (1990). *Cooperative learning: Theory, Research, and Practice*. Englewood Cliffs, NJ: Prentice Hall.

Smith, I. A. (1994). Looking at science holistically: The North American Indian perspective *Programs for Educational Opportunity, Equality Coalition, III, 2*, 32-35.

Solomon, J. (1989). *The social construction of school science*. In R. Millar (Ed.) *Doing science: Images of science in science education*. Milton Keynes: The Open University Press.

Stanley, S. O., Greenwood, C. R. (1983). How much "opportunity to respond" does the minority disadvantaged receive in school? *Exceptional Children*, 49 (4) *1*.

Treuba, H. (1988). Culturally based explanations of minority students' academic achievement. *Anthropology and Education Quarterly, 19*, 270-287.

Treuba, H. (1989). *Raising silent voices: Educating the linguistic minority for the 21st century*. New York: Newbury House.

Treuba, H. (1991). From failure to success: The roles of culture and cultural conflict in the academic achievement of Chicano students. In R. R. Valencia (Ed.), *Chicano school failure and success: Research and policy agendas for the 1990s* (pp 151-163). Basingstoke, England: Falmer.

URL Universal Resource Locator. (1995). *Facts and figures of U. S. higher education*. Gopher: 11 Chronicle.merit.edu:70/00/.almanac/.almanac.txt.

U. S. Bureau of Census. (1991). *Statistical abstracts of the United States: 1991.* (111th ed.). Washington, D.C.

U.S. Department of Commerce. (1986). *1987 Statistical abstract of the U.S.* USPGO, Washington D.C.

Valdivieso. R. & Davis, C. (1988). *U. S. Hispanics: Challenging issues for the 1990's.* Washington D.C.: Population Reference Bureau.

Valencia, R. R. & Chapa, J. (Eds.) (1993) Special issue: Latino population growth and demographic trends: Implications for education. *Hispanic Journal of Bahavioral Sciences, 15,* 163-284.

Vellom, R. P.; Anderson, C.W. & Palincsar, A. S. (1994, April). *Constructing facts and mediational means in a middle school science classroom.* Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA.

Vygotsky, L. S. (1986). *Thought and language.* Cambridge, Mass: MIT Press.

Walker, C. L. & Rakow, S.J. (1985). The status of Hispanic American students in science: Attitudes *Hispanic Journal of Behavioral Sciences, 7, 3,* 225-245.

Wells, S. E. (1990). *A-risk youth: Identification, programs, and recommendations.* Englewood, CO: Teachers Ideas Press.

Wertsch, J. V. (1990). The voice of rationality in a sociocultural approach to mind. In L. C. Moll (Ed.) *Vygotsky and education: Instructional implications and applications of sociohistorical psychology.* Cambridge: Cambridge University Press.

Willis, P. E. (1981). *Learning to labor: How working class kids get working class jobs.* Aldershot, England: Gower.

Zaritsky, J. (1989). *Peer tutoring: Issues and concerns. Results of a survey.* Long Island city, New York: La Guardia Community College.

APPENDIX I

APPENDIX I

Postscript

Participant observations in the Family Science Project enabled the researcher to understand a foreign culture, in addition to experiencing professional growth.

The very first thing to be mentioned is that my participation in the Project provided me opportunities to develop interpersonal relationships with the participants. I come from a culture which is very different from the one I experienced in the United States and what I observed in the Family Science sessions. So I worked in a sub-culture within a foreign culture.

To me, any kind of appreciation in a public setting, such as in a school or in work place, was by means of words. Teachers commended the good work of students by saying, "excellent," "very good," or "good," or by writing in the children's notebooks and report cards. They never hugged children. Hugging was not a common thing for me, and at first I was little bit nervous about it, because I used to keep a distance from children. But what I noticed was that the children

loved to be hugged and touched. This was apparent to me from the way Dr. Rodriguez behaved, and from the families who participated in the Project. I noticed that Sarah and Steve went to their mother--Mrs. Briones- to show what they had done, and she would hug them and say, "very good," or some other rewarding phrase. When I helped the kids they also wanted to hug me. Solomon and Pamela used to hug me all the time. The day I did my interviews with the elementary school teachers, I met them in the hallway. Solomon came to me with raised hands and hugged me. Another day when I was at the Lansing airport to depart to California, the fourth graders had a field trip to the airport. I did not notice them until Andrew, Solomon and Sarah ran to me to say, "Hi." Then I noticed that their teacher and the others were waiting for them. In return I also went to greet their teacher, Mrs. Smith, and Mrs. Briones.

My participation in the Project led me to become part of the community. I attended the celebrations for Thanksgiving and Christmas, and cultural festivals like "Cinco de Mayo." I also got used to tasting Mexican food. I met the parents and children in the shops, the shopping malls, and grocery stores. Even in these places, some of the children and parents hugged me as if we were friends for a long time, saying that they had not seen me for a while. I met Dorothy's mother two times, one day in the pharmacy, and another day in a

grocery store. Both times she hugged me. I learned that it is a cultural thing among Hispanics to hug as a greeting and that is considered impolite if we do not hug in return.

All the children and parents greeted me with pleasure. I was very pleased with this behavior, being a foreigner who had come to their community from a place they did not even know. It also encouraged me to continue working in the Project. I also liked to see them. Even after I finished collecting the data I still went to the school to see them. I had some photographs that I had taken which I could not hand to them. I gave these to Mrs. Briones to give to the children, because she had contacts with all the children and their parents.

Besides these social involvements, by being a participant observer I also learned from the hands-on science activities. The science that I had learned in Sri Lanka was very theoretical. Until I got to the high school level, I had never done a science experiment alone or in a small group. All I learned was from the science textbook and how the teacher interpreted what was in the textbook through her demonstrations. Because of this experience I had, I understood very clearly what some of the children described to me about their own science classes. I can still remember how I learned the concepts behind the laws governing gases. We first

read Boyle's law from the science textbook. Then in the notebook we wrote the experiment illustrating Boyle's law. After the teacher's demonstration of Boyle's law, showing us the different readings of pressure and volume, we tabulated the readings and drew a graph which showed how when the gas increased the volume pressure decreased. Then we wrote the conclusion as, "Pressure is inversely proportional to volume."

When I was a child I never did science activities using the materials which were found in the kitchen, and around home. Similar to most of the parents, I too had the idea that science could only be done with sophisticated equipment. The activity on surface tension with food coloring and milk was an exciting activity not only for the children, I also enjoyed it and tried adding different colors to make colorful psychadelic designs. Doing hands-on activities that one can replicate at home has an impact on the students' learning. It allows the child to practice and enjoy the activity, and also helps develop skills. From what the children told me, they had to answer questions from their family members as to why something had happened. Attempting to explain what had happened in an activity helped the child to further think about the discussion, and to better understand what was done in the activity.

As a researcher, I developed my research skills in many aspects. I had a quantitative research background

until I started working in the BRIDGES (Basic Research in Implementing and DevelopinG Education Systems) Project sponsored by USAID. In the project on which I worked, I had to use qualitative research methods that I did not know. I was trained by Dr. Richard Navarro from MSU when I was in Sri Lanka. That was when I realized I needed to understand more about research methods. When I started my graduate studies here at MSU, in the first year I took the whole series of fieldwork research, and then in the second year I took teaching effects research, quantitative research methods, and survey research. My goal was to understand the changes in the behavior of the participants. Hence, I selected qualitative research for this dissertation. In this study I developed my observation skills and learned how important it is to have on-the-spot field notes. It was amazing to notice how much you forget if you do not document while an event is happening. I also developed the ability to develop questionnaires, perform interviews, interpret, and report data.

I discussed how the participants of the Project were able to form a learning community. As a result of my participation in the Family Science Project, I used the data gathered to communicate to research audiences at national and international conferences, and so became a member of those research communities.

APPENDIX II

APPENDIX II

Steps in making Hot Air baloons

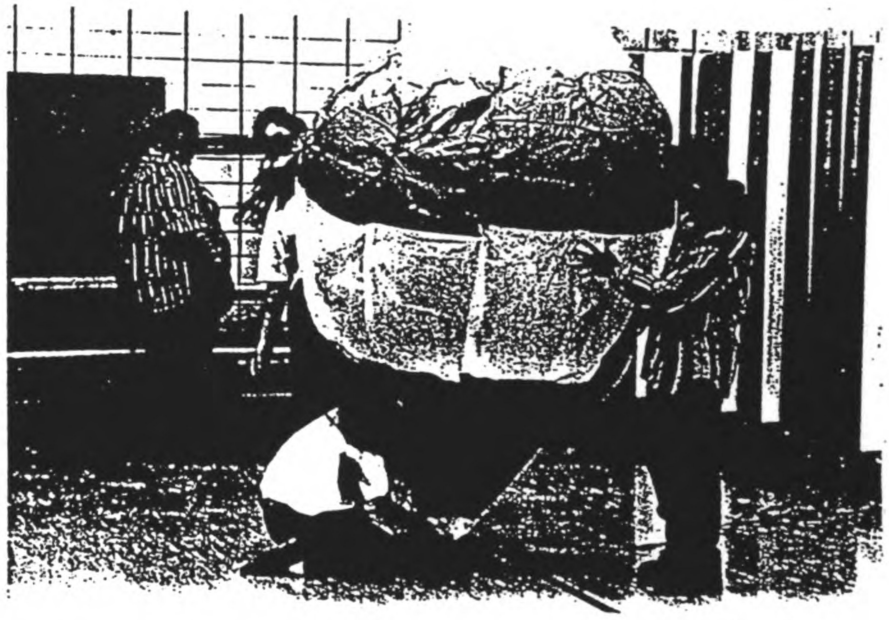


Gluing the final seam of of a ten panel tissue paper hot air balloon takes cooperation, concentration and patience. The middle-school junior scientists assist third and fourth grade students from the elementay school.

APPENDIX III

APPENDIX III

Steps in making Hot Air baloons



Filling up the balloon with air from a hot air popcorn popper.

APPENDIX IV

APPENDIX IV

Steps in making Hot Air baloons



Success! Up it goes

APPENDIX V

APPENDIX V

Original Letter

Dear Dr.

I came down with a migraine headache yesterday and even though I have medication for it - for some reason it has not kicked in this time. Right now my right eye is useless and I am unable to attend class. I thought maybe a Jr Scientist would not mind helping my kids anyway. They really want to be there. If, for any reason, you feel that it won't work out then please send them home. I expect them to be on their best behavior. If not, please let me know the next time I see you.

Thank-you

APPENDIX VI

APPENDIX VI

Pretest

[Before the pretest students and parents will be asked to draw a scientist. The things that they draw will be used in the interviews. During the pretest time each question will be explained to students.]

Before we start we would like to know something about you. Please write whatever you know. Do not think this as a test. This will help us to do a good job for you.

1. In what grade are you?
2. Do you like science?
3. Do you think that science should be taught to everybody?
4. What do you gain by learning science?
5. Have you heard about scientists?
6. Do you have science in school?
7. Do you do hands-on activities in school?
8. Why do you decide to join the Family Science Project?
9. Do you like to work alone or in a group?
10. Do you think you can learn from each other? If so, how? If not, why?
11. Are you scared to share your ideas in school? If so, do you keep quiet in class discussions?
12. Do you respect others ideas?

13. How do you feel when you are in a group with adults?

14. How often do you talk about science at home?

15. Do you ask help from your parents in doing homework?

APPENDIX VII

APPENDIX VII

Survey Instrument

Before you participate in the Family Science Project, we would like to know something about you, your interests, and what do you think about science and the Family Science Project. These information will help us to provide you with a program for your needs, and also help us in planning a good program for you. Please, write whatever you feel. This is not a test. Your information will be kept strictly confidential.

1. To which grade have you studies?----------

   To which grade have you learned science?----------

   When did you leave school?----------

   Have you had any courses after leaving school?------

---

2. How many children do you have?----------

   How much time do you spend with the kids?----------

3. What programs do you watch in TV.?----------

4. Are there any TV. programs that you watch with your kids? If so, what are they? ----------

5. Do you think that your children can gain by learning science? ----------

6. What do you think that your children can gain by learning science?----------

---

7. When you were a child were you motivated by your parents in education? ----------

8. Please feel free to use the back side of this paper to write any suggestions you have to incorporate in the Family Science Project.

APPENDIX VIII

APPENDIX VIII

Pre Interview for Students

My name is Sunethra Karunaratne. I am a student at Michigan State University. I will be here for all the family Science sessions to see how the program is working. I am pleased to be with you in the Family Science Project. I want you to help me by telling your ideas about the Family Science Project. You don't have to talk with me if you don't want to. If you talk to me you can stop me at any time. Please feel free to tell anything you want. I won't tell your responses to anybody. I will not use your name in my notes. If you don't mind I would like to use a tape recorder.

1. Do you have science in school? If so, do you like it? Why? Tell me how do you learn science in school? Do you do experiments, hands-on activities?

2. Why have you decided to join the Family Science Project?

3. Tell me what do you think about scientists?

4. What do your parents say about science? Do you feel that you need help from your parents to complete your science homework?

5. Have you felt that it is easy to ask questions of your parents about science? How do you feel when you learn something from your sisters/brothers or from parents?

6. If you think you know the right answer to a question, do you like to tell it to your group members?

7. Do you think you can learn from other students? If so, how? If not, why?

8. Do you like to work with adults?

9. How do you feel when you are in a group with adults?

10. Do you believe that you can learn from hands-on activities?

11. Do you think that science should be taught to everybody?

12. What do you think as useful to learn science in your day to day life?

APPENDIX IX

APPENDIX IX

Pre Interview for Junior Scientists

We are interested in knowing how you feel about the Family Science Project, and what do you think about how third and fourth graders think of it. Your responses will be kept strictly confidential. You should feel free to tell anything about the program. Your responses do not affect you or anybody in the Family Science Project by any means. Your responses will help us in improving the Family Science Project to your needs.

1. Why have you decided to join the Family Science Project?

2. Do you like science in school? What do you like most about science? What do you do not like in science?

3. How do you do science hands-on activities in school?

4. Do you like to work in a group?

5. Do you feel that you can gain more when you work in a group than working individually?

6. What do you expect from the Family Science Project?

7. What do you like in the Family Science Project?

8. What things that you do not like in the Family Science Project?

9. Are there any things that you do not like in the Family Science Project or you feel that should be changed?

10. Do you believe that you can learn when you are working with third and fourth graders?

11. How do you feel when you work with adults?

12. Do you talk about Family Science with your friends and with your family members?

13. Do you believe that the experience you gain in Family Science will help you in the future?

14. What do you want to be in the future?

APPENDIX X

APPENDIX X

Pre Interview for Parents

We are interested in knowing about how you feel about the Family Science Project, and what do you think your child thinks of it. Your responses will be kept strictly confidential. You should feel free to tell anything that you want about the program. Your responses do not affect you or your child by any means. Your responses will help us in improving the program to your needs.

1. First of all, why have you decided to send your child to the Family Science Project?
2. What do you expect of the program?
3. Have you had science in your school? to which grade? What do you think about science? Do you like science? Why?
4. What do you think about your child learning science in school?
5. What do you suggest as a parents that you could motivate a child in learning science?
6. If you have enjoyed science or had any problems in learning science, could you please state some of those?
7. Do you have any ideas to overcome those problems?
8. Do you have a habit of looking what your kid is doing in school? How much time you spend with kids in helping their homework?

9. Do you think that learning science in schools challenges/hinders student's interest in science? Why?

10. Have you received "Wonder Science?"

11. Have you discussed the things in those magazines with your child? If you can remember could you please tell me an example?

12. How do those things could be useful for your children in learning science?

13. How do you involve your kids in a family discussion?

14. What can you learn when you work in a group?

15. How do you feel when you work with your kids and other kids in a group?

16. Do you believe that you can learn more when you work in a group than you work individually?

APPENDIX XI

APPENDIX XI

Post Interview for Students

(Name), you have participated in the Family Science Project in the last two semesters. I would like to know how do you feel about the Family Science Project. Please feel free to tell anything you want. I won't tell your responses to anybody. I will not use your name in my notes. If you don't mind I would like to use a tape recorder.

1. When I ask you about the Family Science Project, what is the first thing that come your mind? What do you like in Family Science? Why? What do you dislike in Family Science?

2. Have you used what you learned in the Family Science Project in school? How? Have you used what you learned in Family Science in your day to day life, at home or in any kind of activity? How?

3. What do you think about scientists? What do you think about junior scientists wearing lab coats? Do you like to wear name tags during the sessions? Why?

4. What is the activity that you like most in the Family Science sessions? Why? What is the activity that you dislike in the Family Science sessions?

5. Have you told about the activities that you did in the Family Science sessions to your friends or relatives? Did your friends or relatives attend Family

Science sessions, because of what you said? If so, how many?

6. Has your teacher said anything good for what you did in the class because of the Family Science sessions? Explain?

7. You have attended the Family Science sessions regularly/not regularly. Why? What do you think about the other people who did not attend the Family Science sessions regularly? Do you think that they had some kind of problems or anything that they do not like in the Family Science sessions?

8. In all the Family Science sessions you do estimation and sign in Venn diagram, what do you learn by doing that?

9. You work with junior scientists and parents in the Family Science sessions. How do you feel about it?

10. Do you think that anybody can learn science?

11. Why did you attend the Family Science sessions?

12. What do you want to be in the future?

Would you please draw a picture of a scientist on the back of this paper? Thank you very much for your participation in the Family Science Project, and for your responses.

APPENDIX XII

APPENDIX XII

Post Interview for Junior Scientists

(Name), you have participated in the Family Science Project in the last two semesters, we are interested in knowing how do you feel about third and fourth graders think of it, and also I would like to know how do you feel about the Family Science Project. Please feel free to tell anything you want. I won't tell your responses to anybody, it will be kept confidential. I will not use your name in my notes. If you don't mind I would like to use a tape recorder. Your responses will help us in improving the program to your needs.

1. What was in your mind when you joined the Family Science Project? What have you achieved/not achieved from the project? Can you name any skill that you developed by attending the Family Science Project?

2. What is the activity that you liked most? What did you learn from that activity?

3. Do you have any suggestions to make changes in the Family Science Project?

4. For some of the Family Science sessions you have not attended. What kept you absent? (Only for the absentees)

5. In the Family Science sessions, you always do group work. What do you think about working in groups? Does it help you in school to organize group activities such as making posters?

6. What do you think about working with the younger children? (3rd & 4th graders) Do you feel that it is important to work with the kids?

7. How do you feel when parents are working in groups? What do you think that the parents can bring to the Project? Do you believe/do not believe that you can learn when you work with the younger children?

8. How many of your friends know that you participate in the Family Science Project? Have you asked some your friends to participate? How many sessions did they attend? Why? What did they tell you about the Project?

9. Could you please explain to me an instance where the Family Science activities helped you in your day to day life?

10. If you feel that Family Science helped you in science in school, could you please explain to me how?

11. What do you think about your time spent in the Family Science Project? If you wouldn't have participated in the Family Science Project, what would you have done during that time?

12. What do you want to be in the future?

13. Who are scientists?

14. In the Family Science sessions you wear lab coats. How do you feel when you wear them? Do you think that it is a recognition or status symbol? Do you think that it is necessary to wear a lab coat when you do science experiments?

15. In the Family Science sessions, you do estimation and sign the Venn diagram. What do you learn from them?

16. Do you have sisters and brothers?

17. Can you name two science concepts that you learn in the Family Science sessions?

18. How do you feel about yourself after taking the Family Science sessions?

19. What do you think about having projects like the Family Science Project to minority groups, especially for Hispanics? Can anybody learn science?

20. Is there anything that you thought I will ask and I did not ask you? Please tell me.

Would you please draw a picture of a scientist on the back of this paper? Thank you very much for your participation in the Family Science Project, and for your responses.

APPENDIX XIII

APPENDIX XIII

Post Interview for Parents of Elementary Children

(Name), has participated in the Family Science Project in the last two semesters, we are interested in knowing how do you feel about (Name)'s participation in the project, and also I would like to know how do you feel about the Family Science Project. Please feel free to tell anything you want. I won't tell your responses to anybody, it will be kept confidential. I will not use your name in my notes. If you don't mind I would like to use a tape recorder. Your responses will help us in improving the program to your needs.

1. First of all, why have you decided to send your child to the Family Science Project?

2. What do you think about her/his time to learn something useful? If s/he uses her/his time to learn something useful? If s/he would not have participated in the Family Science Project, what would have s/he done?

3. What has s/he told you about the project? Do you think that s/he likes the project? Why do you think so? Have you noticed any kind of changes in her/him since s/he started attending the Family Science Project?

4. Have you felt that you should also participate in the Family Science Project? Do you think that anybody can learn can science?

5. Can you tell me an instance where (name) did something at home, that s/he learned from the Family Science Project or science in school?

6. Do you encourage children of (name)'s age to participate in a project like the Family Science Project? Why?

7. We know that there cannot be a perfect program. What do you suggest to improve the project? Do you feel that we should provide you with more information about the Family Science Project?

8. What do you think about junior scientists' participation in the Project?

9. What do you think about junior scientists' wearing lab coats for the sessions? Do you like to wear name tags during the sessions?

10. In all the Family Science sessions you do estimation and sign in Venn diagram, what do you learn by doing that?

11. Did your participation in the Family Science sessions helped you in helping children's education/in doing any kind of activity in the community or in school/ or at home/ everyday experiences

12. In the Family Science sessions, you always do group activities. Does the group work help you to take a leadership role in the community or in the school activities?

13. When you were a student in the school what did you want to be?

14. What do you expect (name) to be in the future? Why?

15. If (name) has any problems with the friends, at home or any kind of financial problem, can we know about it?

16. Do you have any ideas or suggestions for us to involve parents in child's education?

17. Is there anything that you thought I will ask and I did not ask you? Please tell me.

Would you please draw a picture of a scientist on the back of this paper? Thank you very much for your participation in the Family Science Project, and for your responses.

APPENDIX XIV

APPENDIX XIV

Post Interview for Parents of Junior Scientists

(Name), has participated in the Family Science Project in the last two semesters, we are interested in knowing how do you feel about (Name)'s participation in the project, and also I would like to know how do you feel about the Family Science Project. Please feel free to tell anything you want. I won't tell your responses to anybody, it will be kept confidential. I will not use your name in my notes. If you don't mind I would like to use a tape recorder. Your responses will help us in improving the program to your needs.

1. First of all, why have you decided to send your child to the Family Science Project?

2. What do you think about her/his time to learn something useful? If s/he uses her/his time to learn something useful? If s/he would not have participated in the Family Science Project, what would have s/he done?

3. What has s/he told you about the project? Do you think that s/he likes the project? Why do you think so? Have you noticed any kind of changes in her/him since s/he started attending the Family Science Project?

4. Have you felt that you should also participate in the Family Science Project? Do you think that anybody can learn can science?

5. Can you tell me an instance where (name) did something at home, that s/he learned from the Family Science Project or science in school?

6. Do you encourage children of (name)'s age to participate in a project like the Family Science Project? Why?

7. We know that there cannot be a perfect program. What do you suggest to improve the project? Do you feel that we should provide you with more information about the Family Science Project?

8. When you were a student in school what did you want to be?

9. What do you expect (name) to be in the future?

10. If (name) has any problems with the friends, at home or any kind of financial problem can we know about it?

11. Do you have any idea or suggestions for us to involve parents in children's education?

12. Is there anything that you thought I will ask and I did not ask you? Please tell me.

Thank you very much for to spend your valuable time with us, and for your responses.

APPENDIX XV

APPENDIX XV

Interview Guide for the Principal

My name is Sunethra Karunaratne. I am a student at Michigan State University. I work in the Family Science Project with the project Director,------. I am interested in knowing about how you feel about the project. I want you to help me by telling me your ideas, suggestions about the Project. Your responses will be kept confidential. You should feel free to tell anything that you think about the Project. Your responses will help us in improving the project to the needs of the community. If you don't mind I would like to use a tape recorder. Thank you for your participation.

1. I would like to know a little bit about your background, experiences and your interests.

2. Would you please tell me about the neighborhood of the school? The composition, living standards and what do you think about them?

3. As the principal of the school what would you expect from parents, community and teachers?

4. How do you communicate with the teachers, parents? How often?

5. What are the procedures that you take in sending teachers to in service sessions, organizing field trips etc.? Who make the decisions?

6. How did you come to know about the Family Science Project?

7. Why have you given your consent to conduct the Family Science Project in your school/

8. What have you heard about the Project?

9. In your opinion how should the kids learn science?

10. What kinds of barriers prevent the students in your school to learn and continue science?

11. What do you expect of the Family Science Project?

12. In our Family Science sessions we do a lot of hands-on activities, what do you think kids working with the adults in doing these activities?

13. I know that there are so many programs going on in the school, can you name a few and tell me what kind of involvement they have?

14. I work in the La Clase Magica Project too, I know some of your students go to the community center to attend those sessions. What do you expect from these after-school programs?

15. Do you have any suggestions for us to improve the Family Science Project?

Thank you very much for your participation and for your time.

APPENDIX XVI

APPENDIX XVI

Consent Forms
Attachment I

Verbal Explanation to students

My name is Sunethra Karunaratne. I am a student at Michigan State University. I will come to see your Family Science sessions and sit with you in the classroom to see what is going on. You may like to help me by talking with me to understand what do you think about Family science program. You don't have to talk with me if you don't want to. If you talk to me you can stop me at any time.

Thank you very much.

Sunethra Karunaratne

Doctoral student

Attachment II

Letter to Parents

1401 G Spartan Village
East Lansing
MI 48823
October 1, 1992

Dear Mr./Mrs./Ms. .....

My name is Sunethra Karunaratne. I am a doctoral student in the Teacher Education Department of Michigan State University. I am writing this letter to request your permission for your child/children to participate in the research project that I will be carrying out from November 1992 to May 1993, in the Family Science sessions in Grand River elementary school.

I will be conducting this research project for the partial fulfillment of the doctoral degree. I am interested in observing how students are learning science in a different setting than school with adults. I would focus my observations on strategies that are used by the Family Science project coordinator and how children respond to those to learn science. To get an accurate record, I will observe all the Family Science sessions in the Fall and Spring semesters, and would also like to talk to your child/children and other students to find their interests. Your child/children participation is voluntary; you may choose not to have her/him/they participate, or terminate participation at any time without penalty. I will not use the actual name of your child/children or the teacher or the city at any time in discussing this research. I would like to use a tape recorder while I talk to your child/children to accurately record her/his their ideas. But as soon as transcripts of the tapes are made these tapes will be erased. All the data collected will be treated with strict confidence.

This study is not by any means intended to evaluate your child/children's work. My study may benefit her/him/they by giving the opportunity to talk to an adult to whom the child/children can express her/his/ their ideas freely. I will keep those ideas confidential without telling the Family Science project cordinator, teacher or others. The study will benefit researchers, educators and institutions to design nonformal education programs to educate people in science. I hope you will allow your child to participate in my research project. If so, please sign the attached consent form and send it to the school with your child.

If you have any questions about the project , you may contact me at 355-0742.

Thank you in advance for your cooperation.

Sincerely,

Sunethra Karunaratne
Doctoral Student

Attachment III

Parent Consent Form

I agree to participate in the research project " Family Science as a strategy to overcome underrepresentation of minorities in science," and to allow my child/children to participate in the project too, conducted by Ms. Sunethra Karunaratne who is a doctoral student at Michigan State University. The goals, procedures, and duration of my child's/children's participation in the research project have been explained to me.

I understand that the researcher will be in the Family Science sessions observing how students learn science with adults in a setting different from a regular classroom setting. She will take photographs during the sessions, and use them covering the identifying features of people in it. She will interview me and my child/children at the beginning , end and when a need arises, and those will be tape recorded. She will inform me in advance and will conduct the interviews for our convenience either at home or in school. Interviews will be about 15-30 minutes in length. She will not be involved in my child's/children's academic work or in influencing the teacher's evaluation of my child's/children's work.

I understand that my child's/children's identity will remain confidential. No actual name will be used when discussing this research with others.

I also understand that I may withdraw my child/children or that she/he/they may withdraw from participation at any point without recrimination.

Child/children's name(s)

.....

.....

Signature of parent or guardian

.....

Date .....

Attachment IV

Consent Form to Junior Scientists

I agree to participate in the research project conducted by Ms. Sunethra Karunaratne, who is a doctoral student at Michigan State University. The goals and procedures and duration of my participation in the research project have been explained to me.I understand that Ms. Sunethra Karunaratne will be with us for all the Family Science sessions to observe what we do.

She will interview us at the beginning, end, and when a need arises. She will use a tape recorder in her interviews with our permission and also take photographs during the sessions. She will use the photographs covering the identifying features of us so that one cannot identify us. She will not use any of our names in her notes or any report on this study.

I also understand that I may withdraw from participation at any point without any recrimination.

Name of Junior Scientist

.....
Signature of Junior Scientist

.....

Date.....

Signature of
parent.....

Attachment V

Consent Form to Science teacher

I agree to participate in the research project," A study of Family Science as a tool to overcome underrepresentation of minorities in science," conducted by Ms. Sunethra Karunaratne, a doctoral student at the Teacher Education Department of Michigan State University. The purposes and procedures of the research project have been explained to me and I understand that my participation in the project includes the following activities and understandings:

I will allow my classroom to be observed and audio taped. I understand that observations and discussions will involve students' science learning.

I will provide time for the researcher to interview me within the school hours or after school hours if that best suit our schedules.

I will allow the researcher to interview my students as long as this does not disturb my class (if the approval of the parents has been given).

I understand that the researcher will keep confidential written records of her observations and discussions with me and others.

I understand that the raw data will not be used in any evaluation and will not be released to any personnel.

Further, I understand that I may get the opportunity to discuss and gain information, which may provide insights into my own teaching and practices.

I know my participation is voluntary and I may withdraw from this study at any time without recrimination.

Signature..... Date.....

MICHIGAN STATE UNIV. L
31293014112