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ABSTRACT

Action research is one of the more increasingly popular and innovative techniques for engaging teachers in shaping change in the classroom. The research in this monograph was conducted by teachers in classrooms in Florida and Georgia. Papers were selected from 65 action research papers written in fulfillment of one of the requirements of the Science FEAT (Science For Early Adolescence Teachers) program and are illustrative rather than exhaustive of the types of questions, issues, and concerns that many classroom teachers are beginning to address through action research. Papers include: (1) "Effect of Technology on Enthusiasm for Learning Science" (Jane Hollis); (2) "What Types of Learning Activities Are More Likely To Increase the Involvement of Non-Participating Students?" (Phyllis Green); (3) "Encouraging Participation in a Middle School Classroom" (Patricia Dixon); (4) "What Patterns of Teacher-Student Verbal Communication Exist in My Classroom?" (Elizabeth Graham); (5) "The Use of Cloze Procedure as an Instructional Tool in a Middle-School Classroom" (William Weldon); (6) "Equality in the Classroom: An Attempt To Eliminate Bias in My Classroom" (Stephen Thompson); (7) "The Effect of a Teacher's Questions on Limited English Proficient and Bilingual Students" (Jacqua Ballas); (8) "Conceptual Learning and Creative Problem Solving Using Cooperative Learning Groups in Middle School Science Classes" (Michael DuBois); and (9) "Long Distance Collaboration: A Case Study of Science Teaching and Learning" (Angie Williams). Also included is a description of the Science FEAT program and a concluding chapter, "So You Want To Do Action Research" (Angelo Collins, Samuel A. Spiegel) that provides insight into conducting action research for classroom teachers, school administrators, and college/university personnel interested in enhancing teaching and learning within their local community or organization. (JRH)

ACTION RESEARCH:

PERSPECTIVES FROM *Teachers' Classrooms*

Science FEAT

(Science For Early Adolescence Teachers)

Action Research: Perspectives from Teachers' Classrooms

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1995

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SERVE
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About the SERVE Laboratory

SERVE, the SouthEastern Regional Vision for Education, is a coalition of educators, business leaders, governors, and policymakers who are seeking comprehensive and lasting improvement in education in Alabama, Florida, Georgia, Mississippi, North Carolina, and South Carolina. The name of the Laboratory reflects a commitment to creating a shared vision of the future of education in the Southeast.

The mission of SERVE is to provide leadership, support, and research to assist state and local efforts in improving educational outcomes, especially for at-risk and rural students. Laboratory goals are to address critical issues in the region, work as a catalyst for positive change, serve as a broker of exemplary research and practice, and become an invaluable source of information for individuals working to promote systemic educational improvement.

Collaboration and networking are at the heart of SERVE's mission; the laboratory's structure is itself a model of collaboration. The laboratory has four offices in the region to better serve the needs of state and local education stakeholders. SERVE's Greensboro office manages a variety of research and development projects that meet regional needs for the development of new products, services and information about emerging issues. The development of this manual was funded through such an R&D effort. The laboratory's information office is located in Tallahassee. Field services offices are located in Atlanta, Greensboro, Tallahassee, and on the campus of Delta State University in Cleveland, Mississippi.

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Foreword

Francena D. Cummings, Director
SERVE Eisenhower Consortium for Mathematics and Science Education

As the Southeastern affiliate for the National Network of Eisenhower Regional Consortia for Mathematics and Science, one of our major priorities is the dissemination of print materials that promote systemic reform as well as provide guidance to educators in their quest to increase student achievement in mathematics and science. To that end, I am pleased to present this monograph on **Action Research: Perspectives from Teachers' Classrooms.** Action research is one of the more increasingly popular and innovative techniques for engaging teachers in shaping change in the classroom. The research in this volume was conducted by teachers in classrooms in Florida and Georgia. The questions posed and the findings reported will contribute to the literature on science teaching and learning.

Throughout academia, action research is being endorsed as an effective means to change classroom practice. The NSTA and NCTM both acknowledge the role of "teacher as researcher" as an effective means in promoting professional development and professionalism in teaching. Moreover, it serves as a bridge to link research and practice. This bridge allows practitioners to use and value research by being a part of the process.

I would like to acknowledge the commendable efforts of the Science FEAT (Science For Early Adolescence Teachers) Program as a wonderful example of how we can achieve real reform in science classrooms throughout the Southeast as well as the nation. Action research is an excellent strategy for promoting systemic reform in science classrooms. The findings and recommendations in this monograph should be an inspiration to all that are involved in the improvement of mathematics and science education. It is my hope that it will encourage others to consider action research as a viable means to implement teacher change.

Editorial Acknowledgments

All books depend on the efforts of many more people than those who are listed as authors and editors. The same is true for this monograph. This collection of chapters could not have come into existence without the hard work of the teachers/ researchers, and the many others who helped to take pieces of writing from a variety of sources and bring them together into a smooth product. This difficult task could not have been accomplished without their hard work and dedication.

Bridget Hillyer, an undergraduate in Religion and Philosophy at Florida State University, did technical tasks such as proofreading the citations and preparing the table of contents. Her help and support is truly appreciated.

Cindy Doherty, Bradford Lewis, and Elizabeth Viggiano are Science FEAT program assistants and graduate students in Science Education at Florida State University. They served as mentors during the data collection, analysis, and writing phases. Each edited earlier drafts of the research papers and guided the teachers toward the final versions.

Penny Gilmer, Co-Principal Investigator of Science FEAT, and a faculty member in the Department of Chemistry at Florida State University, also provided essential guidance and assistance both in the design and conduct of the action research and in the vision of Science FEAT.

Thanks also to Robin Marshall, a Science FEAT staff member and teacher at Caroline Brevard Elementary School in Tallahassee, Florida.

This project could not have been completed without the help and support of the faculty in Science Education at Florida State University: Nancy Davis, George Dawson, Alejandro Gallard, and Kenneth Tobin.

Finally, we are appreciative of the SouthEastern Regional Vision for Education (SERVE) and the SERVE Eisenhower Consortium for Mathematics and Science Education for providing financial resources to publish this monograph. Graphic Design and editing services were provided by the Publications Unit.

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This is available in alternative format upon request.

Introduction to the Monograph

Samuel A. Spiegel
Florida State University
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Angelo Collins
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All of the hard work you put into resisting the research is nothing compared to the things you learn through the research.
Frank Sultzer, Science FEAT Teacher

Researchers and policymakers involved with the current reform efforts in the United States are striving to make substantive and systemic improvements in teaching and learning in K-12 classrooms. While the reformers recommend a variety of approaches to the problems that are found in today's schools and school systems, there are several common aspects that can be found in their recommendations. Many of the approaches attempt to refocus the examination of the problems and solutions on the local level, such as site-based management, teacher empowerment, and parental choice (Prestine and Bowen, 1993). These current reform efforts have begun to recognize that although there are many commonalities among classrooms, teachers, and students, the individual differences cannot be ignored if substantive and systemic change is to occur.

How do teachers, administrators, and other concerned persons begin to look at the problems and needs at their schools? Furthermore, how do they look for reasonable solutions with the resources of their schools and community? One approach that has been gaining popularity is action research. By action research we refer to research conducted to solve a specific problem within an organization. The action research becomes part of the solution by engaging the people in the organization in studying their own problems within the context of their own organization (Patton, 1990, p. 157).

The papers presented in this monograph were selected from the sixty-five action research papers written in fulfillment of one of the requirements of the Science FEAT (Science For Early Adolescence Teachers) Program. They are illustrative rather than exhaustive of the types of questions, issues, and concerns that many classroom teachers are beginning to address through action research. In these papers, the organizations are classrooms or schools, and the people within the organizations are the Science FEAT teachers and their students.

To provide you with an understanding of the impetus and context in which these research projects and papers were initiated and completed, we include a brief description of the Science FEAT Program. Following this description is an introduction to each paper. The subsequent chapters present the nine research papers. A concluding chapter provides insight into conducting action research for classroom teachers, school administrators, and college/university personnel interested in enhancing teaching and learning within their local community or organization.

What is Science FEAT?

The inspiration and challenges I experienced in the Science FEAT Program have changed me totally in the classroom. I am taking risks this year, I am challenging the students and receiving very positive results from students and parents. I have given a workshop on cooperative learning and I have gotten lots of positive results from my peers (Science FEAT Teacher).

The Science FEAT Program has given me confidence and encouragement to move away from traditional methods of teaching and venture out to new strategies. I have come to know it's all right to let my students take more responsibility for their learning. The teaching of simple machines as part of a unit of inventions came alive in my classroom for the first time when the class constructed a giant first-class lever and gave their thoughts on what different combinations of force and distance would have (Science FEAT Teacher).

Science FEAT was a three-year teacher enhancement program for middle school teachers of science, based at the Florida State University and supported by the National Science Foundation[1]. Sixty-five middle school teachers from North Florida and South Georgia completed the program. Science FEAT received the 1995 *Innovation in Teaching Science Teachers Award* from the Association for the Education of Teachers in Science (AETS) and was recognized by the Florida Postsecondary Education Planning Commission as an exemplary initiative program in math, science, and technology-related education.

The goal of Science FEAT, as stated in the grant proposal, was to improve local middle school science education and concentrate on solutions to four common problems:

- Science teaching in the middle schools of North Florida and South Georgia is mainly grounded in textbooks which present science as facts and terms to be memorized and as a rhetoric of conclusions.
- Middle school science instruction does not provide a significant portion of African-American, Hispanic, or female students with opportunities to enjoy and succeed in science.
- Middle school teachers in many school districts are isolated from one another and have limited resources available to assist them in improving science teaching.
- Many middle school science teachers do not have the necessary knowledge and skills to implement a science program that both meets the learning needs and interests of their students, and represents science as an engaging, contemporary, and social activity.

While the program provided experiences to enable middle school science teachers to address these problems, it also was designed so that those who completed Science FEAT were eligible to earn a Master's degree in science education. For three consecutive summers, 1993-1995, the teachers engaged in intensive five-week academic sessions at Florida State University. These sessions included course work, seminars, research in both science and education, and experiences in the use of instructional technology. There were also required activities during the academic year. Activities were designed to enable teachers to understand the nature of science; to design and implement student-centered science curricula, materials and instruction in local contexts; and to enhance their theoretical and practical knowledge of the teaching and learning of science. During the second academic year the participants conducted action research at their schools. The papers published in this monograph are the results of this research. The papers selected are representative of the diversity of research topics, schools, and teachers from the whole of the Science FEAT Program.

Science FEAT also included activities for school administrators and for university instructors. An administrator from each participating school was required to attend a one-day meeting each year. These meetings provided guidance for the administrators to assist the teachers in implementing new approaches to teaching science. University instructors participated in planning sessions during the academic year and in weekly faculty meetings during the summer to discuss teaching and learning. These activities have helped university instructors, especially from the College of Arts and Sciences, examine their teaching.

Reading the Research Papers

In her paper, "Effect of Technology on Enthusiasm for Learning Science," Jane L. Hollis examines the impact of a multimedia-based curriculum unit on students' enthusiasm. This is a question many educators are addressing as they seek to prepare students for an increasingly technological world. The design of this study provides an example for other classroom teachers by balancing the constraints encountered by a classroom teacher with the impetus for substantive research. For example, the selection of the class to study was based on logistical reasons (availability of computers) as well as considerations for the quality of the data (such as class demographics). Ms. Hollis' study was strengthened by including parents and students in the data generation. The results of her study highlight some of the advantages of instructional technology in middle school science classrooms. Additionally, insight into discrepancies among students', teachers', and parents' perceptions were discussed.

Phyllis Green's paper, "What Types of Learning Activities are More Likely to Increase the Involvement of Non-Participating Students?" explores a timely issue of great concern to many educators. She examines the issue of motivating nonparticipating students by investigating their perceptions of various classroom activities. Ms. Green identifies common characteristics of underachieving students and addresses strategies to encourage their success. In her discussion of the data and results, she provides insight into her analysis process, such as how she eliminated some of her initial hypotheses about the students and activities. She supports her study and conclusions through both literature and descriptive evidence. Ms. Green also follows through from her main study with an informal study showing the reader where she went and why. This paper captures the quintessential struggle teachers face with non-participating students and provides suggestions and hope for all concerned educators.

Concern about conflicts between the communications she intended and what students perceived led **Patricia J. Dixon** to conduct her study entitled, "Encouraging Participation in a Middle School Classroom." The use of videotaping as an action research tool by classroom teachers has been described as one of the most powerful research tools in education today (Gallard, personal communication, 1995). In this study, Ms. Dixon illustrates some of the strengths of using video for classroom teachers. Through descriptions from her videos and personal journal, she provides the reader with a rich image of her classroom and the impact of nonverbal communication on student participation. The analysis and conclusions from the data and literature raise questions worthy of consideration by all teachers. These issues surface in several other papers presented in this monograph. Reading this paper will provide teachers with a new perspective on their classrooms.

Elizabeth Graham investigated another aspect of teacher-student communication, namely verbal communication. Her study, "What Patterns of Teacher-Student Verbal Communication Exist in My Classroom?," uses a research technique called Interaction Analysis developed by Amidon and Flanders (1971). This technique allows the researcher to identify patterns of verbal interaction by coding spoken communication in the classroom into distinct categories and entering the codes into a matrix. Ms. Graham was able to complete this complex research by relying on an established research technique rather than focusing on developing a new method. As she notes in her discussion section, the results provided her with substantive insight into her classroom and teaching practices, something she had to discover for herself. Most educators can relate to and learn from Ms. Graham's articulate recognition of the incongruency between her teaching beliefs and teaching practices.

"The Use of Cloze Procedure as an Instructional Tool in a Middle School Classroom," by **William H. Weldon**, examines the effectiveness of the cloze procedure in increasing students' learning as indicated by test scores. His analysis of the data uses quantitative techniques that did not require algebraic formulas or computers. Mr. Weldon notes that this was a conscious choice in an attempt to encourage future research using techniques that are realistic for the average classroom teacher. You will also note the more traditional style used in reporting the study. The paper is divided into distinct and traditional sections such as the *Literature Review* and the *Methods* sections. The discussion of his findings suggests those target populations for whom the cloze procedure shows the greatest potential for enhancing their learning.

Stephen Thompson's paper, "Equality in the Classroom: An Attempt to Eliminate Bias in My Classroom," began with his heightened awareness of unintentional bias that can exist in the classroom. As you read his study, notice the progressive narrowing of the focus and change in his purpose as he conducts his data analysis. This is characteristic of many research efforts. Quite often a researcher will find an unexpected phenomenon that redirects his/her interest. Mr. Thompson altered his conclusions, but remains focused on his intended goal. His conclusions highlight many important questions facing today's schools and provide insights that may help other classroom teachers.

In her study, **Jacqua L. Ballas** examines another aspect of equity in her classroom. "The Effect of a Teacher's Questions on Limited English Proficient and Bilingual Students" investigated how questioning techniques affect limited English proficient (LEP) and bilingual students' views of science concepts and their views of themselves as learners. Her research use of an emergent research design(Guba & Lincoln, 1989), allowed her to alter the data collection methods based on a continuous needs analysis from the data. Ms. Ballas' paper, like several others, illustrates the power of videotaping as a reflective research tool for classroom teachers. In the discussion of her results, Ms. Ballas emphasizes the importance of phrasing questions clearly, stating them slowly, and clarifying new terms to promote learning and understanding with all students, not just LEP and bilingual students. She also addresses the myth that LEP and bilingual students do not want to think or are not capable of higher order thinking. In fact she presents evidence to suggest just the opposite.

Michael H. DuBois' study, "Conceptual Learning and Creative Problem Solving Using Cooperative Learning Groups in Middle School Science Classes," develops from his desire to continue using cooperative groups while diminishing the problems he had faced with grouping. These problems included personality conflicts, academic impact of strongly divergent groups, planning time, and classroom time necessary for group organization. His study also uses an emergent research design. The emergent design, which has been gaining popularity recently, requires reflection throughout the study to guide and narrow the study rather than having the research method drive the study. Through a review of current theory on cooperative grouping and data generated from his classes, Mr. DuBois describes an approach for implementing cooperative groups that addresses many common concerns of classroom teachers. In the discussion of his results, he makes a strong case for cooperative grouping as an instructional strategy that enhances student motivation and learning.

Angie Williams' paper, "Long Distance Collaboration: A Case Study of Science Teaching and Learning," also explores an aspect of cooperative and collaborative learning. Mr. DuBois' paper, in conjunction with the next paper, highlights how two

Samuel A. Spiegel

Years Teaching: 8

Present Position: Program Director, Science FEAT

"My involvement with the Science FEAT program has been truly educational and rewarding. Some of the most rewarding moments have been when I have had opportunities to work in small groups or one on one with the teachers and their students."

"Research is a difficult yet worthwhile endeavor. Action research presents a potential tool for teachers to focus on enhancing their classrooms. It allows them to enhance education by focusing on the problems, constraints, and solutions within the local contexts of their schools."

teachers from the same school addressed similar issues in their research. Ms. Williams' study examines issues of cooperative groups within her classroom and interschool collaboration between her school and another middle school in Connecticut. Her descriptive study characterizes the teaching and learning benefits and difficulties associated with in-class cooperative group and long-distance collaborative activities. She provides suggestions and insight that will assist other teachers in implementing long-distance, collaborative efforts.

All of the research papers describe studies designed and conducted by middle school science teachers for the purpose of improving the teaching and learning of science in their classrooms. As the focus of our educational system shifts toward local planning and management, action research will provide a powerful tool for classroom teachers to analyze their classes and schools. This monograph is intended to provide guidance in conducting action research at your school. The final chapter, "So You Want to Do Action Research?" provides an overview of action research and guidance for classroom teachers, school and county administrators, university/college faculty, and other interested persons who want to conduct or encourage action research. The chapter includes advice from the sixty-five Science FEAT teachers and their administrators on conducting action research.

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Footnotes

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Effect of Technology on Enthusiasm for Learning Science

Jane L. Hollis
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Abstract

The effect of technology on students' enthusiasm for learning science (both at school and away from school) was investigated. Pre- and post-student and parent surveys, student and parent written comments, and teacher observations were used to record changes in enthusiasm for learning science during a six-week study period.

In this study, I investigated how the integration of technology into my middle school science curriculum would impact my students' enthusiasm for learning science. Enthusiasm for learning science can be defined as the students' eagerness to participate in science activities in the classroom, as well as away from school. My motivation for focusing on technology was twofold. First, I have had an interest in integrating technology into my students' studies of science for some time. Secondly, the funding for technological equipment and software recently became available. During the 1993-1994 school year, my school was awarded a $115,000 incentive grant to purchase equipment and software and to train teachers in the use of this software and technological equipment. One of the stipulations of the grant was that the equipment and software must be for student use.

According to Calvert (1994), American education is a system searching for solutions. Our children drop out, fail to sustain interest in learning, and perform below capacity. Some have argued that television is the culprit. Others have argued that computers may be the answer.

Today's middle school students have grown up in a technological world with television, electronic toys, video games, VCRs, cellular phones, and more. They are accustomed to receiving and processing information through multi-sensory sources.

I wanted to bring technology into my classroom and incorporate it into my

> *"I can only be confident in knowing that I am the facilitator of understanding, the presenter of an opportunity to explore, discover, and compile knowledge."*

science curriculum using multimedia computer presentations. Barbara ten Brink (1993) noted, "... students look to us [teachers] to prepare them for an increasingly technological world. Fortunately, with videodiscs, we are meeting the challenge by delivering curriculums in ways that engage, motivate, and thrill our students." In this study my students had an opportunity to use assorted multimedia technology as they explored a segment of a middle school science curriculum.

Theoretical Frameworks

Learning is an extremely complex human process. During my twenty-four years of teaching I have used many strategies to enhance student learning and to teach new concepts. I am still not convinced that I thoroughly understand how children learn. Yet, at this point, I do believe children learn through experiences. They build on past experiences and previous knowledge to process new concepts. As children redefine old understandings of concepts and integrate new experiences into their old concepts, they mature in their knowledge and understanding.

In their early experiences of the world pupils develop ideas which enable them to make sense of the things that happen around them. They bring these informal ideas into the classroom, and the aim of science education is to give more explanatory power so that their ideas can become useful concepts (National Curriculum Council, 1989).

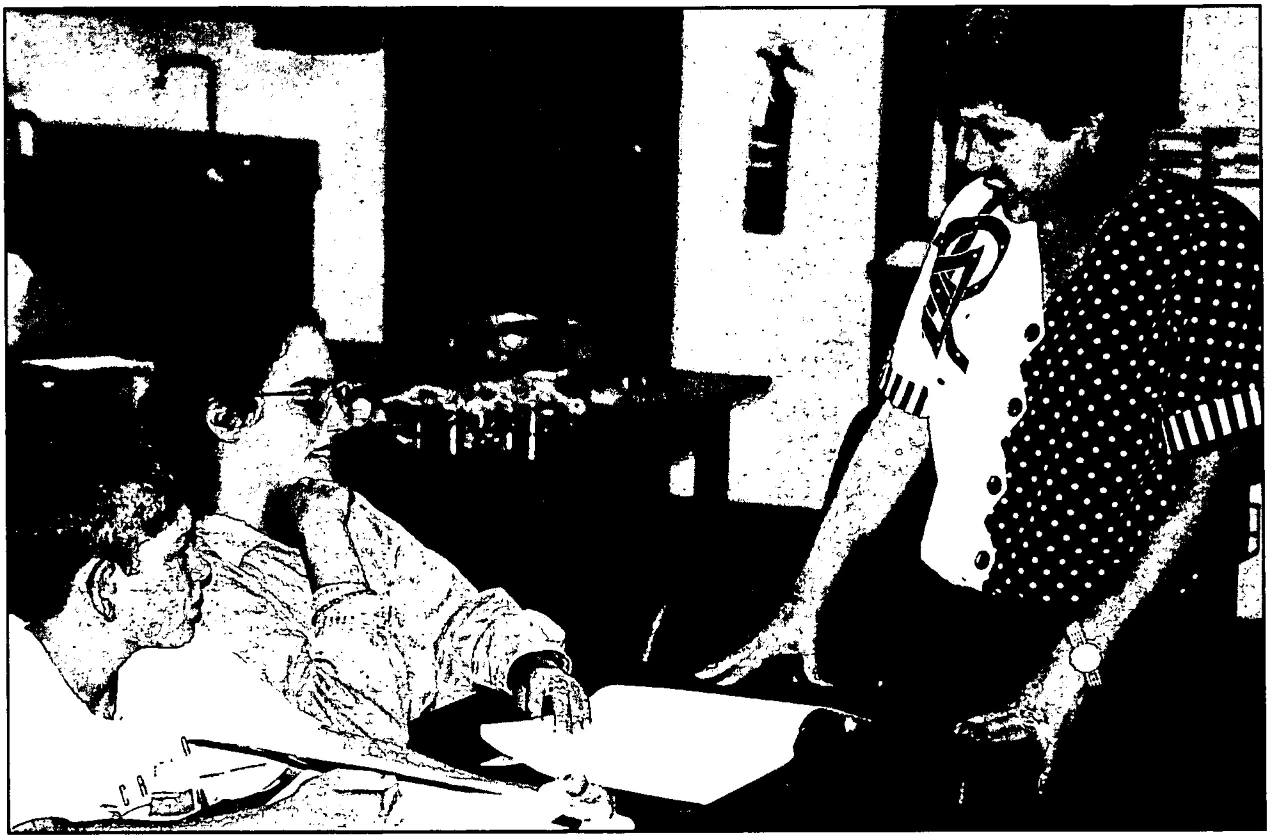
In a discussion in "Discovery, Enquiry, Interaction, Constructive Learning–What's the Difference?" Harlen (1993) suggested that there is no single solution to the complex matter of education. According to Harlen, the objectives of learning are various and so should be the approaches to teaching. A combination of approaches is often the most effective education.

As a teacher I cannot assume that I am the giver of knowledge. I can only be confident in knowing that I am the facilitator of understanding, the presenter of an opportunity to explore, discover, and compile knowledge. A student's willingness to learn and his/her enthusiasm for discovering knowledge and developing understanding will dictate the level of student learning.

Students need to be actively involved in their education. Interested and enthusiastic students are more willing learners, and I believe willing learners become active participants in their own instruction. As children become more actively involved in their learning, they develop interest and enthusiasm for the content and/or the process that is their conduit for acquiring new knowledge.

Through this study I hoped to find that multimedia technology would be the conduit that my students needed to acquire new knowledge, develop new concepts, and express strong understanding. Through the integration of multimedia computer software I hoped to tap the enthusiasm of my students towards learning science and make them active participants in their own instruction.

> *"As I watched and listened to my students during the study, it was apparent very early that they were thoroughly enjoying using computers and developing their presentations."*



The Study

I teach eighth grade, comprehensive science (an integrated life, earth/space, and physical science program) at a middle school in a rural North Florida county. I am a member of a four-teacher team, along with one math, one history, and one language arts teacher. We instruct 130 students who make up the academic team (Team E). Although I teach five science classes a day, I targeted my seventh period class for my research.

This class is made up of thirty-one average and above-average science students. I chose this last class of the day for purely logistical reasons. With only one computer in my classroom, I needed to borrow eleven computers daily from neighboring teachers. Seventh period was the most agreeable period to the other teachers. An extra advantage of using the last period of the day was that students could return the computers after the final dismissal bell and not take valuable class time for this task.

My data was generated by comparing these students' attitudes toward learning science at the beginning of the school year, during my study, and at the conclusion of the study period. The students' attitudes and reactions were documented by the students themselves, by their parents, and by my own observations. Collecting data from three sources allowed for triangulation of the findings in this study. Data triangulation helped reduce the likelihood of error in the findings when similar results are reported from two or more of the sources. I surveyed all of the class members and their parents at the beginning and the end of my study.

During the first six weeks of school, I reviewed the scientific method, the metric system, scientific measurement, and laboratory safety. At this point multimedia technology was not part of the curriculum. Some hands-on activities were used at this time. The students worked both individually and in groups. To determine each student's level of enthusiasm for learning science, during this time I administered a survey which contained the following questions: How do you like learning science? How have you liked learning science so far this year? How enthusiastic are you about exploring science at home? Students were asked to rate their answers to each question using a scale of 1 to 5. The scale was represented by (1) a very unenthusiastic response, (2) an unenthusiastic response, (3) indifference, (4) an enthusiastic response, and (5) a very enthusiastic response.

Additionally, I sent home parent surveys with each student in order to solicit and record the parents' opinions concerning their child's enthusiasm for learning science. The survey included two questions: How enthusiastic is your child about learning science? How enthusiastically does your child do science activities at home? I used the same rating scale for the parents that I used with the students.

At the beginning of the second six weeks I introduced a unit on oceanography. Oceanography was used as the unit of study primarily because of the number of resource materials available to the students through the media center. It was during this unit that I began to integrate technology into my curriculum. As the unit was introduced I asked my students to look through the oceanography chapters in their textbooks and make a prioritized list of the eleven subtopics in physical and biological oceanography they would like to study. Students were grouped according to their interest as much as possible and were assigned to work in groups of two or three to develop a multimedia presentation that would be used as an instructional tool for the other students.

During this period I began to introduce them to the multimedia computer program, HyperStudio (Wagner, 1994). HyperStudio is a program that allows the user to combine sound, graphics, and animation with text to make creative and entertaining presentations. The introduction of HyperStudio and the development of the student presentations took six weeks to complete.

Throughout the study I observed and made notes as to how the students were working and their reactions to class. These observations were guided by several questions: What problems are the students encountering as they work on their multimedia presentations? Are the students having problems with content? Are there problems working in groups? Are they having problems using the multimedia software? These observations and notes were useful in making sense of any fluctuations I found in the end-of-study student surveys. I was able to discern the source of problems so that content difficulties or friction within groups was not confused with a loss of enthusiasm for technology.

At the end of the oceanography unit I had each group of students share their presentations with the rest of the class. After the presentations, each group was asked to comment to the class on how they enjoyed developing their works. I noted these student comments as they were presented to the class. Each student was also asked to make written, individual comments to me, responding to the following questions: What problems did you encounter while you were developing your presentation? What did you learn about your topic while you were developing your presentations? Did you learn from the other students' presentations? Would you like to do another presentation on some other topic in science? Again I surveyed the parents of these students to gain information about their child's interest in learning science. I asked the following questions: Is your child talking about science at home? Is your child eager to share what we are doing and learning in science class? Do you feel that your child is learning science? Why or why not? How enthusiastic is your child about learning science? How enthusiastically is your child doing science activities at home? I again surveyed the students asking the same questions that I had asked in the beginning survey.

Results

As I watched and listened to my students during the study, it was apparent very early that they were thoroughly enjoying using computers and developing their presentations. Students rushed to class, eager to get started on their presentations. There were no tardies to class during the study period, while there had been fourteen tardies to class in the month before the study period. Normally these students would ask to pack up their things three to five minutes before the end-of-the-day bell sounded. During the study period I had to insist that they stop work, and often they ignored me and worked through the dismissal bell. Several times a week students would ask to stay after school and work on the computers. One group worked for an hour and a half after school and would have stayed longer, but I had to go lock up for the day.

Twenty-eight of the thirty-one members of the class responded to the pre- and post-study surveys. One member of the class withdrew from school during the study period, and two students did not return their surveys.

The pre- and post- study attitudinal surveys show an increase in my students' enthusiasm for learning science (see Table 1 on the following page). In the pre-study survey, 75% of the students were enthusiastic or very enthusiastic about learning science, while the post-study survey showed 96% of the students enthusiastic or very enthusiastic about learning science. When the students were asked how enthusiastic they were about doing science away from school, their responses showed a decrease in enthusiasm for learning science away from school after the study as compared to pre-study data. On the pre-study survey, 49% of the students were enthusiastic or very enthusiastic about doing science away from school, while only 28% of the students were enthusiastic or very enthusiastic on the post-project survey. Students' comments on the post-study survey concerning their diminished enthusiasm for learning science away from school centered around the lack of availability of computers and software at home. Only eight students had access to a computer at home, and only one student actually had the HyperStudio computer program to use at home.

When the students were asked how they had liked learning science so far this year, their responses again showed an increase in enthusiasm for learning science. On the pre-study survey, 70% of the students were enthusiastic or very enthusiastic about learning science during the first half of their eighth grade year, while 81% of the students were enthusiastic on the post-study survey.

The students were questioned before and after the study about their likes and dislikes while learning science this year in an attempt to determine the impact that the topic oceanography had on their enthusiasm for learning science during the study. The students' responses all centered around the method of instruction rather than the curriculum. Their responses made reference to lectures, note taking, group work, projects, lab work, using computers, etc. Since the students did not mention content in their likes or dislikes, I do not think the topic used during this study had a significant effect on the results of this study.

The increased enthusiasm of my students was made apparent during the study through two separate incidents. The first incident occurred during the second week of the study. Seven of my students missed class one day a week to participate in a gifted program. These students told the teacher of the gifted program that they did not want to miss class while they were working on a computer presentation. However, these students were not allowed to miss gifted class and were very unhappy.

The second incident occurred during the sixth week of the study. The entire student body was being rewarded with an incentive assembly. They were allowed to watch or participate in a student versus faculty basketball game instead of attending sixth and seventh period. Seventeen of my students in the seventh period study group asked for permission to miss the incentive assembly and spend the two hours in science class working on their computer presentations.

Enthusiasm for learning science was also reflected in student comments during and

Table 1

Student Responses to Pre-Post Surveys

Number = 28 students

Pre-Post Survey Questions

1. How do you like science?
2. Do you do science activities away from school?
3. How have you liked learning science so far this year?

	Very Unenthusiastic				Very Enthusiastic
Question 1 Pre	0%	0%	25%	46%	29%
Question 1 Post	0%	0%	4%	32%	64%
Question 2 Pre	10%	28%	14%	17%	32%
Question 2 Post	25%	21%	28%	28%	0%
Question 3 Pre	0%	10%	17%	53%	17%
Question 3 Post	0%	0%	21%	71%	10%

after the study. Some of these comments were as follows:

- "Everyone gets into the topic more when they use HyperStudio."
- "It's creative and it is fun."
- "It's a lot more fun working on a computer than in a book."
- "You get to make friends with people and learn what they know. It's a different way of teaching and I think it keeps our attention better."
- "I think anyone could benefit from studying a topic in science by developing a multimedia presentation."
- "It is like doing book work but fun."
- "I enjoyed doing the multimedia presentation. I feel it was very helpful and fun at the same time but educational."
- "It was a fun learning experience."
- "Computers are millions of times more fun than book work."
- "Using books gets boring, but you can learn by computers at the same time if working on them."
- "There is so much you can learn off computers that you just can't from books."
- "With books it gets boring after a while, but with computers it's fun and exciting. Computers make learning fun."
- "I find it very interesting to work on computers. It makes me think a lot."

Table 2

Parent Responses to Pre-Post Surveys

Number = 10 parents

Pre-Post Survey Questions

1. Is your child enthusiastic about learning science?
2. Does your child do science activities at home?

	Very Unenthusiastic				Very Enthusiastic
Question 1 Pre	0%	20%	20%	30%	30%
Question 1 Post	0%	0%	40%	30%	30%
Question 2 Pre	0%	40%	20%	20%	20%
Question 2 Post	0%	0%	40%	30%	30%

- "It made me enjoy looking up information for my presentation."

Parents were surveyed before and after the study. The same ten parents completed and returned both the pre-study and post-study survey. The parent surveys (see Table 2) showed that 60% of the parents considered their children enthusiastic or very enthusiastic about learning science both before and after the study. These surveys did show that 20% of the parents felt that their children were unenthusiastic about learning science before the study, while none of the parents recorded their child as being unenthusiastic about learning science after the study. When asked how enthusiastic their child was about doing science activities at home, 40% of the parents noted that their children were enthusiastic or very enthusiastic about doing science activities at home on the pre-project survey. On the post-project survey, 60% of the parents reported that their child was enthusiastic or very enthusiastic about doing science activities at home.

Several parents added comments to their post-project surveys. Their comments were as follows:

- "I feel the more 'high tech' the equipment, the more important the subject will be to the students. If they think science is "cool," because the equipment they use is "cool," then more learning will take place and interest will remain high."
- "As our society is becoming more computer dependent our students need an early start."
- "Hands on is fine, but they need the basics too. We also need to have more computers in the classroom to be effective."
- "It seems to generate more enthusiasm for science and learning."
- "My daughter talked more about science during the use of computers."

Discussion

y findings show a marked difference in the opinions of the parents as compared to the opinions of the students. The parents perceived no change in the enthusiasm for learning science, while the students noted a 21% increase in enthusiasm for learning science. The parents recorded a 20% increase in enthusiasm for doing science activities away from school while

> *"Seventeen of my students in the seventh period study group asked for permission to miss the incentive assembly and spend the two hours in science class working on their computer presentations."*

the students recorded a 21% decrease in away from school science activities.

The differences between parent results and student results could be a reflection of the communication gap between parents and students of this age. The parents equated the increase in conversations about science and planning of presentations that their children were doing at home with increased enthusiasm. The students on the other hand were enthusiastic about working with the computers but did not consider their conversations at home and their planning of presentations actually "doing science activities." They indicated instead a frustration about not having more access to computers and software to "do science" at home.

The results of this study support the notion that the level of enthusiasm for learning science was increased through the incorporation of computers and multimedia software into the middle school science curriculum. The integration of technology will be an ongoing pursuit in my classroom. The enthusiasm it brought to my students has been infectious. Students and parents of students in my other four classes have asked when they would have an opportunity to work with computers. Teachers throughout the school have become interested in integrating technology into their curriculum. Through the insistence of my co-workers, I have taught two HyperStudio training sessions for twenty-one teachers and teacher aids from all academic disciplines as well as areas such as special education and the media center. Seventeen of my study group students volunteered to assist me with these teacher training sessions.

"The integration of technology will be an ongoing pursuit in my classroom."

Jane L. Hollis

Years Teaching: 25

Present Position: 8th grade Comprehensive Science

"I really enjoy dealing with nature. I especially love the water and have spent time as an instructor at various marine biology summer camps. I guess my dream someday is to become a naturalist."

"I had more fun doing action research than I have had in my science classroom in a long, long time. It gave me a second wind after 25 years on the job."

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I believe that multimedia computer technology could enhance all of the core curricula. In English, it could be used to illustrate creative writing assignments. Social studies classes could use multimedia to develop geography or history presentations. One of my study group students used HyperStudio to develop an award-winning math fair project. Adding enthusiasm to learning in any discipline through the use of technology is limited only by the ability of a school to provide funding for the equipment, adequate software, and teacher training. The availability of equipment when doing class projects involving technology is critical.

This active research study was made possible through the cooperation of my fellow teachers. By borrowing computers from neighboring classrooms, each group of students that developed a presentation had a computer to use throughout the study period. Ideally, computers and software should be made available to students and teachers for check-out and use at home as well as at school through the school's media center. The difficulties encountered in this study (all of which involved the logistics of accessing the equipment needed) were far outweighed by the academic benefit to my students.

This active research study not only increased my students' enthusiasm for learning science, but it also rekindled my excitement for teaching. During the pre-study period, I was extremely apprehensive and began to question the feasibility of the study. Once I began, however, I found myself looking forward to the hectic pace and the commotion that resulted from eleven groups of middle school students using sound, animation, and graphics to develop multimedia computer presentations.

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What Types of Learning Activities Are More Likely to Increase the Involvement of Non-Participating Students?

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Abstract

This research was a study of the effect of different types of learning activities on the participation rate of non-participating students. Forty-three individual learning activities were analyzed. Results indicated that participation was best when the learning tasks were assigned as cooperative group tasks, when there was a set time limit, and when the work had an element of creativity.

Purpose and Background

Why isn't Brian taking an active role in learning? Why isn't he participating? What's the reason for his failure to turn in work? How can I induce him to become involved in class activities?

Josh is working! He's actually participating in the activity. He's got some work down on paper. He's helping others in his group. He'll make a passing grade for this day's work!

What's the difference? What makes students take part or opt out? As educators we go to great lengths trying new activities, new approaches, new strategies to meet the needs of all our students. Nevertheless, there are always some students who do not participate in the learning activities offered.

Non-participation is a constant source of frustration for teachers. We talk to the student, meet with his parents, observe him in the classroom. We see the student's potential, and we know the ability is there, but somehow the desire to participate is not. Grades, parental disapproval, fear of retention, peer pressure—nothing has an effect. At this point, teachers often throw up their hands and say, "If he won't do the work, let him fail. I wash my hands of him. I'll just seat him at the back of the class and ignore him. If he doesn't bother me, I won't bother him." This laissez faire policy benefits neither teacher nor student. The challenge remains and must be addressed. What will work with these students? What tasks will motivate? What classroom activities will prove so irresistible that students will choose "*to do*" instead of "*not to do*"?

The purpose of this research was to explore the issue of motivating non-participating students and to determine their feelings and attitudes about different types of classroom tasks. Specifically, I wanted to learn what types of learning activities are more likely to increase the involvement of non-participating students. In the end I found that the answer was not merely a matter of selecting appropriate tasks.

I have always felt a strong link between participation and motivation. I feel that students who are motivated to learn will be more likely to participate in learning activities and, conversely, that a lack of motivation to learn will be common in non-participating students. Learning about one might yield insight into the other.

Brophy (1987) characterized motivation as having two essential components. One is what he terms the *trait* of motivation, "an enduring disposition to strive for content knowledge and skill mastery in learning situations" (p. 40). The other is the *state* of motivation which exists "when student engagement in a particular activity is guided by the intention of acquiring the knowledge or learning the skill that the activity is designed to teach" (p. 40). Both forms of motivation intertwine to become a student's *motivation-to-learn*, an "acquired competence developed through general experience but stimulated most directly through modeling, communication of expectations, and direct instruction or socialization by significant others (especially parents and teachers)" (Brophy, 1987).

> *"What classroom activities will prove so irresistible that students will choose* 'to do' *instead of* 'not to do'?"

Research into motivation, including studies by Alderman (1990) and Knight & Wadsworth (1994), has found that poorly motivated students are generally inefficient learners who do not possess the usual repertoire of independent learning strategies. They may have experienced a long-term pattern of classroom failure that has caused them to give up (Clifford, 1990). Frequently they consider themselves helpless, unable to attribute their own actions to subsequent success or failure (Alderman, 1990). When asked why they fail, students frequently respond that they don't know (Alderman et al, 1989).

Poorly motivated students have special needs. They may not be able to automatically relate old and new experiences, and, therefore may require remediation in such areas as information acquisition, i.e., listening; information organization skills such as note-taking and graphic organizers; and information utilization, specifically test taking and problem solving (Knight & Wadsworth, 1994). In addition to remediation of deficient skills, students with low motivation-to-learn require a supportive classroom environment. Essential within this environment are positive teacher expectations, opportunities for success, goal and attribute settings, a minimum of external constraints, plentiful informational feedback, tolerance for error-making and correction, an appropriate level of challenge, and remedial socialization.

Selection of learning activities is another critical point in motivating students to learn. Some attributes of activities that make tasks inherently motivating to students include the following:

- They provide appropriate levels of challenge. Students quickly become bored if the task is too easy and frustrated if it is too difficult.

- They incorporate meaningful learning objectives. Activities should teach something students consider worth knowing, either in its own right, or as a step toward a higher objective.
- They are adapted to student interests. Whenever possible, students should be involved in the design and selection of learning tasks.
- They contain an element of choice. Again, where possible, students should be offered a choice of assignments, or alternate ways of meeting the requirements of the activity.
- They offer an appropriate level of social interaction. Activities should be designed with ample opportunity for students to share knowledge, clarify meaning, and communicate their learning with others.
- They allow for active participation rather than passive response.
- They include novelty, fantasy, simulation, or game-like elements.
- They allow for the creation of finished products.
- They rely more on formative than summative assessment.

(Ames, 1992)

> *"Clearly, society's strong influences affect our students' lives as learners."*

The Study

This study was undertaken in the fall of 1994. The settings were my eigth grade general science classes at a middle school which serves mainly affluent, suburban, white collar neighborhoods, with a smaller number of students from lower to middle class homes. Our students typically do not want for material things, but they increasingly lack traditional parental support. The number of latchkey children (children who are home alone after school from 3:00 PM to 5:30 PM or later) is escalating. Furthermore, children too often are left to supervise younger siblings while single parents work or pursue their own goals. Increasing numbers of parents seem too busy to be involved in their child's education. Conference requests are more frequently answered with, "I don't have time to come to the school." In addition, we often learn that parents fail to scrutinize midterm reports, report cards, or other communications from school. An alarming number of our students have experienced divorce and the adjustments involved with acquiring stepparents. Many are living in single-family homes. Clearly, society's strong influences affect our students' lives as learners.

Selecting Students for the Study

Selecting a target group of students to study was a critical early task. I looked for a set of students who showed a pattern of frequently opting out of learning activities. It is conceded that motivation-to-learn is a complex mixture of personality, past experiences, and preferences, and that it is not valid to equate failure to participate with lack of motivation-to-learn. However, because I was studying students' attitudes about participation in various types of learning activities, lack of participation was the key to selecting my subjects.

Since I started the year with 154 students I'd never met before, one valuable source of data was the previous year's science teacher. At our school, teams of students stay together from grades six to eight. All students, except those new to our school, had the same seventh grade science teacher. I interviewed her, soliciting input about students whom she described as frequently choosing not to participate in learning activities. To complement this input, my early classroom observations were crucial. Reviewing records of the first six weeks of school (before the study began) provided me with information concerning students' degrees of participation in learning activities. These records included checklists of work completed, skills databases, and gradebooks. At the close of the first six weeks I was able to select my initial target group of eight students.

That initial selection proved to be the easy part. Narrowing it down beyond that became very frustrating. First, I eliminated students who were in any learning-related Exceptional Education programs (specific learning disabilities, emotionally handicapped, etc.). I felt that these exceptionalities might in themselves explain the students' lack of participation. Next, I regretfully eliminated one of the targets because of his near daily truancy. I felt that he would not be present in class enough to provide me with worthwhile data. By this point the four target students who remained were boys. Although there were girls who habitually did not participate, the *degree* of non-participation was markedly less. In narrowing the field down from four to two target students, I eliminated one because I decided his status as an underachieving gifted student, with decidedly different interests and preoccupations, made him unrepresentative of my class as a whole. The other I eliminated simply so I could consolidate my observations into two class periods. I was left with two boys I consider wholly representative of the "typical" underachieving, non-participatory students I have encountered over sixteen years of teaching. For this study I have assigned to them the pseudonyms Brian and Josh.

Early in the selection process I was discouraged to learn that most of the underachieving students shared a number of common characteristics. As I began to work with Brian and Josh, this was confirmed to me many times. Each of the boys had a long history of failing grades and discipline problems behind him. Both came from families undergoing divorce, remarriage, and stepparenting. Both were above average in intelligence and had started off in the early years with good grades and conduct marks. By fourth grade, however, the current pattern of failure to do classwork or homework was well established in their records, along with an extensive list of discipline referrals, mostly for classroom disruption during instruction or work time. Numerous parent conferences were documented over the years. In each case, at one time or another, the parent expressed a lack of ability to control or influence the

child. "I can't make him do his work," and "He won't come in at night and I can't make him," were two comments recorded. At the start of this study, Brian's family was refusing any communication with the school.

Conducting the Study

I had planned to begin the formal part of the study at the start of the second six weeks' grading period. Obtaining school board permission to conduct classroom research, however, took much longer than I expected. Delaying the start of data collection didn't necessarily have a negative effect. It allowed me ample time to set the classroom climate and get to know my students. I was able to observe Josh and Brian as they worked through a variety of different tasks related to the nature of science, the scientific method, and what I call "tools of science" (measurement, charting and graphing, laboratory procedures). We also worked on study skills, research skills, computer applications, and some interdisciplinary units. All in all, it was a mixed bag of activities and scientific disciplines and a good balance for my initial observations. When my research permission arrived, I was satisfied I had established a rapport with my classes as a whole, and with Brian and Josh specifically. The beginning of the third six weeks marking period was the time to begin.

Collecting the Data

Data collected for this study came in several forms. One important form was the daily activity analysis sheet. This form was designed so that I could describe the activity in detail, code for category of activity and degree of participation, and add comments as needed. It yielded a great deal of information. My daily journal entries and informal anecdotal records were also very valuable. The journal was my reflective writing of impressions at the end of each day. The anecdotal records were my on-the-fly, write-it-down-before-I-forget-it notes that I jotted down on the spot when I noticed something about either of my target students. Perhaps I overheard Josh make a revealing comment about why he didn't complete an assignment. Or perhaps Brian, who rarely volunteers in class discussions, raised his hand and gave his input. Those events were worth recording before I lost the immediate impression or the feel for the context.

Surveys were useful as I sought out the students' own feelings about the activities assigned. During the study, students were surveyed four times, at the end of various types of learning tasks. The surveys contained general statements about the day's class, as well as statements concerning specific activities. Typical items included: "I enjoyed today's class," "I feel I learned a lot today," and "I can really use what I learned today." Students responded to this section by assigning a number from 1 (strongly agree) to 5 (strongly disagree). Open-ended questions were also included: What is there about this activity that you enjoyed? What is there about this activity that you especially did not like? Given a choice, what kinds of activities would *you* choose to help you learn this material? These ungraded evaluations have been a regular part of my classroom routine for four years now, and once students are comfortable enough to know they can be open and honest in their evaluations, I get meaningful insight and thought provoking input about students' feelings about the class, individual lessons or activities, dynamics within a co-op group, or any number of other concerns they might have.

The surveys were anonymous, except in the case of Josh and Brian. As I distributed the forms I discreetly coded theirs so I could isolate responses. Results of the surveys allowed me to get a picture of how the classes as a whole viewed the day's work. I was then able to compare this picture to the impressions of my target group. Checking their survey responses against work checklists also lent interesting comparisons.

Initially I expected that interviews, both of the target students and of a sample from the team as a whole, would provide valuable insight into motivation-to-learn, what learning had taken place, and attitudes about the class and school in general. I planned to interview Josh and Brian at the start of the study and once a week thereafter, concentrating on topics related to participation–why a student completed this task and not that one, what about the activity was attractive, or what caused a certain interaction? I planned to interview a random sample of two other students from the same class at the same time. I felt that interviewing students outside the target group on the same day and from the same class period would help me better compare attitudes and perceptions. For example, if both Brian and the non-target students reported that the assignment was "over their heads," and "too hard," it would tell me something different than if Brian alone reported that perception.

After the very first interview I reconsidered. The boys were veterans. They have been "interviewed" and questioned about their work habits and lack of participation since elementary school and by everyone from teachers to guidance counselors to principals. They were suspicious, and they were defensive. Each closed up immediately and gave only safe, noncommittal answers.

> *"The boys were veterans. They have been 'interviewed' and questioned about their work habits and lack of participation since elementary school."*

Teacher: "What did you think about today's class?"

Josh: "I don't know."

Teacher: "What would you have chosen to do if you had wanted to learn about volcanoes?"

Josh: "Nothin."

I considered the other data I was collecting and decided to abandon interviews and rely on the measures of work completed along with the secretly-coded survey results.

Coding of Data

Data collected in such diverse forms had to be coded for analysis. Codes for indicators of data related to student participation in learning included the following:

O No Attempt was made on the assignment.

A (Attempt) The student attempted the assignment.

P (Partial) The assignment was partially completed.

C (Completed) The assignment was completed.

Early on I realized that the many different types of learning activities assigned could be broken down into general categories so it

would be possible to make conclusions as to the general types of tasks. The assignments fell into six general categories:

L (Literal) Seek-and-Find comprehension questions, drill-and-practice activities requiring literal comprehension, computer-based drill, etc.

I (Interpretive) Higher level questions, summarization, reflective writing, active reading journals, minute papers, etc.

T (Time Limit) Activities completed under a time limit, under my direct and close supervision, often with immediate discussion or feedback involved–quizzes, tests, other assignments with short-term time limits within the class period.

C/V (Creative/Visual) Activities inherently creative or visual in nature, such as designing an imaginary machine or drawing a diagram to demonstrate knowledge of the layers of the atmosphere.

Lab (Lab) Laboratory activities based either on process or result.

IND (Independent Reading or Study) Activities requiring independent application of study skills–reading a current events newspaper article for later class discussion, rereading study materials to prepare for a quiz, or taking notes from lecture.

Additional general codes evolved as the data were collected. These codes included:

H (Homework assignment)

GR (Cooperative learning or other group assignment)

- ★ (Alert!) The assignment had a special quality that made it unique or different.
- ! (Special note!) Noteworthy data that may help develop a conclusion or add insight. For example, a comment by Brian as to his feelings about an assignment, or completion of a particular written assignment by Josh—who generally does not perform these types of tasks.

6 Analyzing the Data

I did some of the early steps in analysis while the data was still being collected. Each day, during or immediately after each target student's class period, I filled out an activity analysis form for both Brian's and Josh's class periods. On it I described the activity, coded it by general category, and coded the degree of Brian and Josh's participation (if the assignment was completed in class or I could determine participation by observation). I also noted whether it was a cooperative group or other group assignment and added any comments I felt necessary. In cases where the assignment was completed or evaluated at a later date, I went back to the forms at that time and added codes for Brian and Josh's degree of participation.

As each survey was completed, I averaged the numeric scale portion and compared the class average scores to the scores of Brian and Josh. I then wrote an interpretation of the comments given on the open-ended survey questions. In this interpretation I noted the general responses of the classes as a whole and compared them to Brian and Josh's. I also looked for relationships between Brian and Josh's survey comments and their degree of participation for that day. In other words, I looked for indications that their feelings about the task influenced their participation or vice versa. Finally, I earmarked for later review any surveys with noteworthy or insightful comments.

At the end of the period of study, the first overall analysis I undertook was a basic determination of how many learning activities each target student participated in compared to the total assigned. Then I tackled the assignment analysis forms. There were eighty-six individual sheets, representing forty-three assigned learning tasks for the two target students. I sorted the sheets into the six main categories of activities and calculated how many activities in each category were completed or attempted by each student. This gave me a preliminary look at Brian and Josh's patterns of participation in each general type of activity.

My next step was to go back to the data and look for other patterns, such as whether or not the day of the week was correlated to participation, and whether or not the design of the activity—individual, whole class, or cooperative group work—made a difference. I took another look at the survey results to see if lack of participation resulted in negative survey responses or if participation resulted in more positive ones. I also sought out whether degree of success on a particular activity was related to how negatively or positively the activity was perceived.

Looking for any insight that might explain Brian's and Josh's decisions on whether or not to participate, I went to my journal entries. I sought out observations of behavior changes, moods, verbalizations, interactions with other students, anything that might indicate a pattern. As I reread the entries, I coded them using the same codes I had used for the assignment forms. In addition, I used marginal comments and color-coded stickers to allow me to correlate

Figure 1

Overall Participation

Participation vs. Total

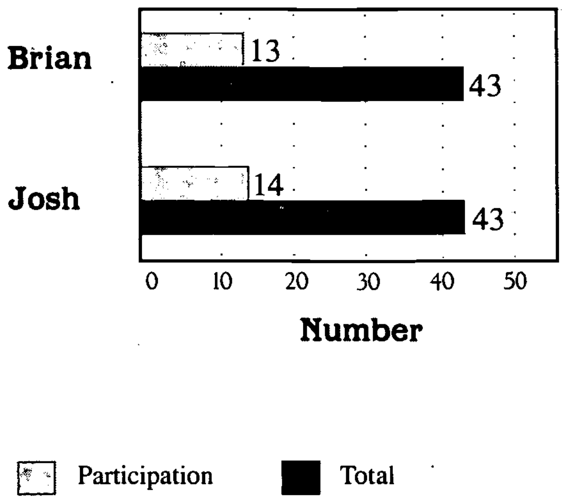
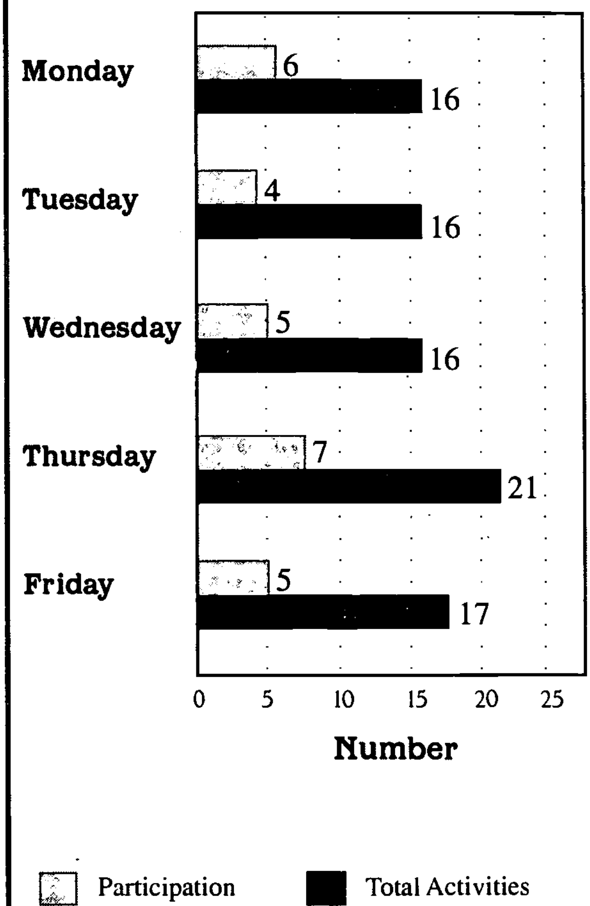


Figure 2

Participation by Day of the Week Compared to Total Activities



the journal data to specific assignment forms.

I found I had to go back to the activity analysis forms and the survey results several times to try out different leads and propositions. For example, at one point I wondered if the data would support a pattern of better participation on Mondays and Tuesdays. After going back to the raw data and looking at the dates/ days of the week, this proved to be incorrect. I followed several such false leads.

Results

My data indicated that during the study period, Brian and Josh completed or attempted twenty-seven of eighty-six assigned learning activities (see Figure 1). I found no clear indication that participation was better on any given day of the week (see Figure 2). Neither student had a good record of participation in activities assigned as homework. Brian completed three of eleven during the data collection period, Josh completed none.

Breaking the learning activities down by what I call "work environment" (meaning whether the activity called for *individual work, whole class participation*, or a product

Figure 3

Work Environment: Whole Class, Cooperative, or Individual

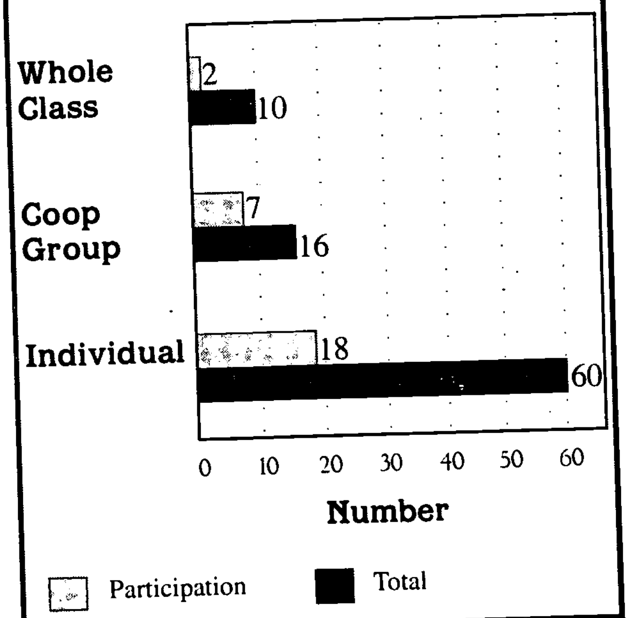
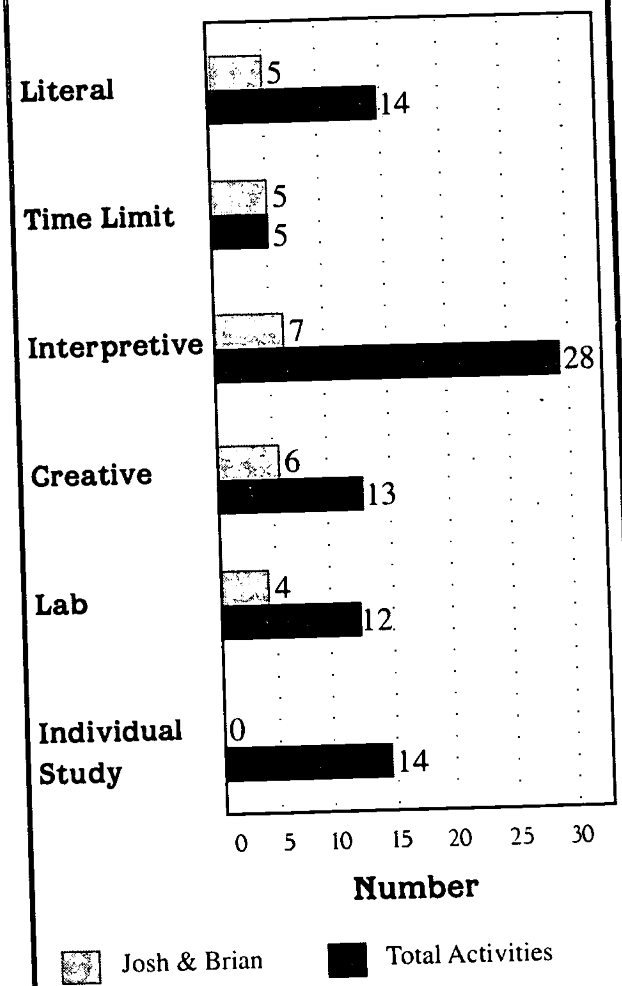


Figure 4

Participation by Category Compared to Total Number of Activities



based on the efforts of a *cooperative group*) showed that the target students participated most frequently, 44%, when the work was done in a group setting. When the activity called for individual completion, participation dropped to 30%, and participation in whole class activities dropped to 20% (see Figure 3).

Regardless of work environment or whether the activity was assigned in class or as homework, neither student completed or even attempted any activity that called for independent reading or study. This included reading of textbook material, newspaper/current events articles, and computer-based instructional materials, as well as taking or rereading notes, flashcards, vocabulary, etc., to prepare for quizzes or tests. Literal activities, including seek-and-find comprehension questions, basic lower order literal questions, fill-in-the-blank activities, etc., yielded a participation rate of 36%. There was only a 25% rate of participation in Interpretive activities which included summarization, paraphrasing, reflective writing, active reading journals, and similar assignments. The Creative/Visual category, with activities such as

Table 1
Survey Questions

Ranking: 1=Strongly agree 2=Strongly Disagree	Class Average Score	Target Student's Average Score
I enjoyed today's class.	2.4	3.5
I feel that I learned a lot today.	2.6	4.0
It was too hard.	3.8	2.5
I am interested in this topic.	2.5	3.5
I can really use what I learned today.	3.1	5.0

drawing diagrams, building models, or creating inventions, rated a 46% participation rate, and Laboratory-based activities were attempted or completed 33% of the time. These results are shown in Figure 4.

The most interesting pattern that appeared in analyzing data related to the six categories of learning activities, was that there was 100% participation by both students in activities in the Time Limit category. These were activities performed under my direct supervision, sometimes one-on-one. Frequently, they were quizzes or other summative evaluations. Two were assigned as pre-laboratory activities with the understanding that completing them would be the "ticket" to the laboratory. Two were computer-based instruction with the built-in incentive that, when they finished with at least an 85% success rate, they could explore other multimedia science programs.

The survey results for the numerically ranked questions showed significant differences in Josh and Brian's scores and the average scores of their classmates (see Table 1). Brian and Josh responded to every question with a much higher rating than the classes as a whole. They rated the difficulty of the activities much higher than the class average. Their scoring of whether they felt they had "learned a lot today" was significantly lower than the average. I was especially interested to see that Brian and Josh responded to the question, "I can really use what I learned today," with a uniform rating on all eight of their surveys of 5, strongly disagree. The overall average for the 244 surveys was 3.1.

These negative trends were apparent, as well, in the open-ended questions. In response to the question "What did you like least about this activity?"only twelve of 244 surveys listed responses of "the work," or some variation of the same. Four of them were Brian and Josh's. On the eight survey sheets completed by Josh and Brian during the study period, *both boys indicated each time* that they thought the activity was "boring." The response "boring" was indicated on only 37 of the 244 survey sheets. In response to the question "What did you like about today's activity?" Brian and Josh responded "nothing" five of eight times. Only 31 other

> *"Participation was lowest in whole-class or other large-group settings."*

"nothing" responses appeared on the 244 sheets. I saw no correlation on the survey for that day between success on a given activity and a more positive response. Likewise, participating or attempting to participate did not result in more positive survey responses than did not participating. The survey results were uniformly negative.

Conclusions

My initial literature search for this study indicated that underachieving, unmotivated students are frequently deficient in basic skills. Both Josh and Brian fit that profile. Both show a real lack of what I term "school survival skills." They began the year with poor organizational habits. They frequently lost books and papers, arrived in class without basic materials, didn't use our team assignment calendars, or keep their assignments and materials sorted and organized. Folders, papers, assignments, all were wadded up at the bottom of their bookbags. It was evident, too, that neither student was skilled in listening or interpreting oral or written directions. Neither had learned any form of note taking, from graphic organizers to outlining. Basic test-taking strategies were foreign to them.

Both Brian and Josh had been identified, on the basis of a checklist-type instrument, by school officials as being at risk due to low self-esteem. Neither willingly made eye contact during conversation. Both walked slumped, with a shuffling gait and sprawled, head lowered, in their seats. Neither was well-groomed or, some days, even clean. I had heard each of them refer to himself as "dumb." Each bragged and made a show of the low grades they received. I noted in my journal that their disruptive behaviors were more evident on days when the activities were of the types in which they were least apt to participate. I wonder if the misbehavior was a response to the possible embarrassment of not being able to keep up, let alone compete?

According to the study data, the first obvious trend was that both Brian and Josh participated much more frequently in activities that were assigned in a cooperative group or laboratory group setting. Their survey responses and my journal entries shed some light on the possible reasons. In response to the question, "What was there about this activity that you especially liked?" Brian responded, "We get to split the work up." Josh's response was, "I only had to do my part." Their responses to "I enjoyed today's class" were a full point closer to a positive response on group work than the average for this question. In my journal I noted that each boy relied heavily on support from his cooperative group. Members restated directions, reminded them to remain on task, or proofread/gave clarifications on written work. I was pleased with the degree of support offered to them; since neither boy is popular with classmates, some gestures and comments of disapproval were made when the group assignments for this marking period were announced. Survey comments included, "Josh didn't do anything to help on this lab," and, "I wish we could choose new partners." I also noted in my journal that both boys were more outgoing and animated, and appeared to enjoy the opportunity to interact with the group. According to their survey responses, Josh and Brian were attracted to group work because it seemed to them to require less effort. Further, I believe they felt more comfortable with the support given by the other group members. The tasks seemed less daunting and intimidating to them, and they had hope of assistance and guidance from their peers. The activity required less risk taking than it would have if they had had to work alone.

Participation was lowest in whole class or other large group settings. One of my journal entries describes Brian as "hiding in his seat" during a "jeopardy game" drill. He appeared uncomfortable and did not want to be selected to participate. Twice he said aloud that he wasn't playing. I also noticed his behavior became very disruptive and stayed that way all period even after we had moved on to another activity. Since participating would have meant taking the risk of responding in front of the entire class, his behavior reflected feelings opposite from the support and comfort level he experienced in the group activity.

When the activities assigned during the study period were broken down into the six general categories, the "easier" (i.e., more literal, fill-in-the-blank) activities generated more participation than the ones that required higher level skills or higher order reasoning or analysis. Activities requiring good reading and composition skills lost out, as did those requiring the reading or following of complex, multistep directions. Activities taking longer or requiring more than approximately fifteen minutes lost out. Even laboratory or creative/visual activities were not completed when they were accompanied by structured requirements or directions, or when they required a set of prerequisite skills.

The category called "Time Limit" yielded a surprising 100% participation rate. This was interesting because Brian and Josh could have opted out of these activities as easily as they did any other. They participated in the quizzes that made up most of the activities in the category regardless of the fact that the highest score either made on any of them was 48%. They completed two computer-based instruction activities with scores of at least 85% because it was understood that completion was their ticket to be allowed to move on to other science software. Two pre-laboratory activities were completed as a condition to be given access to the equipment needed for the laboratory. Clearly, the last four activities were incentive-based. The two boys saw a reward and were willing to work to get it. The participation in the quizzes was less obvious. From their responses in class and on the surveys, I judge it to be simple conditioning; no matter how low their grades are or how many zeros they compile in the gradebook, one is "supposed to" complete quizzes when a teacher hands them out.

Exploring the differences between Brian's and Josh's perceptions about learning activities as indicated on the student surveys proved to be both fruitful and time-consuming. I cross-checked the activity analysis sheets, the surveys, and my journal entries and anecdotal comments for additional evidence for my assertions regarding their overall negative attitude toward the activities. One noteworthy piece of data is their overall average rating of 5, the most negative score possible, on the statement, "I can really use what I learned today." To get an average of 5, they had to answer 5, strongly disagree, on every one of the surveys they completed. The remainder of the classes reported an overall average score of 3.1. It would be interesting to explore further to discover whether these students feel a disconnection between school and what they see as relevant skills.

I do not feel I learned very much new about what types of tasks prove more inviting to non-participating students. Ames' list (1992) of motivating attributes generally applies down the line to my results. The boys, logically enough, tended to participate more in activities they perceived as easier. They made this clear with both their oral and survey comments. Group work was more attractive than individual. Homework held no allure at all. Much of this was not unexpected.

I found myself dwelling more on the whys of the non-participation. As stated earlier, I found Alderman's (1990) and Knight & Wadsworth's (1994) assertions about poorly motivated students being inefficient learners to be confirmed in Brian and Josh. I also agreed with Brophy (1987) that a lack of parental support was one key to their lack of motivation. I saw their pattern of years of failure being reasons for their unwillingness to take risks in academic work. Everything pointed more toward the need for remediation and a positive, supportive classroom climate than to any magic of task selection.

Because I was unwilling to leave this question with no real answers about how to reach Brian and Josh, I began another, informal study at the conclusion of this one. I began by contacting the parents of each boy and obtaining permission to keep them in my classroom all day; they would not change classes. Their work would be brought to them, and I or a peer tutor would give assistance. We would start every morning by organizing their bookbags and folders. We would check their assignment calendars, and they would have to show me their completed assignments for the day. Any missing assignments would get first priority. Completed assignments would then be taken to the subject area teacher who had agreed to give half credit for all missing work. They could earn their way out of my room back to a specific class based on bringing their assignments up-to-date often with a tutor's help. Any class disruption brought them back to my room to start all over again.

> ***"Basically they had to see me as their last chance."***

Initial responses from Brian and Josh included sulking, anger, and rebellion. Fortunately they had little choice but to comply. Their parents were not coming to their aid, and their constant class disruptions had brought the office to the brink of suspending them for ever-lengthening periods of time. Basically they had to see me as their last chance, and once we developed the ground rules and they came to see that I was trying to help, things gradually smoothed out. The other students realized why they were there, and since I openly teased and bantered with Brian and Josh, sent them on errands, used them as demonstrators in science presentations, etc., they came to realize they weren't really being punished. They were being helped. I even had several other students ask how they could get to be one of my "special buddies."

After six school days of this treatment, I lost Josh when he was staffed into SLD (specific learning disability) and no longer took science. When he left, he had all work up-to-date in all classes. I have continued with Brian, and, in the meantime, I picked up three more part-timers. Brian has received no grade below a "D," and most days has all his work done. I still monitor his calendar every day and require him to organize his books and materials. Peer tutors are working back through previous chapters in the grammar and history books to help him catch up. About once a week his behavior causes him to be "sentenced" to spend all of the next day in my room. But he is participating. Whether or not there will be any long-term improvement because of these weeks, I cannot predict. It does seem to me, however, that all Brian really needed was a home base, someone to take an interest in him, and a chance to catch up.

Unfortunately, I also have come to feel that our school system is partly to blame for the

Phyllis Green

Years Teaching: 17

Present Position: 8th grade Life Science

"I tend to do non-traditional female things both in and out of the classroom. Kids really seem to enjoy it when we talk about windsurfing or skydiving. The one thing I don't do is shop!"

"To me action research only formalizes and quantifies what teachers already do all the time. It helps provide structure to help make changes on-the-fly when something is wrong in the classroom."

pattern of failure into which these two boys became locked. They have both failed since their elementary school years. Why were they allowed to reach eighth grade without any intervention? Neither of these students was ever evaluated for any learning disabilities or other exceptionalities. Brian is still on the waiting list for testing. Neither boy was ever referred for counseling, even though their discipline folders are among the thickest in our school. It is almost as if they were ignored and left behind as the rest of the students moved through the curriculum, and no one set up a safety net to provide them with the help they needed to be successful.

I used to have a saying when I taught third and fourth graders. Occasionally I'd get upset because I felt I hadn't "covered the book" or gotten as far along in the curriculum as the other teachers had. But then I'd think back about the year and say, "If I have given these kids a good year, full of exploration, full of the excitement of learning, if I've given them some self-confidence, if they feel good about themselves, it's enough. The rest will come." It turns out that I believe that for eighth graders, too.

6 Ramifications of the Research

I still believe task selection is crucial to designing an effective lesson. Selecting motivating, stimulating activities can greatly enhance the learning experience for all students. This study however, has confirmed what I always felt, that classroom climate is absolutely critical. As I continue to reach out to students like Brian and Josh, the most important thing I can do is work every day to make my classroom a positive place, a place where kids are secure and comfortable. Beyond that I see more emphasis on remediation of organizational skills and patterns. This will be a team effort, since my teaching partners have followed this research and have come to share my conclusions. We plan to use in-class diagnostic reading and listening skills tests at the beginning of next year. Once we identify the needs, we will use parent or peer tutors to help with remediation. At the school level we are investigating the prospect of before and after school tutoring sessions and providing a structured study skills curriculum for grades six through eight.

I believe that as our society continues to fragment and change, schools are going to have to effectively reach out to every student. Our mission must be to prepare *every* child to be a productive citizen, and that necessitates finding a way to reach out to children like Brian and Josh.

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Encouraging Participation in a Middle School Classroom

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Abstract

Nonverbal messages teachers send directly relate to the degree of participation in a middle school science classroom. Three areas of nonverbal behavior were considered: proxemics, coverbal behavior, and paralanguage. Although the research was limited to one classroom of twenty-three gifted sixth-grade science students, the study itself led to a deeper understanding of how sixth-graders view their teachers and the classrooms in which they are being taught.

Don't yell at me! said a student with whom I thought I was having a conversation. I told him that we were talking in rather hushed tones and were hardly "yelling."

But, you have your yelling face on! he exclaimed.

At that moment, a concern that I had for quite some time crystalized. It had occurred to me about a year ago that my perception of what was coming across to my students was vastly different from what they were actually inferring. Although it was my goal, it appeared that active student participation was not what I encouraged in my sixth-grade earth/space science classroom. Reactions on the part of my students were not always what I expected, and often times reactions were just the opposite.

Students seemed reluctant to interrupt, ask questions, make assumptions, or join in. I was under the mistaken impression that students were being encouraged to openly participate in my classroom. Communication was a large part of the problem, nonverbal communication in particular. For the purposes of this study, nonverbal communication will be defined as those signals which are shared by both the teacher and the student so that the behavior is regarded as communication by both (Bull, 1983).

> ***"But, you have your yelling face on!"***

Significance of Nonverbal Communication

In the past, research in nonverbal behavior has been done by anthropologists and psychologists (Smith, 1979). However, more recently teachers, researchers, and evaluators have been considering the fact that "whenever teachers and students interact, they are communicating in both explicit and implicit ways" (Puro & Bloome, 1987, p. 26). The importance of this is underscored when it is considered that some studies reveal that "82% of teacher messages are nonverbal and only 18% are verbal" (Grant & Hennings, 1981). These numbers support my supposition that student participation is directly affected by teacher nonverbal behavior.

It is important to recognize both the negative and positive effects that nonverbal behavior can have on students. Harrison and Crouch (in Smith, 1979) suggest that "in the development of each human being, nonverbal communication precedes and perhaps structures all subsequent communication," (p. 632). In view of this, the elements that create an atmosphere in which students can begin to make sense of science become of vital importance to a science teacher.

Class participation is based on teacher-student and student-student communication. Students must communicate to the teacher and their fellow students their level of involvement in the classroom (Puro & Bloome, 1987). For my classroom, and this self-study, classroom participation will be described as the number of people making comments, the variety of ideas indicated by these comments, the amount of off-task behavior observed, and the willingness to volunteer as indicated by the number of unsolicited questions/comments. These criteria are quite subjective and vary greatly from classroom to classroom, indeed from class to class.

Researchers (e.g., Banbury & Hebert, 1992; Puro & Bloome, 1987; Woolfolk & Brooks, 1985) recognize three major groupings of nonverbal behavior: (a) proxemics, (b) coverbal behavior, and (c) paralanguage. Paralanguage (tone of voice, pausing, speed of speaking) is perhaps the most important of the three in a science classroom. Proxemics (physical space and distance) and coverbal behavior (gestures, eye contact, facial expressions) are difficult to separate from paralanguage, so all three groupings will be considered in the evaluation of my classroom.

In particular, the focus of this study will be on nonverbal behavior and its use as an indicator of teacher expectations, to which student participation is directly tied.

A student's definition of his or her own space within a given classroom is extremely important when discussing nonverbal behavior. Whether the student interprets leaning forward as a positive behavior or as an invasion of personal or social space is a determining factor in the way the student interprets a teacher's nonverbal cues (Woolfolk & Brooks, 1985). Each student will make his or her individual determination, and it seems an impossible task to identify each student's definition. All that can be hoped for is some realization that this is one of many nonverbal teacher behaviors that can affect the way students react.

Also included in the interpretation of proxemics is the distance allotted between student and teacher. Is he in the first row or the fifth row? Are the chairs placed in rows or clusters? Smith (1979) asserts that "as the distance between the teacher and students increased, the teacher was perceived as being less warm" (p. 648). This perceived warmth clearly is an indicator to students of teacher

expectations. Closeness is considered by both teachers and students to be a sign of "acceptance, concern, and approval" (Banbury & Hebert, 1992, p. 35). However, due to the cultural diversity in a classroom, an experienced teacher will immediately identify closeness as being threatening or intrusive to students. For the purposes of this study, proxemics will be defined as closeness, both in the context of classroom set-up, and the distance between the student and the teacher in different situations.

Kinesics, defined by Smith (1979) as "the study of body motions and movement, posture, and facial and eye behavior" (p. 648), requires that teachers recognize that students' perceptions of them as either friendly or unfriendly is extremely important in establishing open lines of communication. These lines, whether verbal or nonverbal, are the basis upon which class participation is judged. Miller (1981) states that "if the verbal and nonverbal messages do not agree, the nonverbal will often dominate" (p. 20).

Gestures, their use and frequency, are sometimes equated with enthusiasm, which is often cited as an important factor in the classroom which can affect student motivation (Smith, 1979). Body movements must be considered with the verbal messages that accompany them so that specific meanings can be assigned (Banbury & Hebert, 1992). Direct and frequent eye contact can indicate approval and acceptance, can be used to express disapproval, or can be used as a directional tool. According to Woolfolk and Brooks (1985), attention can be improved, participation increased and strengthened, student self-esteem increased, and retention of information improved by close attention to teacher nonverbal behavior. This certainly underscores the importance of analyzing kinesics as the most critical category of nonverbal behavior on the part of the classroom teacher.

Middle school students are concerned about fairness, sometimes to the point of going beyond what they perceive as fair or unfair and disregarding the importance of what is being presented. Nonverbal behavior and verbal message agreement would, I believe, fall into the category of fairness. It is also clear that nonverbal behaviors on the part of the teacher are directly associated with teacher expectations and attitudes, and this makes it extremely difficult for students to make sense of their entire classroom experience (Woolfolk & Brooks, 1985).

Begin by Self-Analysis

Data were collected in the form of video tapes, interviews, and class discussions. After allowing my sixth grade science students to become familiar, and hopefully comfortable, in their new middle school surroundings, I chose one class for this study. My class of twenty-three gifted individuals was chosen for several reasons, not the least of which was that I was confident that they could articulate their views of our classroom experience. Five nonconsecutive classes were videotaped for approximately 30-45 minutes. Since I was focusing on student participation in response to my nonverbal behaviors, the beginning of the class period was the basis for my data collection. I chose this based on the fact that the tone is set at the start of class, and it is this tone that influences the rest of the lesson.

Videotapes were chosen as the medium to collect data because without a full-time outside observer, nonverbal behaviors would be otherwise impossible to record. The use of videotape as a self-analysis tool is becoming more and more prominent as a way for teachers to "identify intended messages, and solicit structured feedback regarding the congruency of ... nonverbal behaviors" (Banbury & Hebert, 1992, p. 37). Smith (1979) supports the use of videotape and its supporting equipment as a requirement for analysis of nonverbal communication in today's classroom. Woolfolk & Brooks (1985) support the use of both video and audio portions of the tape to include student responses since "the teacher's nonverbal behavior [is] information for students" (p. 513). Analysis of student nonverbal behavior in response to my nonverbal behavior is beyond the scope of this research, but some analysis of student response was necessary to put into perspective the entire classroom experience. Audio responses of students were considered in relation to student and teacher behavior being analyzed.

What Do Students See?

Twenty-three gifted earth/space science sixth graders were involved in this study to give the student view of teacher nonverbal behavior, both specifically and generally. I asked this group the following questions and recorded their observations/responses by taking notes:

- What kinds of things do teachers do that show you they are listening?
- What kinds of things do teachers do to show you they want your input?
- What things do teachers do that make you feel that it's NOT safe to ask or answer a question?
- Of all your classes, which classroom is the most comfortable physically? Why?
- With which teacher are you the most comfortable? Why?

All student responses were considered in the analysis of data. This technique was so enjoyable and revealing to me that it was clear that using it for this study would be very helpful. Not only could I complete my self-study through viewing the videotapes, but I could also see those videotapes through the eyes (and ears) of my students.

Videotape Self-Analysis

After determining that the videotaping did not inhibit my students, I decided to look at the same characteristics in each video. The physical layout of the room was a definite influence on the dynamics of the classroom. In the first videotape, the desks were arranged in clusters, which was my choice at the start of the school year. This arrangement lent a casual atmosphere (I thought) to the room and encouraged students to talk with one another during our discussions. The three subsequent tapes revealed the desks in rows, which was done to satisfy student requests for "their own space." This seemed to make no difference in my attitude or demeanor.

In response to question #4, students without hesitation said they were most comfortable when their desks were in rows. They stated that this not only gave them their own space, but when their desks were in rows they were not required to worry about "social stuff" with their classmates. To the contrary, when desks were in clusters, they not only had to think about work and the teacher, but they also had to consider the other students at their cluster and how they relate to each of them. One of the students said she was uncomfortable with boys at the table. Another agreed, but said that clusters would be "okay if we could choose our own groups."

Several students related that they wanted "chairs that roll." This response surprised me because it never once entered my mind that this would make a difference in their classroom attitudes. At one point in the discussion, one of the boys said that "as long as the room is different" the seating arrangement did not matter. A discussion then ensued as to what constituted a "different" room. Some of the responses were: "a room where something is always changing;" "when a room is painted an unusual color;" "darkish colored walls;" and "lots of elbow room." To say that I was surprised by the results of this discussion would certainly be an understatement. There were an equal number of students who wanted to be close to the teacher or far from the teacher.

The one area of general agreement, as far as proxemics were concerned, depended upon the nature of the work. My students agreed that there are certain situations, such as when they are reading or doing creative writing, when they would prefer to be in rows, but otherwise clusters were "okay." Apparently, "okay" is the most enthusiastic response I could get about this particular part of my research. As an aside, I found it interesting that at our open house, parents frequently commented on the seating arrangement, stating that they liked the cluster arrangement.

The most dominant characteristic of my presentations involved a lot of moving around, accompanied by almost constant hand gestures. It was unclear to me whether or not these hand gestures were a distraction to the children. However, in response to question #2, my students indicated that hand gestures are one of the nonverbal behaviors that teachers use to indicate that they want input from the students. Hand gestures both added to my explanations and seemed to work as a distraction for some students.

> "What did I do to turn him off?"

Hand position also appeared to encourage or discourage student response/participation. Hands up/palms up elicited more student responses and seemed to indicate a more open appearance. It was clear that their opinions were not only expected, but desired. Students openly and willingly answered questions and gave opinions when I stood with my hands up/palms up. Palms down was also considered to be a receptive stance. However, this position seemed to indicate that the discussion was coming to a close and some conclusion was being reached. At times, a student would raise his or her hand, but by the time I called on that student, the response would be "never mind," "I forgot," or "it wasn't important anyway." I have often asked myself the question, "What did I do to turn him off?" I believe I am coming close to the answer. Hands on hips got an immediate reaction: disapproval was the only interpretation, no responses were elicited, and it was an obviously negative message. When my hands were either in my pockets or behind my back a casual atmosphere prevailed.

Although hand gestures were the dominant nonverbal behavior, there were many other behaviors involved. Head shaking and head position were prominent in the discussion of teacher behavior (student questions #1 and #2). These movements also seemed prominent in sending messages on the videotapes. The importance of matching nonverbal and verbal behaviors was clear. Oftentimes I gave a positive verbal response but was shaking my head in a negative manner. It clearly confused the student who had asked the question, and, in fact, confused me when I viewed the videotape. At one point, I sent a "don't" message which was accompanied by smiles. It seemed to me that this implied tacit approval. Students could easily have interpreted this to mean that I really didn't mean it and found the behavior cute or endearing.

Head nodding was definitely an encouraging behavior and when accompanied by either a smile or laughter seemed to give the students free rein to respond and join in the discussion. Head shaking, on the other hand, meant an inappropriate behavior had occurred. This got an immediate reaction, and caused a stopping of the behavior. Nodding my head had become prominent in my demeanor and seemed to constantly elicit positive responses. In response to question #3, many students indicated that when a teacher shakes his or her head, he or she did not feel safe in either answering or posing a question.

When I leaned toward a student or actually walked up to his or her desk and stood in front of it, the student seemed more likely to participate. This showed the importance of proxemics in my teaching. This behavior works both ways, however, as it could have left out everyone but the teacher and that particular student. When I asked my students a question on the kinds of things teachers do that show you they are listening, they answered without hesitation that the proximity of their teachers is not as important as what the teacher is doing at the time. Surprisingly, some teachers with whom these students have experience grade papers, read mail, read books, and deal with other students while conducting the class discussion. All of my students were adamant; "we want to know that the teacher is *really* paying attention to what we are saying."

> "At one point, I sent a don't message which was accompanied by smiles."

Another behavior that I noticed, which was difficult or distracting, was mouthing words. This was a way of approaching one particular student, but it had an immediate negative connotation which was apparent by the reaction of that child. Focus on the individual was cited by the children as an important factor in which the teacher made them feel the most comfortable. But this particular method of focusing was considered negative regardless of what the verbal message was.

Eye movement was, not surprisingly, an indicator of my approval or disapproval, agreement or disagreement, questioning, interest, encouragement, or impatience. Students agreed that certain eye movements can be a factor in their decision to participate or not, and whether they are comfortable with certain teachers. In response to questions #1, #2, #3, and #5, eye movement was an indicator of teacher attitude and strongly influenced how the students felt in most classroom situations. In looking at the videotapes, I realized that my facial expressions were extremely important to my students because I often used them in place of words or hand gestures. They were used in conjunction with hand gestures, which makes for a powerful tool indeed. Never before had I realized how effective eye contact and movement could be.

Eyebrow raising is a questioning device, and when accompanied by smiling or laughing got immediate results from most students. It was not a negative nonverbal behavior because of the smile/laugh, and was one of the items listed by the students that showed that a teacher was listening only to them. It was considered by my students to be a "comment" about what they were saying at that particular moment. Eyebrows down, though, for some of the students made them feel very comfortable. They felt no response was required at that time.

Eye contact figures prominently in the videotapes, as well as the student responses. Almost to a person, eye contact was perceived as a positive response that showed students the teacher was listening to them. In several cases the students said direct eye contact made them "nervous or uncomfortable" because they felt put on the spot, that the teacher was speaking only to them. However, this was indicated as a way that teachers show that they are attentive. I use eye contact to get immediate responses from individuals, to show some students that I am aware of their presence, to get the attention of a student whose concentration has wandered, or to encourage a student who is having trouble verbalizing an opinion. In fact, at one point I was completing another task while talking with the children. Although I thought this would be distracting to them, as long as I maintained eye contact, the other task was secondary to the moment.

There were situations that I would not have thought required much eye contact, but when seen on the videotapes it was clear that eye contact was important at every point in the classroom experience. Several students said in response to question #1 that blinking showed that their teacher was listening to them and not thinking about something else. This was in contrast to "glaring," which made the children feel that the situation was unsafe for speaking out.

At one point in our discussion several students said that, "teachers who watch the clock don't care about what we are saying." This is a real dilemma for teachers, I believe, because students have very little time to pass between classes, and as teachers we must get them on their way on time. At the end of each of my classes, I read aloud from a novel and find myself looking up at the clock frequently. This, as I explained to my class, is not a sign that I am disinterested in what we are doing. On the contrary, it is so easy to get immersed in what we are doing that it worries me that I will lose track of time. The students did say that, "it is stressful when a teacher keeps us after the bell," but reconciling the two behaviors appears to be difficult for them.

A final word on eye contact. Not only can it be amusing, but often it bridges the generation gap. Two of the students, upon being asked about eye contact, immediately asked me if I knew what the "hairy eyeball" was. Of course I recognized the phrase immediately from my own middle school days. As soon as we began talking, a lot of head nodding began and "um hmming" by my students. They agreed, to a person, that all teachers have the hairy eyeball, but some are much better at using it than others. In middle schools, the hairy eyeball is "worse than glaring, worse than staring, and very, very scary." The teachers that are best at using this technique are perceived as being "mean" and "they do not really care about their students." If there is any piece of evidence that supports my contention that nonverbal behavior conveys a stronger message than verbal behavior, this was it. Unlike Archimedes, I did not run naked into the street shouting "Eureka! I have found it!" However, it has been responsible for my attempting to change my own way of "looking" at students.

This brings me to my final and most revealing piece of evidence from the videotapes and the interview questions: tone of voice. There is no question that in my case this was the most conspicuous nonverbal behavior that I employed, and that sometimes I did not use it in the way I had intended.

A "whiny" tone got immediate reaction as the students totally shut down all communication with me. Although I previously thought that an even tone would be boring for the students, it seemed that it was a

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"I've spent a good amount of time doing things outside of the classroom. I think teaching, then taking time off, and then coming back to the classroom has really helped me to become a better teacher."

"Doing the action research was wonderful. I think more teachers should be encouraged to do it. Although it can be risky at times, it is a fabulous self-evaluative tool."

comfort to them; it was one less thing for them to have to interpret. I realized this when I asked about situations that make the students feel safe. We acted out a situation with my students showing me standing in front of the room talking "at them." They indicated that an even tone made no demands on them; it was a safe situation.

Students were very concerned that when a comment was made, that it was in response to what they were saying and not "just a noise." On most of the videotapes my intonation was the same; when it varied, it was obvious and usually taken in a negative way, depending on the facial expression that accompanied the tone of voice. Sarcasm, for instance, although not apparent often, was taken both as positive and negative by my students, depending on whether or not I was smiling or had a serious expression.

So What?

So, did I see the "yelling face?" Only once, but I immediately realized why the student thought he was being yelled at when that was not my intention. It expressed immediate disapproval and that was the intention, although I never raised my voice. This is a nonverbal behavior that I am not certain can be controlled. While most can be, and perhaps were in the videotapes, there are some nonverbal behaviors that are natural. Without them the human quality would be removed. I saw other things in the videotapes as well: openness, kindness, caring, encouraging, learning, and teaching. The results are in: my nonverbal behaviors are obvious and their effect is immediate.

The most difficult part of this self-study was knowing when and where to stop. This issue of nonverbal behavior is much deeper than it first appears. Having identified this area to study, my nonverbal behaviors immediately changed. At each juncture, the behaviors were altered, and new questions were asked. Is it important to be consistent? Is it possible to be consistent? How much nonverbal behavior do I really want to control? Can the students determine when a response is genuine or controlled? Does a response become genuine after repeated use once it is recognized? Is the interpretation of nonverbal behaviors generalizable outside of this one situation or classroom? The questions keep coming! Each time I examine one, another and another seems to come up.

So, what did I learn? My students are very concerned with nonverbal behaviors on the part of their teachers, but not necessarily concerned with their own nonverbal behaviors. Nonverbal behaviors do not enter into their social interactions with their peers as much, which leads me to believe that their desperate attempt to understand adult behavior has a lot to do with the matching of verbal messages and nonverbal behavior.

The implications of this for teachers are enormous, but I am afraid, not generalizable. Each classroom chemistry is different. Each teacher has a different "look" that he or she may not want to deal with. My own opinion is that every teacher should take a look (no pun intended) at how he or she presents himself or herself to children. It bears repeating what Harrison and Crouch (in Smith, 1979) said because it has important implications for middle school teachers: "In the development of each human being, nonverbal communication precedes and perhaps structures all subsequent communication" (p. 632).

Personally, I have become much more aware of what I am saying to my students and, more important, how I am saying it. In lesson planning I now consider how my presentation of information or instructions will impact what the students do and how they will react. When one of the behaviors that elicited negative responses from my students becomes apparent to me, I try to control it. Of course, then I ask myself, "Do I want to control these behaviors?" Sometimes the yelling face is just a human, uncontrollable response that, unfortunately, makes other people uncomfortable. Perhaps that is, as my students say, "an okay thing."

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What Patterns of Teacher-Student Verbal Communication Exist in My Classroom?

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Abstract

My purpose was to explore the patterns of teacher-student verbal communication that existed in my classroom. Sequences were coded according to the ten categories defined in **"The Role of the Teacher in the Classroom"** *by Amidon and Flanders (1971). I found that if I could avoid monopolizing class time with teacher talk, I could provide deeper and more meaningful learning experiences for my students.*

The purpose of this study was to find the patterns of teacher-student verbal communication that exist in my classroom. One thing that I have learned since the beginning of my teaching career is that teaching and learning take place in many different forms. At certain times one learns by listening and watching, and at other times one learns by sharing and discussing ideas with others. For every style of learning there is a style of teaching. Through the years I have been able to share many ideas with my students, and during the sharing process my students have taught me many things in return. One of these things is that two-way communication between students and teachers is essential in a classroom where teaching and learning is happening on a continuous basis.

I believe four things influence teacher-student communication in my classroom. These are: my perception of my role as a teacher; my level of confidence in different areas of science; my responsibilities as they relate to this role; and the students' perception of a classroom where they interact with the teacher because their input is valued. The way in which I view my role as a teacher influences the way I verbally interact with my students. At one point in my teaching career I would have said my role as a teacher was to be a "giver of knowledge," as if I possessed all the answers and the students only needed to listen to me. Verbal interaction with a student who had a comment to make might have resulted in me saying, "Yeah, I heard something about that, let's go on," because it challenged my level of knowledge in a certain area and made me feel uncomfortable.

"Where once I considered myself a giver of knowledge, I now feel I am a resource, providing experiences which motivate students to ask questions of myself and others."

A danger exists when students ask questions of teachers. The danger arises when the teacher is not familiar enough with the subject matter or does not know the answer to a question. Some teachers fear their authority in the classroom will be hurt if they do not answer every question the students ask. Teachers must be comfortable with the process of finding answers to questions in order to help students answer their own questions (Pearlman & Pericak-Spector, 1992). In cases where this situation occurs, I try to admit to my students that I don't know all the answers, but maybe, through a shared experience, we can find the answers together.

Having attended many teacher in-service workshops where the instructors came into the school as "givers of knowledge," I often left feeling that I learned very little. As a student in these in-service workshops, I felt something was missing; communication seemed to be taking place, but the pattern was not one that flowed back and forth from teacher to student.

These experiences have helped change my perception of my role as a teacher. Where once I considered myself a giver of knowledge, I now feel I am a resource, providing experiences which motivate students to ask questions of myself and others. The question then becomes, "When do I back off and open the door to allow for an influx of student questioning?" Students ask questions at the point in a lesson where the subject being discussed becomes relevant to them (Tobin & Fraser, 1989). Serving as a resource, I now have the freedom to change the agenda to meet the needs of the students. The floor can now be open for discussion of new ideas by any member of the class, to any other member of the class.

One of my responsibilities as an educator is facilitating the learning process to create a positive classroom environment. Every year, while preparing to meet my new group of students, I set high priorities for creating this environment. Tables and chairs are arranged in patterns to allow students and teacher freedom of movement, a variety of resources are chosen carefully to spark student interest, and posters are placed on the walls to invoke the students' thoughts. However, there is still an element of the classroom environment left untouched that may influence students' learning to a greater extent. This element is teacher-student communication.

One necessary ingredient to hold this two-way communication together is the amount of freedom given to the student to express himself or herself. Students must believe, from the first day they enter your classroom, that their input will be valued. There is no such thing as a dumb question or an idea that will not work.

If the idea is to give students more freedom to express their viewpoints in the classroom, the extent to which verbal behavior influences the students in my class must be understood. Teachers either consciously or unconsciously influence the amount of freedom that students have to respond to questions or statements (Amidon & Flanders, 1971). The Flanders system categorizes teacher verbal behavior as indirect or direct. A teacher's indirect verbal behavior maximizes student freedom to respond to questions and statements. A teacher's direct verbal behavior minimizes student response (Amidon & Flanders, 1971).

Indirect influences include verbal behaviors from the teacher. These can involve accepting students' feelings, giving praise and encouragement, accepting student ideas, and asking questions. Direct influences can include lecturing, giving directions, and criticizing. Since I am looking at the total interaction in the classroom, student talk must also part of the discussion. Student talk can include student responses to a teacher's questions and student-initiated talk to the teacher.

Methods

My first period Integrated Science class was chosen for the focus of this study. This class is made up of thirty-five sixth-grade students from eleven to twelve years old. The nineteen girls and sixteen boys are in their first year of middle school, coming from four feeder elementary schools in the Leon County area.

Room 001-B, the classroom assigned to me for the last two years, is one of the larger classrooms in the sixth-grade wing of the open concept school in which I teach. Three walls and a sliding curtain are the boundaries which encompass the partially carpeted room. A large model of the human body sits along the wall where the sliding curtain is located. The wall opposite the sliding curtain is equipped with six sinks, an eyewash station, and a drain.

Two weeks prior to my starting date, a video camera was placed in my first period classroom and left on so that the students would become comfortable in the presence of the camera in the room. Students were given numbers on construction paper and asked to hold on to them for later use. On day one the first period class was videotaped for the first time. At the close of the period students were asked to complete a four-question survey. They were asked not to use their names, but instead, they were asked to use a number that was given to them earlier. I jotted down notes on how the class session went in a teacher journal.

The week continued with the second taping three days later. Student surveys were filled out for the entire week. Entries were made in the teacher journal whenever I could remember. This turned out to be about three times during that first week.

During the second week the class was taped on Monday and Thursday. At the end of the second week modifications to the student survey were made on questions 1 and 3 due to mixed responses given by students. The modified student survey questions were:

1. Did you share something in class today? Yes/ No

   If yes, did you share with:

   a) students only;

   b) the teacher;

   c) a group of students; or

   d) a group of students and the teacher.

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3. Did you ask a question today?
   Yes/ No

   If yes, did you ask a question of:

   a) a student only;

   b) teacher only;

   c) group of students only; or

   d) group of students and the teacher.

I continued to tape my first period science class twice a week for a total of five weeks. Student surveys were given to all students on a random basis throughout the five-week period. Journal entries were made daily.

Classes were videotaped and analyzed by looking at the sequence of teacher-student verbal interactions. These sequences were then coded according to the ten categories defined in Amidon & Flanders (1971). A number from one to ten was assigned to ten different types of behavior. Each number represented a category of teacher-student verbal behavior. However, it should be mentioned that no scale is implied by these numbers. The ten categories of student behaviors were (1) accepts feelings, (2) praises or encourages, (3) accepts or uses ideas of students, (4) asks questions, (5) lecturing, (6) giving directions, (7) criticizing or justifying authority, (8) student talk(response), (9) student talk (initiation), and (10) silence.

Acceptance of Feeling

The teacher accepts feelings when he/she says he/she understands how the child feels. The child is supported and told he has the right to have these feelings. These kinds of statements often communicate to children both acceptance and clarification of their feelings. Included in this category are statements that recall past feelings, refer to enjoyable or uncomfortable feelings, or predict happy or sad events that may occur.

Praise and Encouragement

This includes jokes that release tension but do not threaten students at the expense of others. Often praise is a simple phrase such as, "good job," "fine," or "alright." Encouragement is slightly different and includes statements such as "continue," "say that again," or " you're hot now, tell us more about it."

Accepting Ideas

This is quite similar to category one (acceptance of feeling). However, it only includes acceptance of student ideas, not the acceptance of expressed emotion. When a student makes a suggestion, the teacher may paraphrase the student's statement, restate the idea in simpler terms, or summarize what the student has said. Included here is when the teacher says, "I see what you mean. That's a good point."

Asking Questions

This includes only questions from which the teacher expects answers. A rhetorical question is a question to which the teacher does not expect an answer, and these are not included in this category.

Lecture

Lecture is defined as the form of verbal behavior used to give information, opinions,

or orientation. This presentation of material may be used to introduce, review, or focus the attention of the class on an important topic. Usually information in the form of a lecture is given in fairly extended time periods, but it may be interspersed with childrens' comments, questions, and encouraging praises. Rhetorical questions are included in this category.

Giving Directions

This is used only when the student's compliance takes the form of an observable act. An example would be if the teacher says, " Chad, move to the seat up front."

Criticizing or Justifying Authority

A statement of criticism is one designed to change student behavior from unacceptable to acceptable. The teacher says, in effect, "I don't like what you are doing, do something else." Another group of statements included in this category are statements of defense or self-justification. If a teacher is explaining herself or her authority, defending herself against the students, or justifying herself, the statement falls into this category.

Student Talk-Response

This is used when the teacher has initiated contact or has solicited student statements. Also included here is when the students respond verbally to teacher directions.

Student Talk-Initiation

This is when a student raises his/her hand to make a statement or ask a question when he/she has not been prompted by the teacher to do so.

Silence or Confusion

This includes periods of confusion in communication when it is difficult to determine who is talking.

Recording Data

Every three seconds I wrote down the category number of the interaction I had observed from the videotape. This sequence of numbers was recorded in a column on a tally sheet (approximately twenty numbers per minute). Each class session lasted an average of 40 minutes and yielded about 300 responses. At the end of a period I had several long columns of numbers. This sequence was entered into a 10 row by 10 column table called a matrix (see Table 1). Numbers from the sequences were examined in pairs in order to show the patterns of interaction. After compiling tallies in each cell, totals were found for each column. Percents of tallies in each column were computed by dividing the columns total by the total number of tallies in the matrix. This gave a proportion of the total

Table 1

Interaction Matrix for Laboratory Activity

	1	2	3	4	5	6	7	8	9	10
1										
2		1.04	0.26	1.04		0.52			1.04	
3		0.78	1.83	3.14	0.52	1.50		0.26	0.52	0.52
4		0.78	1.04	4.46	3.14	2.36	0.26	6.03	2.60	3.67
5		0.26		4.70	4.70	2.36	1.04		2.60	0.78
6		0.26		5.20	2.09	5.77	0.26		1.50	2.62
7				0.52	0.52	0.26	0.26	0.52		0.52
8		0.26	2.30	0.26	0.26	0.26		0.26	1.04	0.26
9		0.52	3.40	1.31	1.31	1.31	0.26		6.03	1.04
10					1.57	3.93			1.83	
Total	0	3.90	8.83	20.6	14.1	18.3	2.08	7.07	17.2	9.41

interaction observed in the classroom in each category.

After examining the matrix, I was able to look for patterns in teacher talk, student talk, indirect-direct ratio, and ratio of student-initiated talk to student talk and high frequency cells. The total amount of teacher talk was important because my goal was to act as a facilitator or resource and not to monopolize the class time. The total percent of teacher talk during the class time was found by dividing the total number of tallies in columns one through seven by the total number of tallies in the matrix.

Student talk, either student-initiated or elicited by the teacher, was important because this was the time when the student's ideas and beliefs were being shared, exchanged, examined, and challenged. To find the percent of student talk, the total number of tallies in columns eight and nine was divided by the total number of tallies in the matrix.

The I/D (indirect-direct) ratio was a comparison of teacher-indirect statements, statements from categories one through three, and teacher-direct statements, the types found in categories four through seven. A comparison of indirect teacher statements to direct teacher statements showed if I was using direct influence to minimize the freedom of the student to respond, or if I was using indirect influence, which maximized the freedom of the student to respond.

The use of praise and encouragement, as well as repeating the student's answers, allowed me to maximize the student's freedom to make other responses. On the other hand, when I said, "Put that ruler on the desk and act like a sixth-grader," I was giving directions and criticizing the student,

> *"The total amount of teacher talk was important, for my goal was to act as a facilitator or resource and not to monopolize the class time."*

which minimized the student's freedom to make other responses. The I/D ratio was found by adding the total tallies in columns one through three, and then dividing this total by the total number of tallies in columns four through seven.

The matrix contained cells called steady state, which lay along any diagonal. Examples of steady-state cells are one-one, two-two, and three-three. These cells identified continuous talk in a single area. A build-up of tallies in a steady-state cell showed a particular behavior remained in a single category for longer than three seconds. All other cells were transitional cells. These cells represented movement from one category to another. I looked for patterns in steady state cells and transitional cells that contained at least 3% of the matrix tallies. These areas showed the major interaction patterns that existed in my classroom.

Data Analysis

In analyzing the data I looked for similarities in the type of instruction used during the allotted five weeks. I found that the lessons could be divided into two basic categories, whole class instruction, where the focus of the lesson was a discussion or demonstration lead by the teacher, or laboratory activity, where students were actively engaged in problem solving. Once each lesson was classified as either class instruction or lab activity, a typical lesson from each area was identified in order to look for patterns of instruction.

In looking for patterns, I expected to find differences in the amount of teacher and student talk when comparing laboratory instruction and class instruction. I expected teacher talk to be high during whole class instruction and low during laboratory activity. During laboratory activities I expected that the students would discuss things as they explored within their groups. Laboratory activities also often take unpredictable twists and turns which challenge or confuse students, thus leading to high levels of student interaction.

Typical Whole Class Instruction

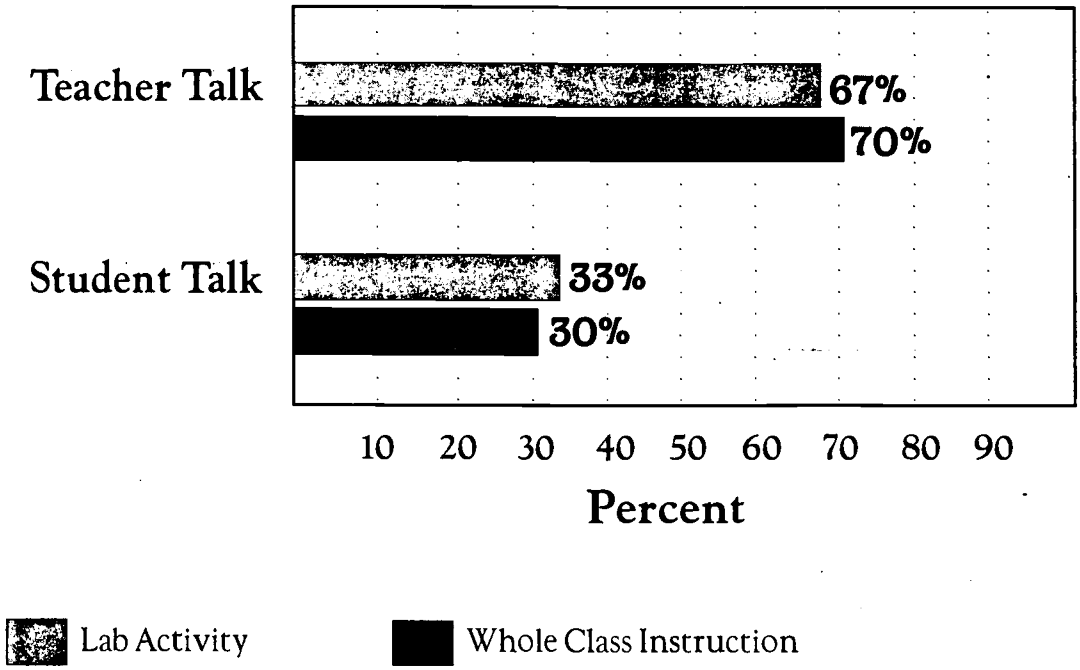
Students were given a list of five tasks from which to choose to write a detailed procedure. The list included tasks such as folding a sheet of paper into nine squares, addressing an envelope correctly, and locating similar words in the dictionary.

After completion of the tasks, thirty-one students completed and turned in surveys. Sixty-eight percent of the students who turned in surveys shared something with the class during this lesson. Forty-two percent of the students shared something with another student. Sixteen percent of the students shared something with the teacher. Nineteen percent of the students shared something within a group of students, where the teacher was not present

> *"I expected teacher talk to be high during whole class instruction and low during laboratory activity."*

Figure 1

Verbal Interaction: A Typical Class



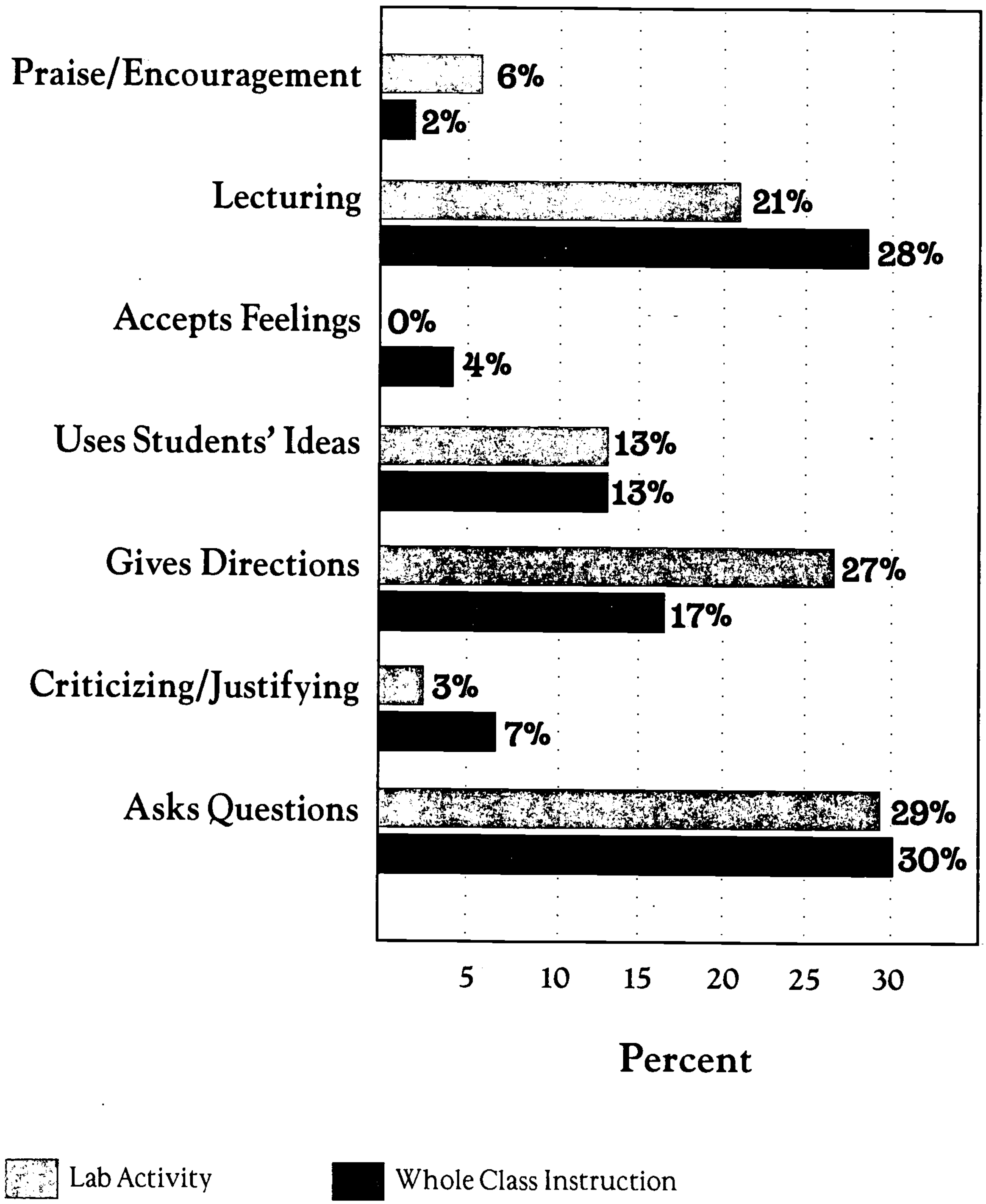
or part of the group. Twenty-nine percent of the students shared something with a group of students while the teacher was part of the group. Seven students wanted to share something but did not. Ninety percent of the students who shared something or asked a question during the lesson felt their statements or questions were taken seriously.

Students seemed to like the topics they received. Some students chose to actually do the task they were writing about. Doing the task described in the assignment allowed the procedure to become real for a lot of them.

In viewing the video I was also able to see patterns in the instruction. Teacher talk made up 70% of the lesson, and student talk made up 30% of the lesson (see Figure 1). The I/D ratio was 65/298. A breakdown of teacher talk revealed 30% questioning, 28% lecture, 17% giving directions, and 13% acceptance of students ideas (see Figure 2). Each of four steady-state cells, four-four, five-five, six-six, and nine-nine, contained three percent of the matrix tallies. This pattern indicated periods of continuous questioning, lecturing, and giving direction by the teacher. Five transition cells, which contained three percent or more of the matrix tallies, were three-four, four-eight, eight-three, five-four, and nine-three. This pattern indicated that I asked direct questions of students, accepted student ideas, and used these ideas to form other questions. Questions were interspersed during periods of continuous lecture.

Figure 2

Breakdown of Teacher Talk



A Typical Laboratory Activity

The class was divided in half. Half of the students worked on laboratory activity number one, "Where is It?" In this activity students used a triple beam to find the masses of five objects. Once completed, the students then had to identify the two objects with identical masses. The remainder of the class worked on laboratory activity number two, "Ranking Order." In this activity students used a triple beam to find the masses of five household items. They then ranked them in order from smallest to largest and generated a bar graph illustrating their findings.

Thirty-three student surveys were completed and turned in after lesson two. Seventy-three percent of the students who turned in a survey shared something with the class during the lesson. Of the students who shared ideas, 34% shared something with another student, 13% shared something with the teacher, and 30% shared something with a group of students. Twelve percent of the students wanted to share something, but did not. Only one student gave a reason for not sharing their idea (he was helping someone else at the time). Seventy-six percent of the students asked a question. Of these, 42% asked a question of another student, 27% asked questions of the teacher, and 6% asked questions of a group of students. Of the students who shared ideas or asked questions during the lesson, 61% felt the teacher took their statements and questions seriously.

Student participation was good during this activity. When asked questions, students volunteered to answer, rather than wait for me to call on them. Students seemed interested in the short demonstration on how to use the laboratory balance, and were very eager to get back to their groups. Students also worked eagerly, showing a great deal of enthusiasm. They asked good questions of each other and me.

In viewing the video I was able to calculate that teacher talk made up 67% of the lesson. Student talk was about half this, at 33%. The I/D ratio was about one-fourth. For every indirect statement the teacher made, four direct statements were made. A breakdown of teacher talk revealed 29% of teacher talk was questioning, 21% was lecture, and 27% was giving directions (see Figure 2). Four steady-state cells contained 3% or more of the tallies in the matrix, four-four, five-five, six-six, and nine-nine. This indicated periods of continuous lecture, questioning, and giving directions by the teacher. The following transition cells contained 3% of the tallies in the matrix: three-four, five-four, six-four, four-five, four-eight, four-ten, nine-three, and ten-six. Heavy use of cells five-four, six-four, four-five, four-eight, and three-four indicated patterns where the teacher gave directions and asked students direct questions during the activity. When students answered questions, their ideas were often used to form other questions. Cells four-ten, and ten-six indicated times when questions were asked of the class as a whole. In these cases confusion often set in, causing me to give further directions. Cells nine-nine and nine-three gave some indication of extended student-initiated talk and my acceptance of students' ideas.

An Atypical Laboratory Activity

As the class completed their activities and began to prepare for a new section, I was able to show examples of teacher-student verbal communication patterns that I would like to see more of in my classroom. Students were first asked to bring closure to the laboratory activities, "Ranking

Order" and "Where is it?" Once this was completed they were asked to compare results, making new measurements if needed, completing charts and graphs, and writing a short conclusion. During the last ten minutes of class I introduced the next topic we would discuss, volume.

Thirty-five student surveys were completed and turned in after lesson three. Seventy-one percent of the students shared something with the class, 51% shared something with another student, 14% shared something with the teacher, and 11% shared something with a group of students. Twenty-three percent wanted to share something, but did not. The following reasons were given for not sharing something during the lesson: (a) I wanted to work by myself, (b) the teacher did not call on me, (c) so I could help someone, (d) I did not want to interrupt class, (e) because I just wanted to talk, (f) because I wanted to feel good about what I shared, (g) because I wanted every one to feel good about what I did. Of the 63% of the students who asked questions during the lesson, 29% asked a question of another student, 37% asked the teacher a question, and 9% asked a question of a group of students. This total exceeds 63%, which means some students asked more than one question. All of the students who shared something or asked a question during this lesson thought the teacher took their statement or question seriously.

Students started work immediately during this lesson. They relied heavily on the help of other students around them to answer questions. I spent time walking around the room, asking questions of groups as they worked. Near the middle of the class period we had a class discussion and short lecture.

Teacher talk made up 57% of this lesson. Thirty percent of the lesson involved student talk. The I/D ratio was one-fourth. For every indirect statement made by the teacher, four direct statements were made. A breakdown of teacher talk revealed that 14% of the time I asked, 17% of the time I lectured, 13% of the time I gave directions, and 9% of the time I was accepting or using students ideas. Each of four steady-state cells in the matrix contained 3% or more of the matrix tallies five-five, six-six, eight-eight, and nine-nine. This indicated periods of continuous lecturing and giving directions. Questions posed by the teacher were answered in greater detail by the students. Students also expressed more of their ideas during the lesson. The following transition cells contained 3% of the matrix tallies, three-four, five-four, eight-three, six-five, four-eight, four-ten, five-six, and ten-six. The heavy use of these cells gave an indication that I was asking direct questions of both individual students and the whole class during the lecture.

> ***"It seemed that regardless of the type of instruction given, I talked more than 60% of the time and the students talked roughly 30% of the time."***

Discussion

In looking for patterns I expected to find differences in the amount of teacher and student talk which would match the type of instruction being used. I expected teacher talk to be higher than student talk during whole class instruction and lower than student talk during laboratory activities. What I discovered was that during laboratory activities I talked an average of 67% of the time, while the students talked an average of 33% of the time, as illustrated by Table 1. During whole class instruction I talked an average of 70% of the time, while students talked an average of 30% of the time. It seemed that regardless of the type of instruction given, I talked more than 60% of the time and the students talked roughly 30% of the time.

This pattern of teacher-student verbal communication had been modeled for so long that one day a student confided in me, "Mrs. Graham you really do talk too much." My immediate reply to his observation was, "No I don't." The student then proceeded to describe how a typical class often begins with my introducing the lesson, giving directions, and asking questions. He ended by saying that by the time I finish students rarely had time to complete the lesson. After viewing the videotapes I was surprised to find that for the most part the student had been right. I had been monopolizing the class time. Students were not being allowed enough freedom to engage in verbal interaction with myself or each other. Class discussions were led by the teacher and often took the direction I encouraged. A breakdown of teacher talk revealed I was more accepting of students' feelings during whole class instruction than during laboratory activities. Student feelings were being accepted about 4% of the time during whole class instruction.

Praise encouragement was used 2% of the time in whole class instruction, while during laboratory activities praise and encouragement was used 6% of the time. I think this increase was appropriate, for the middle school child likes to receive little pats on the back which do not cause them to seem "uncool."

> *"Recognizing there is an incongruency between my teaching beliefs and my teaching practice is the first step."*

On the other hand, the use of criticism and justification decreased during laboratory activities and increased during whole class instruction. During lab activities I used criticism and justification an average of 3% of the time, while during whole class instruction I used criticism and justification 7% of the time. The restrictive nature of whole class instruction, as shown by the amount of time the teacher talked, probably influenced student restlessness and my criticizing and justifying behavior.

The use of student ideas was very similar in both types of instructions. I managed to use the students ideas about 13% of the time in both cases. Another surprise was that I asked questions about the same amount of time in both types of lessons. I asked questions 29% of the time during laboratory activities and 30% of the time during whole class instruction. I lectured 28% of the time during whole class instruction and 21% of the time during laboratory activities. I also tended to give about 10% more directions during laboratory activities than during whole class instruction.

The pattern of teacher-student verbal communication that exists in my classroom is one in which teacher talk dominates classtime. This often restricts verbal interaction between the teacher and students, as well as between the students themselves. I often used a distinct pattern of lecture, giving directions at the beginning of each class, with questions interspersed throughout. The majority of teacher-student verbal communication occurred when students were either asked a question, or asked a question themselves.

If given a chance, the students often shared ideas with others in the class. However, during these times the students often received mixed signals from the teacher which would generally say, "I want to hear what you think about it, but what I have to say is more important." I now believe children learn through their interactions with others, and therefore, must be given a chance to develop new ideas by having their own ideas challenged by others through open discussion.

Recognizing that there is an incongruency between my teaching beliefs and my teaching practice is the first step. I now wish to explore several options which should help me facilitate better teacher-student communication in my classroom. Some of these are: giving written directions so students can refer to them during the lesson as needed; providing students with an outline, covering important points in the lesson; asking questions that promote thinking, relating questions to students' previous experiences; and encouraging students to talk freely amongst themselves in groups.

Conducting this study has given me insight into my classroom. I now realize that students come to class with a sense of inquiry. They are ready to explore and find answers on their own. I feel students are excited about engaging in the process of science, and they show this by their willingness to share ideas and beliefs with others. It is my job to step back and trust this sense of student inquiry. By not monopolizing the classroom I feel I can now provide rich opportunities for students to investigate the world of middle school science at a much deeper level than ever before.

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Elizabeth Graham

Years Teaching: 13

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"I, more than anything else, really enjoy working with the kids. Everyday it seems to present me with some kind of new challenge."

"Although the action research was time consuming, it was very rewarding. I was able to show myself areas of my own classroom that needed work, and I was able to see if the solutions were doable."

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The Use of Cloze Procedure as an Instructional Tool in a Middle School Classroom

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Abstract

This research evaluated using a modified cloze procedure in a middle school science classroom. Conclusions suggest that the cloze procedure may be beneficial to students who typically achieve on an average or below average level.

The purpose of this research was to assess the effectiveness of cloze procedure as an instructional tool in a middle school classroom. The question that the research revolved around was, "Does the use of cloze procedure increase student learning as measured by performance on multiple-choice tests?" For several years I have used a form of cloze procedure as an instructional technique in my seventh grade classroom. Although cloze procedure was originally developed as a way to measure the readability of written material, it has come to be used for a wide range of teaching purposes (Jongsma, 1980). I do not believe a textbook should form the core of classroom curriculum or dictate instructional methods. Yet, textbooks remain an important resource that can contribute to high levels of student learning. Improving the ability to read subject content has been shown to be an effective way of improving student comprehension (Jongsma, 1980).

Cloze procedure, which arose primarily in the field of reading, grew out of the cognitive school of psychology. Cognitive psychology, like earlier Piagetian theory, views learning as an active process that combines the acquisition of new information with prior knowledge and structures. Human behavior is not controlled by stimuli only, but also by how people interpret and react when in contact with the environment. A primary ambition of cloze procedure is to encourage the learner to link new information with previously learned material and to initiate questions to be asked. Besides helping the learner to link new information with prior knowledge, cloze sheets also actively involve the learner in thinking about what they are reading. In general, cloze sheets provide opportunities for recall and contribute to better conceptual organization of information (Santa, 1988).

> *"A primary ambition of cloze procedure is to encourage the learner to link new information with previously learned material."*

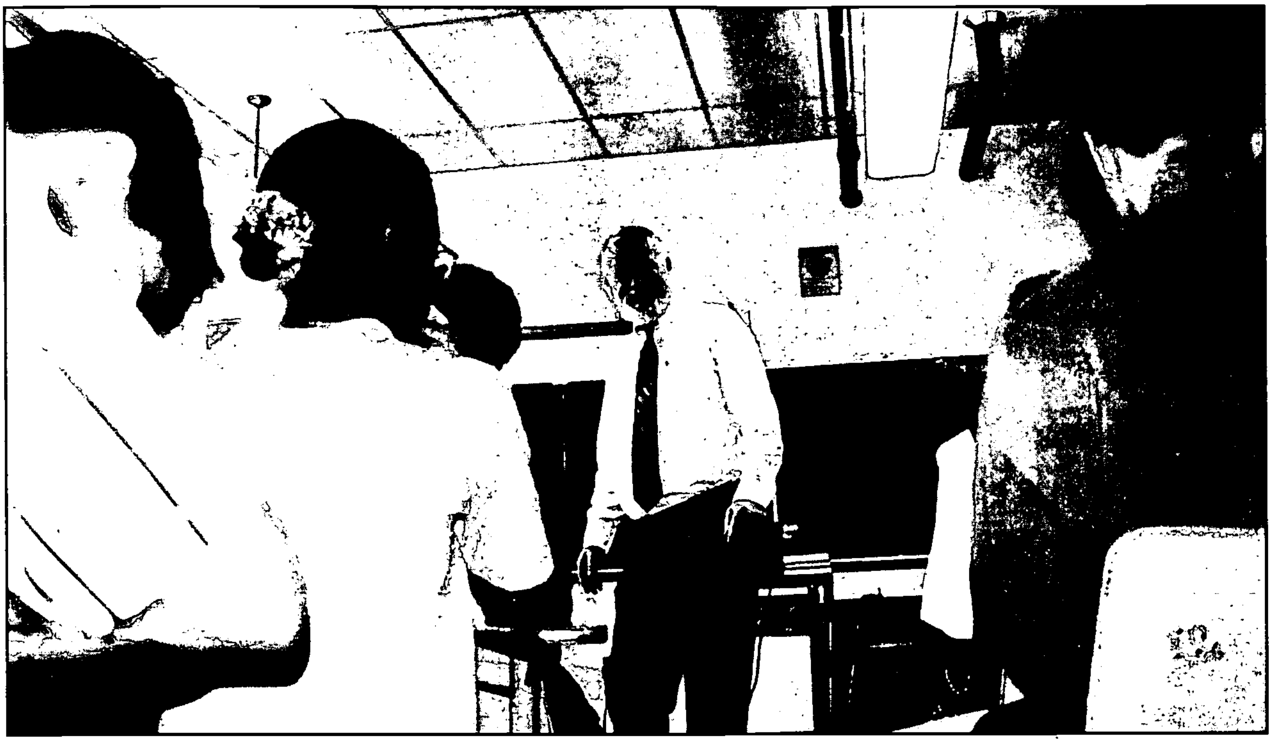
For the purpose of this study, standard cloze procedure will be defined as the random deletion of every n^{th} word in a body of text. A modified method is to purposely delete specific words of text that include key concepts and words. Typically, I construct five or six cloze sheets for a chapter of written material (the number of cloze sheets varies depending upon the length or difficulty of the chapter), selecting lines of text that I think best summarize and highlight key concepts and terms. These teacher-made "cloze sheets" are completed by students as they read assigned portions of their textbooks. The cloze sheets are then checked, graded, and returned to the students. I have found the quickest and most efficient way for me to grade the sheets is on a "did it" and "did not do it" basis.

I have found two major advantages to using cloze sheets in my classroom. First, the use of cloze sheets increases the likelihood that students will complete reading assignments, and second, completed cloze sheets can be used by the students as a study guide. A majority of my students verbally describe cloze sheets as helpful. Such anecdotal evidence from my students indicates that the use of cloze sheets aids in their learning. However, at the time of the study I was unsure whether the perceived gains justified the amount of time required for teacher preparation and student usage.

Review of the Literature

One of the developments for the use of cloze procedure has been for aiding student comprehension by creating teacher-made worksheets that summarize key portions of text. These worksheets delete relevant words that the student supplies as he/she reads (Santa, 1988). Several studies (Hayes, 1988; Gauthier, 1990; Andrews, 1991) have found cloze procedure effective in helping students make connections with concepts contained in content material. Fuchs (1988) found cloze procedure to be effective with special education students, while McKenna (1990) found cloze procedure to be marginally effective with upper-level elementary students.

Andrews (1991) completed a study in a high school science classroom with emphasis on the use of cloze procedure for creating a reading study guide. This study ascertained that only 28 percent of her students reported completing reading assignments prior to the introduction of cloze sheets. She found that "to complete the individualized reading study guide, students were unable to skim text material, but, instead had to read the assignment thoroughly" (p. 11). Also reported was a posttest increase of 16 points



in mean test scores. However, others (Kintsch & Yarbrough, 1982; van Dijik & Kintsch, 1983) have found the procedure to have little effect on students in grasping the text as a coherent whole.

Research Method

The research setting was a seventh-grade classroom in a rural county of a large southeastern state. The community possesses an agricultural history and presents a country facade, but nearly half of the employed adults in the county travel out of the county for employment. Many travel to a contiguous county that has a major research university and serves as a regional shopping and commercial area. The county's 1994 population was around 10,000 people. However, almost a 100 percent growth increase was experienced during the 1980-1990 census periods. Population density is approximately 25 persons per square mile.

The county population consists of approximately 95 percent Caucasian and 5 percent African American. The county's largest employers are the county school board, a prison, and a dairy. Primary agricultural products are hay, soybean, corn, watermelons, and vegetables. Although many residents are involved in agriculture, a majority of family income is often derived from non-farming employment. Local politics are typically dominated by these "old families."

The county has slightly over 2,500 students who are divided between two K-12 campuses. Both campuses are administratively separated into kindergarten through fifth grade and middle school/ high school which includes sixth through twelfth grades. Nearly 50 percent of the school's students are eligible for free or reduced price lunches.

The research design was a posttest-only control group design. In such a design, students were randomly assigned to either the experimental group or the control group. The treatment (cloze sheets) was administered to the experimental group and not to the control group, and both groups were administered a posttest.

The unit of investigation was the individual student. The population of the study included seventh-graders in my first four periods (n=100 students). A list was compiled of the first 100 students in each of my classes, numbering them from 001 to 100 in the order that they appeared in my class rolls. From a table of random numbers, 50 students were placed into the treatment group and 50 students were assigned to the control group. Of the total, 42 students were female and 58 were male. Forty-two of the 100 students participating in the experiment had received all of their schooling within the county, while 58 of the participants had moved into the county after beginning their public school education elsewhere. Nine of the students in the research group were African American.

The experimental treatment consisted of the treatment group completing a set of teacher-made cloze sheets in addition to participating in class lectures and activities in a single unit of instruction. While the treatment group completed cloze sheets, the control group was completing reading assignments without being engaged in the completion of a written product. The treatment group had the cloze sheets graded on a "did it"/"did not do it" basis, and they kept the cloze sheets for use as a study guide.

The potential for the treatment group to be resentful of the control group for not having to do cloze sheets became a concern. This problem was addressed by stating that while only the treatment group did cloze sheets for the second grading period, the control group, exclusively, would be required to do cloze sheets during the third grading period. Neither group was told that only the data collected during the second grading period was used for data analysis.

At the end of the unit of instruction both groups were given a teacher-made multiple choice test that yielded a numerical grade with a potential scoring range from zero to 100 percent.

Research Findings

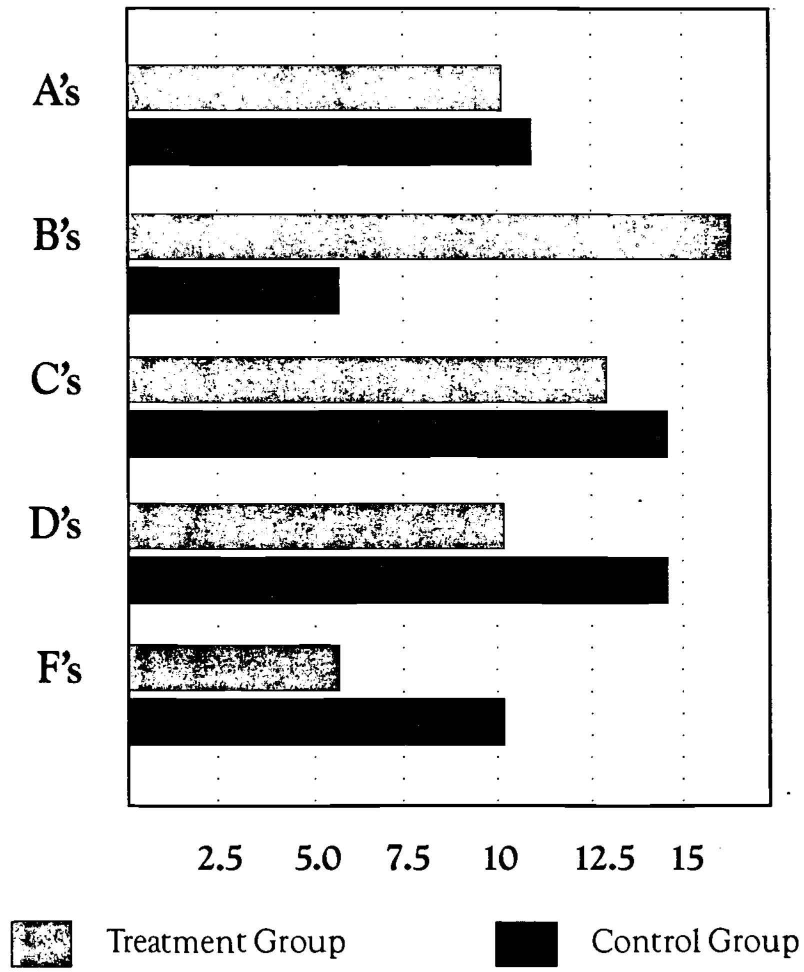
The research conducted was done to provide additional information about a classroom practice that I use regularly. Data analysis was conducted without the use of algebraic formulas or computer analysis. This choice of statistical procedures was made with the intention of encouraging research that was realistic for the average practitioner's classroom. Analysis of the data supported the affirmation that increased student learning did occur as a result of the use of cloze sheets. The treatment group produced a mean score four percentage points above the mean score of the control group.

An additional objective of the experiment was to ascertain whether the gain warranted the amount of time required for teacher preparation and student usage of cloze sheets. Data collected supported the conclusion that this may not be the case. The study produced only a four percent increase in the mean of the treatment group as compared with the control group. The treatment group did not achieve a greater number of "A's" than the control group, and the control group actually had one more student that received an "A." The treatment group did have a slightly higher mean score when only the "A" grades are considered (98% vs. 96.2%).

In this study, cloze sheets were not especially helpful to students with a history of consistently high academic achievement. I did not find this surprising. In my experience, by the time a student reaches seventh grade, those who receive superior grades often do not need additional external motivators to ensure that course requirements, such as reading assignments, are completed. However, median scores revealed that one-half of the students in the treatment group made grades above an 84%, which in our school means they received a letter grade of "B." The median score for the control group was a 76% which is only two percentage points above a letter grade of "D."

Figure 1

Test Scores by Letter Grade



Analysis of the data (see Figure 1) indicated that cloze sheets have the potential to help average and below-average students enhance their learning. The treatment group produced three times the number of "B" grades as compared to the control group, which received more "D's" and nearly twice as many "F's."

Implications

As a classroom teacher working with a heterogeneous student population, I believe the gains evidenced in this study justify the time required for teacher preparation and student usage of cloze sheets. In my classroom I now allow students who achieve an "A" in the course the option of either completing cloze sheets or choosing enrichment activities to do while their classmates are working on cloze assignments. This change in my classroom policy has not resulted in the expected protestations that this is "unfair."

Much research remains to be done on the use of cloze procedure for instructional purposes. A majority of published articles on cloze procedure concern the use of cloze for text selection and readability. Few studies address using modified cloze procedure as an instructional tool, especially with middle school populations. This research suggests that cloze procedure, used as an instructional tool, can be beneficial to students who achieve on an average or below average level.

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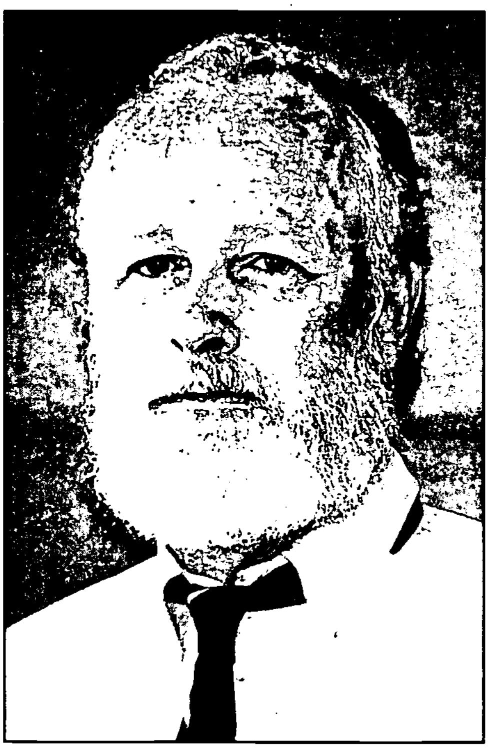


William H. Weldon

Years Teaching: 8

Present Position: 7th and 8th grade Social Science

"After teaching high school I really have found that I like teaching the middle school kids best. For most teachers middle school is a love/hate relationship. For me that relationship is love."

"The most important thing to me in doing the action research is to explore a question you really want to have answered. It must be something you're truly interested in and can't find in the literature."

Equality in the Classroom: An Attempt to Eliminate Bias in My Classroom

Stephen Thompson
DuPont Middle School
Jacksonville, Florida

Abstract

My research was conducted to see if I showed bias toward my students because of gender or race. I analyzed my own beliefs and found that to create a classroom atmosphere that is most suitable for teaching and learning I must come to an understanding of how I respond to students of all possible backgrounds.

The purpose of this study was to determine if I show racial or gender bias in my treatment of students. During the course of the study I defined bias as an inclination or preference, especially one that interferes with impartial judgment. This is an especially important issue in the area of science education, because research has shown that traditionally, minority and female students have had less success in science classes than males and non-minorities (National Science Foundation, 1988; The Task Force on Women, Minorities, and the Handicapped in Science and Technology, 1989).

If this large segment of the student population is performing poorly in one area of education, there must be a reason(s). Numerous studies have been compiled that try to explain the factors that contribute to this situation. One of these is that middle school science teachers show unintended bias in their treatment of minority students (Contreras and Lee, 1990). Having been awakened to these reports, I chose to focus my attention on the treatment of minorities in my own classroom.

There are two areas I examined in great detail during the study. These were discipline and interaction. In the area of discipline, I wanted to know if my treatment of students was the same regardless of their race or gender. In regards to interaction, I was curious to see if I responded and/or interacted equally with students, again based on these criteria. I feel that the way I act in each of these areas has a direct impact on students' attitudes towards school and, more important, towards science.

My disciplinary action in the classroom leads me to a situation where I feel I have a huge responsibility. If I treat a student unfairly because of a bias, then how will it

"If I treat a student unfairly because of a bias, then how will it affect that student's view of the subject matter?"

affect that student's view of the subject matter? As a student goes through his/her academic career, attitudes about subject matter can be strongly influenced by a teacher's attitude about that particular student. If a student receives positive feedback from teachers then the student will probably try harder, which should translate into more academic success. If a student is being unfairly singled out because a teacher has a hidden bias, then success becomes increasingly difficult, and it becomes hard to keep that student positively motivated. If this situation occurs over many years, how can one expect a student to excel or even do average work? The area of discipline in a science classroom then has far greater implications than just the immediate action/reaction that is visible.

If, as a science teacher, I want all students to have equal opportunity to succeed, I must provide an environment that will make success possible. The only environment where this is possible is one in which every attempt is made to eliminate bias. Teacher-student interaction plays a huge role in the success of students in the classroom. If I make students feel that they are welcome, a comfort zone should form. Without this feeling of comfort, I don't feel maximum learning is possible. It is only through positive, genuine teacher-student interaction that the zone begins to form.

"The teacher must make sure not to punish a child for what may be cultural clashes disguised as discipline problems."

Background

The first area I looked to explore was the effect that cultural differences have on teacher expectations. I feel students must know that the teacher expects hard work on a regular basis while in the classroom. If teachers are to convey this attitude, they must understand the different backgrounds from which each student comes. One must adapt to cultural expectations in order to match those of the student's home.

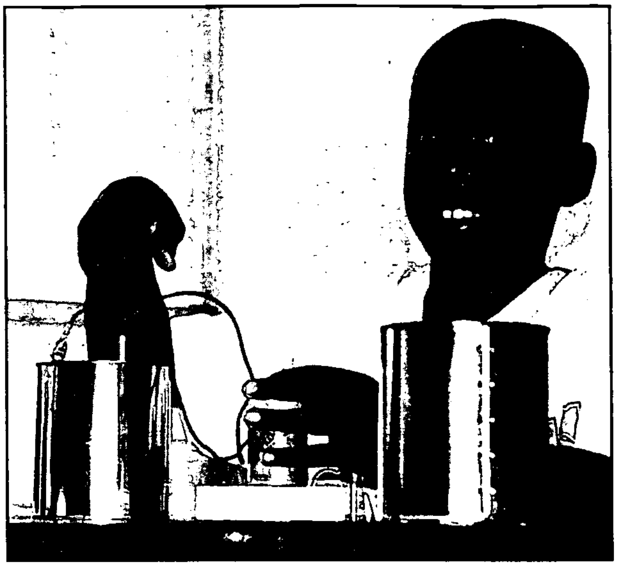
If this is not done, a type of cultural "clash" can ensue. The results of these cultural clashes are evident. The dropout rate among minorities is much higher than the rate among the majority in this country. In relation to science, one only has to look at the numbers of minorities employed in science-related jobs to wonder if science teachers are doing all they can to reduce clashing.

This idea can also be addressed when speaking of stereotyping. Our society inundates us with jargon to suggest that only white men can be scientists. Many movies that portray the lives of scientists show females only as assistants, not as scientists. This is an example of learning from society's culture, and this can negatively affect our decision-making process. It takes a great deal of introspection to realize that stereotyping may be affecting students' learning decisions. The clashing that often occurs is the clash between what is said, ("You can be anything you want") and what is experienced ("This is all you will ever be").

In respect to the relationship between cultural differences and interactions, the situation is clear. In order to socialize or interact well with someone, one must feel comfortable with the other person. This situation is not likely to occur if you are unable to understand the "frame of reference" or culture of that other person. Each culture also has its own ideas about what is acceptable behavior. One culture may expect children to be seen and not heard, while another encourages children to express themselves verbally. One thing is sure; as a teacher, one is going to encounter all types of cultures in the classroom. If teachers are to be effective, I feel they must be able to deal with all types of students who come from all types of backgrounds.

The teacher must make sure not to punish a child for what may be cultural clashes disguised as discipline problems. It is my belief that teacher expectations affect the discipline in a classroom. One must know the different levels of tolerance that are the "norms" of different cultures and consider these when constructing discipline plans. Students' attitudes and behaviors have a great impact on classroom discipline. However, both can be traced back to the teacher's understanding of and appreciation for specific cultures. If children feel accepted for what they are, then they will be less likely to have a bad attitude about the teacher and the subject matter, and a greater opportunity for learning with understanding should occur. The key, I feel, is to avoid the situation where the student is convinced that "the teacher does not like me!"

Finally, the level of teacher-student interaction that occurs in the classroom can play a role in affecting classroom discipline. The more genuine the interaction, the better both parties should know each other. If both parties share a common characteristic, then there is less chance of conflict based on miscommunication, which so often causes discipline problems in today's schools.



Method

Discipline

The first type of data I collected was gathered through observations. I observed my classes on videotapes, taping one class per week. Classes were selected on a rotating basis so that neither class nor particular time of day was prevalent. All classes were 52 minutes long. I turned the tape on between class periods and began counting responses from the time that the students walked into the room until the time they walked out. As I began my observations, I tried to identify patterns in my handling of discipline problems. I focused on any area of unequal treatment.

In doing my collecting this way I was able to see clearly any unintended bias that may have occurred. Using the videotapes also made me aware of other important aspects of my teaching that warrant further study in the future. These include classroom management, questioning techniques, and time management.

The second method of collection came in the form of a teacher discipline log. The log served as a place for me to express thoughts relating to the disciplinary situations from the taped sessions. Its purpose was to document my reflective thoughts so I could begin to identify the "whys" in my discipline decision-making process. If I have a bias, the first step in fixing it would be to understand why it was occurring. Log entries were made during my second viewing of each tape. Notations on the race and gender of each child were made, followed by my impressions of how I thought I handled each situation. I also made note of how the child was handling each situation. After viewing a completed session I recorded how many children of each gender and race were involved in disciplinary situations. I then compared these ratios to the ratios of my classroom populations. These ratios were compiled to help me see if there were clear biases in the number of a certain race or gender of children who were being disciplined.

Interaction

These data were collected through observations made while viewing videotapes of my classroom. I recorded data based on verbal teacher responses and teacher-student interactions during class (from this point on verbal teacher responses and teacher-student interactions will be called responses). These responses were broken down into three categories: positive, negative, and neutral. For the purposes of my study, I identified the three categories as follows:

1. Positive—any response that elicits a clear sign of acceptance, encouragement, or goodwill. Examples are a smile, a positive nod, or any body language which can be identified as showing that the students and/or teacher feel good about the situation.

2. Negative—any response that elicits a clear sign of unacceptance, discouragement, or bad intent. Examples include a scowl, verbal comments, or any body language that can be identified as showing that the students feel bad about the situation.

3. Neutral—a remark that shows characteristics of neither positive nor negative responses. Examples include simply answering yes or no, giving additional instruction or demonstration, and saying hello with no discernible expression or body language.

I made seating charts for each class, and these were labeled to allow for easy identification of each student's race and gender. During the observation period I used a tally system to mark the chart. Each positive response received a "+" sign, each neutral response received a "o" sign, and each negative response received a "-" sign. The purpose of using the tally system was not to gather numerical data. It was intended to allow me to identify patterns in the treatment of all students. Through the use of this system I hoped I would be able to see any differential treatment.

By using these tools, I believed that I would be able to see patterns in my treatment of students. These patterns could then be used to see if unequal treatment did exist and to identify what these patterns were. Once identified, I hoped the log would help me ascertain why these patterns existed.

Data

All data were collected during a twelve-week period beginning on September 8, 1994. After experiencing various difficulties with the videotapes due to an inability to see the entire classroom and an inability to identify what was being said while the air conditioner ran, I decided to extend the collection two weeks in an effort to ensure

adequate data on which to base any conclusions. One class was taped each week on a rotating basis, ensuring that no group was excluded or favored in the number of times that they were observed.

Coding and Analysis

The first step in coding my data was to make seating charts of each class I observed. I used the following abbreviations to identify students by gender and race:

AF African-American Female

AM African-American Male

CF Caucasian Female

CM Caucasian Male

HF Hispanic Female

HM Hispanic Male

XF Asian-American Female

XM Asian-American Male

OF Other Female

OM Other Male

I used these abbreviations when noting disciplinary actions and when analyzing teacher-student interactions. I tallied one mark (+, -, o) for each teacher response noted. This was done on the aforementioned seating chart.

I then transferred the marks onto a coding sheet which broke down all results by race and gender. Coding sheets were examined for frequency patterns. In this manner I hoped I would be able to clearly see any patterns that developed by gender or race. If patterns existed, I compared them to the patterns that were found in the discipline

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section of my study. If these patterns showed any correlation, then I felt that this was sufficient evidence to warrant future studies. Also, if a correlation was found, the teacher discipline log was looked to in order to offer additional insight.

Table 1

Coding Session #1

	Responses		
	+	-	0
Caucasian (25)	8	3	38
African American (2)	2	0	15
Hispanic (1)	2	1	5
Asian (0)	N/A	N/A	N/A
Other (2)	3	0	8
Male (15)	3	2	31
Female (15)	12	2	35

Table 2

Coding Session #2

	Responses		
	+	-	0
Caucasian (19)	3	4	36
African American (6)	5	9	7
Hispanic (2)	1	1	1
Asian (0)	N/A	N/A	N/A
Other (2)	1	2	1
Male (13)	5	13	17
Female (16)	5	3	28

Results

Interaction

The first tape I coded on the seating charts showed an immediate pattern. The class had equal numbers of males and females, while the racial make-up of the class was 25 Caucasians, 2 African Americans, 2 others, and 1 Hispanic. The coding revealed that I gave more positive responses to females during that particular period (see Table 1).

The second coding session did not show the same results. The class make-up consisted of 16 females and 13 males. I gave females a greater number of neutral responses, while the males received a greater number of negative responses. At the same time, I gave a large number of negative responses to African Americans and a large number of neutral responses to Caucasians (see Table 2).

The viewing of the fourth tape gave me additional insight into my research. The class gender make-up was 16 males to 6 females, while the racial mix was 11 Caucasians, 1 Asian American, 9 African Americans, and 1 other. Once again, I gave males more negative responses than females. As I examined the racial breakdown of the coding sheets I could find no patterns in the responses given to students of different cultures. The ratio of neutral responses was almost exactly the same as the class population ratios according to race (see Table 3).

The rest of the coding revealed a pattern that was so consistent, I began to group all data together (see Table 4). I saw in the coding that females received more positive responses than males did on a consistent basis. I also saw that males were much more likely to receive negative or neutral responses than were their female counterparts. However, I was unable to determine why this was occurring. I hoped that I might be able to gain more insight into my study through the discipline log. I felt that I may be able to further establish some type of pattern in my treatment of students in relation to discipline, and more importantly, establish why these patterns were occurring.

My treatment of students from different cultures was not so clear. I attributed much of this lack of evidence to the low number of minority students in my classes. There were, however, coding sheets which indicated that during any given period I may have responded more positively to a student from a certain race or culture. The duration of these patterns were usually short, only lasting for about one full class period. There were also coding sheets which indicated that I treated some races more negatively during certain class periods. An example can be seen in Table 2 where the data indicate that I gave more negative responses to African Americans. However, when I examined the data more closely this pattern did not hold true for any other class period. Further study failed to yield any data which showed a bias in my treatment of any particular race.

Discipline

I first examined the area of race in conjunction with discipline. Analyzing the data, I found no real connection between race and treatment of students. The ratios of students to disciplinary actions were very similar. I then attempted to examine the ratio of disciplinary actions based on gender. During the study I found that I took disciplinary action against males 13 times and females 11 times. This comes out to a ratio of one disciplinary action for every 5.2 males, and one disciplinary action for every 6.9 females. I found data to support these results in the teacher log where comments were made that seem to show me being more tolerant of female misbehavior. I also found that I was much more likely to act swiftly and firmly when a male misbehaved.

Table 3

Coding Session #4

	Responses		
	+	-	0
Caucasian (11)	5	6	10
African American (9)	2	4	6
Hispanic (0)	N/A	N/A	N/A
Asian (1)	2	3	2
Other (1)	1	1	1
Male (16)	8	13	14
Female (6)	2	3	5

Table 4

Averages of All Remaining Coding Sessions

	Responses		
	+	-	0
Caucasian (14)	7	6	56
African American (6)	4	3	23
Hispanic (2)	1	1	9
Asian (2)	2	1	6
Other (1)	1	1	1
Male (13)	5	8	51
Female (11)	9	4	44

Rarely did I give a male a warning, usually acting on the first sign of a problem. In contrast, I was more likely to give females "the look," on their first misbehavior.

> *"I also saw that males were much more likely to receive negative or neutral responses than were their female counterparts."*

There were no indications as to why I was reacting in this fashion, but there were no doubts that gender bias was occurring in my classroom.

Many of my comments in the teacher log tended to flow toward the area of maintaining classroom discipline. I stated several times that I acted swiftly in a discipline situation because I didn't want things to get "out of hand." I'm not sure if I did so because of my prior knowledge of the student(s) involved, or because the students involved were males. I also wrote that I felt that the punishments were usually appropriate for the situation. However, this could have been a further indication of my bias. In each case the method I chose appeared to work. Giving a female "the look" was usually enough, while using the same technique on a male usually wasn't quite a strong enough message.

Conclusion

The interactions section of my study indicated that I am much more likely to have a positive interaction with a female student than with a male student. This data also showed that I tended to be more neutral or negative towards male students. This discrepancy alone was not enough, I feel, to indicate that there is a difference in my treatment of males and females.

This cannot be said for the disciplinary section of my study, however, where clear patterns in my treatment of students can be seen. As a teacher of all children it is important that I am aware of any hidden biases. In this study I believe the most compelling piece of evidence found was that I do indeed have biases. When conducting my classes I seem to act more positively toward females, and act more stringently with males, meting out harsher disciplinary actions.

The reason for my gender bias is unclear at this point. I feel that much of it possibly can be attributed to all of the recent attention being given to discrimination against women in science. I have been exposed to a great deal of information in the last few years regarding this issue. It is possible that this is a subconscious attempt to NOT discriminate against women, an attempt to the point that I actually begin discriminating against males. My bias could also have something to do with the natural differences seen between males and females. As a male, I feel like I am more likely to "know what the boys are up to," whereas with females, I have not experienced many of the things they do, and am therefore unaware sometimes of "what they are up to."

It is my responsibility as a teacher to recognize the consequences of my actions. Is what I am doing helping female students become excited about science? Am I helping a young female scientist get the solid start she needs to fully develop her potential as a scientist? Is it possible that what I am doing is not that at all? By my actions I may actually be turning off males to a subject in which they have excelled in the past.

In doing this study I hoped that I would improve my teaching. I intended to do this by examining my own personal beliefs on

> *"Is what I am doing helping female students become excited about science?"*

Stephen Thompson

Years Teaching: 7

Present Position: 8th grade Physical Science

"I feel a good understanding of the Earth and its environment is essential to all people, not just scientists. I try to convey to my students the many environmental problems that are facing us now and those that will be confronting us in the future."

"Action research is a valuable tool. I think all teachers should be working to try to continually improve themselves. Action research is a way to help make these improvements."

discrimination. At the start I truly believed I had no bias toward any group. I now know that I was wrong. How I handle bias will have an impact on my teaching in the future. More important, it will also impact the attitudes of my future students. It will be those attitudes that shape the level of competence of our next generation of citizens and scientists, male and female, black and white.

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The Effect of a Teacher's Questions on Limited English Proficient and Bilingual Students

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Abstract

This study analyzed teacher behaviors when dealing with Hispanic students in a middle school science classroom. What was found to be most important is that a teacher's attitude can encourage LEP and bilingual students to become successful students in science.

Desks in Florida's classrooms are changing, occupied by a cultural mix of students very different from just ten years ago. In my school district, 1984 statistics showed a student population of 74.18% Caucasian, 23.45% African American, 1.88% Hispanic, 0.41% Asian, and 0.08% American Indian. In 1994, those statistics had changed to 72.68% Caucasian, 21.61% African American, 4.83% Hispanic, 0.64% Asian, and 0.18% American Indian. These changes in minority populations reflect how this area is growing demographically with a large influx of Hispanic families from northern states such as New York.

Meeting the needs of such a diverse population is one of the many tasks given to Florida's teachers. This study targeted one group of seventh grade students from this cultural mix, a Hispanic group of limited English proficient (LEP) and bilingual students. The purpose of this study was to investigate how questioning techniques that a teacher uses affects students' learning of science concepts and their view of themselves as learners. The students targeted for this study included one LEP student and two students who were no longer classified as LEP, but continued to speak Spanish as a second language. The research focused on interactions between these students and me, their seventh grade science teacher, during a unit on cells. Using data collected from videotaped lessons, interviews, a teacher's research log, and student answers to a set of open-ended questions, I identified various factors that helped LEP and bilingual students in learning science concepts. As the study developed, I also gained insight into how these students were influenced by the type of response given by their teacher when they asked a question.

The Background That Influenced the Study

Students come to my class from a variety of backgrounds. I try to find out what they know, introduce new ideas, and give them unique classroom experiences. I allow students time to reflect on their life experiences so they can make sense of science and weave new ideas into their knowledge base. Using flexible and creative methods to get across difficult points is one of my main strategies in teaching science. Due to the fact that every student is unique and has a personal learning style, I find it useful to use a wide variety of teaching methods. Often my students and I will break out of the arena of the textbook and abandon the established curriculum to pursue a topic of interest. Although these excursions are fun, I feel they are also crucial in making science meaningful to my students.

Because of my beliefs in how children learn, I am constantly looking for ways to enhance and improve my teaching. In choosing a research topic, I wanted to study an area where I felt a weakness existed in my teaching style. Four factors influenced my choice of a topic: (1) a videotape analysis of my classroom; (2) an awareness of a personal inadequacy; (3) interactions with two former students; and (4) a review of the current literature.

> *"I allow students time to reflect on their life experiences so they can make sense of science."*

Reflecting on my teaching methods, I noticed a pattern in my questioning techniques, particularly with the LEP and bilingual Hispanic students. During a summer research class, I was required to view videotaped lessons of my classrooms. When I viewed the tapes, I noticed that I tended to avoid asking questions of the LEP and bilingual students, or I asked them very simple questions. In thinking about why I did this, I realized that I felt the LEP and bilingual students would be embarrassed at not knowing the answer to a difficult question, or I felt that they did not possess the language skills to answer. In retrospect, I never gave them a chance.

A brief history of my background with LEP students is warranted here. My teaching experience has been in four schools. The first of these was a predominately Caucasian high school in a rural setting. I then taught for eight years in a racially mixed middle school where the student population consisted of Caucasian, African American, and a few Asian students. My next teaching experience was with a predominately low socioeconomic group of Caucasian students with no LEP students. I taught in this setting for five years and then moved to my current teaching situation, a culturally mixed school with students from several ethnic backgrounds. The school is located in an area where there is a growing population of students of Hispanic descent. Being exposed to such a different population of students has been a big change for me.

Several of the LEP students I taught last year made a lasting impression and evoked a desire to improve my teaching practice in relation to these students. There were two students who especially impressed me with their desire to learn and their extreme effort to be successful in science. Due to the influence of these students, I decided to focus my research on ways that a teacher uses questions to increase student learning, especially with LEP and bilingual students.

Educational research concerning questioning techniques and strategies has shown some interesting trends in teacher-student interaction. In classrooms of the past, teachers' questions seemed to dominate most student-teacher interactions. However, a new climate is emerging where the trend in questioning is shifting away from teacher-dominated to student-centered questions. Now, teachers and students explore questions together (Pollio, 1989). Teachers are being encouraged to use thoughtful, well-planned questions to focus on higher level thinking skills rather than spontaneous, off-the-cuff-questions. Questions promoting the how and why of things are being strategically used by many educators in today's classrooms. In this way, teachers and students become equal participants in the collaborative adventure of learning.

A teacher's questioning strategy can also promote critical thinking skills. Concerning the issue of asking questions of a high cognitive level, several studies have shown some interesting results. Higher cognitive questions are ones that lead students to compare, contrast, explain, give reasons, and apply their knowledge. Lower order questions promote factual recall, defining, and listing. There have been conflicting studies done that have looked to answer the question, "Does asking higher order questions lead to greater student achievement?" Early studies by Gall (Pollio, 1989) supported the idea that students would achieve more if asked higher order questions. In Winne's study (Pollio, 1989), results led to a conclusion that teachers who use predominately higher cognitive questions or predominately fact questions see little difference in student achievement. A later study by Redfeld and Rousseau (Pollio, 1989) showed an alternative view. In this study, asking higher order questions led students to score at the 77th percentile, while asking lower level questions led students to score in the 50th percentile.

Where the Study Was Done

The research site was a rural school with a population of 1,250 students. The school opened in 1993, fully retrofitted as a showcase school of technology. Every classroom in the school is equipped with a computer that is networked within the school and to the county office. A CD ROM tower allows access to the library from every classroom. Access to Florida Information Resource Network and the Internet is available from the library.

The student population consists of a rich cultural blend. The Hispanic population is a mix of students with Puerto Rican and South American ancestry, many from families which migrated from the northeastern United States. The school serves 37 LEP students.

How the Study Was Done

To learn more about how a teachers' questions affect students, I chose a qualitative research approach. The information I sought came from two sources, student interviews and classroom videotaping. By videotaping my classes, I was able to determine my own questioning style. The design of the study was emergent as described by Guba & Lincoln (1989). As I began the interview process, I saw the need to make changes in how I collected my data. Therefore, my techniques changed as the

study progressed. My initial plan was to focus on how questions asked by teachers affected the academic learning of science by limited English proficient and bilingual students. However, as I began to collect data, my focus shifted away from the facts the students were learning to examining how the students were affected by teacher-student interactions. This shift emerged as I analyzed the data from the initial student interviews.

To begin the study I selected a target group of students to question. To do this I made an initial list of all the Hispanic students on my team. Using this as a source, I conducted an informal poll to see if any of these students or their parents spoke Spanish at home. From this information, I selected a target group of four students–three male and one female–Alex, Roberto, Michael, and Maria. Michael was dropped from the study at a later date for ethical reasons.

Maria is a pleasant, well-rounded female student. She is twelve years old and is a high-achieving, steady learner who is conscientious about her school work. She sees the value of getting a good education. She was born in Puerto Rico and then moved to New York where she lived until she was in the second grade. Her family moved to Florida where she currently lives. Maria speaks Spanish with her family and friends, but at school she speaks English with teachers and schoolmates. She has good communication skills and is fluent in Spanish and English.

Alex is an average-achieving, twelve-year-old male student, who is classified as limited English proficient and bilingual. Although Alex does enjoy school, he occasionally becomes unfocused and gets into mischief. He makes average grades and shows more academic strength in math and science than language. Alex does well when his interest is piqued, but can be distracted by the actions of his peers. He was born in Puerto Rico and moved to New York when he was four. From there his family moved to Florida. Alex has average communication skills but often has trouble communicating his ideas in English. He enjoys conversing with his family and friends in Spanish, but uses English at school.

Roberto is a pleasant twelve-year-old male student. He lived in Puerto Rico until he was eight years old. His family then moved to Georgia and finally moved to Florida this year. He speaks Spanish at home with his family but converses with school friends and teachers in English. He comes from a traditional Puerto Rican family where education is strongly emphasized. Roberto stays very focused on his school work and maintains good grades, but he can occasionally get into mischief. When reprimanded, he is respectful and settles down quickly.

I explained the project to the students and asked if they would be interested in participating. I asked the students to tell their parents about the project and sent home a letter and permission slip to sign. When these were returned, arrangements were made with other teachers so that interviews could be conducted.

The next step in my research was to select a unit of the curriculum to present to the target group. I chose the unit on cell structure, function, and reproduction. This unit contains difficult concepts and terminology that most students know very little about. I felt this unit would enable me to successfully explore my questioning techniques with a target group.

In the next phase of research I studied the type of questioning environment that existed in my classroom. From research on questioning techniques, I had learned that the atmosphere in many classrooms is a rapid fire of questions, on the average of two-three per minute. Cazden (1986) showed that 80% of most classtimes involved the teacher speaking. Of this 80%, 30-50 % is lecturing, 25% is questions, and 2% is praise. In contrast, questions from students make-up only a small part of classroom interactions, 1% in high school, 14% in junior high, and 4% in elementary.

I was curious about my own classroom environment and how it compared with the research. I decided to videotape several lessons taught to the science class that contained the target students. I viewed three sample lessons to identify my questioning style. I analyzed these tapes to see how I questioned and responded to all my students, including the LEP and bilingual students. I also looked at the type of questions the students asked.

The following questions guided my analysis of the videotapes:

- Were the questions of an academic nature?
- Were the questions phrased clearly?
- Were questions of a high cognitive level asked?
- Were the student responses probed in a non-judgmental way?

These four aspects were part of eleven questioning practices Wilen (1987) identified that effective teachers use to increase student learning. I chose these areas to focus on when I analyzed my classroom interactions.

Academic questions are important in guiding students about the content being studied. I feel these questions are at the core of all classroom instruction. Procedural and affective questions are sometimes necessary in directing classroom situations, but these questions should not account for the majority of a teacher's questions if the concern is academic achievement. Clearly phrased questions give students a precise guide to find answers which the teacher is seeking. If a question is ambiguous, it is difficult for the student to know how to respond, and this can lead to frustration.

High cognitive level or higher order questions require students to know more than just a recall of facts. Higher order questions, defined by Gall (Pollio, 1989), enlist the student to analyze, compare, contrast, explain, and evaluate, while lower order questions promote factual recall, defining, and listing. High cognitive level questions seem to be effective in intermediate and high-school settings. I wanted to see how I used these questions in my own classroom.

> ***"Clearly phrased questions give students a precise guide to find answers which the teacher is seeking."***

Following the analysis of the videotapes for questioning interactions, data sheets were completed for each interaction. Each teacher question in the lesson was labeled as academic or non-academic. Academic questions related to the content material being presented, while non-academic questions related to other classroom factors such as behavior of the students, questions about directions, supplies, and time constraints. I was more interested in the academic questions and how I responded to them. Each academic question was analyzed, and I coded it as to whether the question was clearly phrased or poorly phrased, higher order or lower order, encouraged student responses or discouraged student responses. Clearly phrased questions were short, clear, and to the point, while poorly phrased questions were wordy, long, and vague. The kinds of questions that the students asked were recorded for both the target group of LEP and bilingual students and the other students in the class. Two separate tally sheets were used to distinguish teacher questions from student questions.

After determining the atmosphere of teacher-student interaction within my classroom, I felt I needed more information from the students on how teacher's questions affect their learning. Therefore, I conducted separate interviews with Roberto, Maria, and Alex. Most of the questions dealt mainly with biographical data, specific teacher behaviors, and feelings the students have when asked different questions in class. I asked the students to identify which teacher-questioning behaviors were the most helpful when learning a new concept. In this first interview I also probed the students about their content knowledge about the unit on cells.

Each interview was audiotaped, transcribed, coded, and marked with marginal notes. I made marginal notes as I read and reread each student's interview. The notes centered around four themes: phrasing of questions, self-esteem, level of difficulty, and vocabulary development.

After the first set of interviews was analyzed, I decided to make some changes in the design of the study. I chose to question the students as a group instead of individually. The reason for this decision was based on Alex's interview. While conducting this interview, I found it very hard to get him to respond more than "Yes, I do" to many questions. I felt that his guarded responses could be from his discomfort with audiotaping. To elicit more of a conversational atmosphere, I chose to interview the students together and use videotape instead of audiotape. The students were comfortable with videotaping as we had done several tapes for other curriculum pilot studies. I hoped that having the other students to rely on during the interviews would make it easier to elicit deeper responses.

The second set of interviews was designed to clarify and expound on the themes found in the first interviews. Here I took two specific questions and asked the students to give me input as to which question they thought was easier to answer and which question helped them to learn more about the subject. I also clarified their answers concerning how a teacher responds to their answers in class.

Another change that emerged was to have the students answer a series of open-ended questions where they could choose as many responses to a question as they liked. The decision to use open-ended questions was also influenced by the data from the first interviews. I felt the students all had trouble verbalizing their ideas and were searching for words in giving their answers. I hoped that by giving them some guided responses I could tell more about what they were thinking.

In the first interviews the students clearly showed concern dealing with how teachers respond to questions or react to students' answers. I structured the open-ended questions to delve into these thoughts. An example of the type of question I asked was, "When I ask a question in class, I like my teacher to . . .". The question was followed with a list of four or five possible responses from which students could choose. To complement this question, I asked "When I ask a question in class, my teacher usually. . .". Analyzing their responses gave me some interesting insights from their viewpoints.

In order to complete the study, I met all three students together for a final interview and presented the major ideas that I had learned. I discussed each idea and confirmed that these ideas were what the students had wanted to tell me. I listened to their final comments and asked for their opinions about the interview techniques I had used.

What I Learned in the Study

The first conclusion I was able to make from the data was that the questions I ask in class are generally of an academic nature and clearly phrased. I tend to ask more lower order questions of all my students regardless of their language background. Videotaped analysis of my questioning strategies showed that a majority of the questions in the sample classes were academic (57%). The number of non-academic questions throughout the study was fairly high due to the nature of the classes sampled. For example, one of the lessons involved explaining many procedures about an upcoming project. Eighty-three percent of the questions sampled were clearly phrased, while only 17% were listed as poorly phrased. In the classes sampled, 42% of the questions were higher order while 58% were lower order. My responses seemed to encourage the students in all the questions.

In analyzing the data from the videotapes, I determined that the questions I ask in class are academic and clearly phrased, but do not require the comparison and analysis that higher order questions require. I also found that I encourage students and try to elicit more responses when they respond to a question. When the students' questions were analyzed, 53% were lower order and 47% were higher order.

The data also showed that LEP and bilingual students process questions better when the questions are clearly phrased, stated slowly, and explained. A common theme that emerged from the student interviews was the importance of how teachers frame questions. Maria related that when she has difficulty understanding a concept, a teacher should repeat the question slowly so she can comprehend. Alex confirmed this idea. In his interview, he stated that it helps him when a teacher asks questions slowly. Roberto related that explaining new words helped him to understand difficult material.

In class I often find myself rushing to complete questions. Too often I am concerned about covering all the material. My LEP and bilingual students have given me a clear message to slow down, explain new words, and be clear in what I am asking. Maria and Alex told me that they ask questions to get more examples and information. When I observed my classroom videos, I noticed that I was rushing the questions and trying to fit in all the information, rather than slowing down and checking for understanding.

> ***". . . he stated that it helps him when a teacher asks questions slowly."***

I also found that the LEP and bilingual students in this study prefer questions that are higher order and challenging. It became apparent that the students' self-esteem was not challenged when they were given difficult questions, even when the question was answered incorrectly. From analyzing my classroom videos, I saw a tendency to ask more lower order questions. Due to my feelings of inadequacy in dealing with the LEP and bilingual students, I felt it best to ask these students easier questions which they could understand. In the interviews both Alex and Roberto told me emphatically that they like the more difficult questions. "The hard questions make me think," said Alex. In the second set of interviews, Alex confirmed this idea by choosing the more difficult question when offered two choices of questions. Roberto also showed a brave attitude about answering difficult questions when he stated, "Most teachers help with hard questions."

In previous situations, I was hesitant to ask difficult questions of my LEP and bilingual students for fear that they would be embarrassed if their answer was wrong. The students in this study showed high self-confidence and demonstrated repeatedly that they would not be embarrassed if their answer was incorrect. Roberto stated, "I'm not embarrassed by a hard question." Alex showed confidence when he said, "If I get a question wrong, I just find out the answer, and when you ask me again, I will know!" Maria was guarded in her reply, "It depends on how the teacher reacts to the question." In the open-ended questions, both Alex and Maria wanted more information and explanation when they answered a question incorrectly.

"LEP and bilingual students also seemed to want more detailed explanations."

The way I responded to a student's answer became as important a factor as the question itself. Self-esteem and confidence are linked to how a teacher responds to the student. Interview data suggested that students will risk answering a difficult question if they trust the teacher to respond positively. This assertion was dramatically supported in the interview with Maria. She had previously had a negative experience when a teacher responded to her answer in a very impatient and negative manner. This experience had influenced Maria and made her cautious in other classes. She related, "It tears you down. She [the teacher] gave me a look that said just answer the question!" The nonverbal look was just as devastating as the tone the teacher used.

LEP and bilingual students also seemed to want more detailed explanations. They enjoyed being questioned in great detail for they felt this process could lead them to a correct response. However, their teachers usually responded nonverbally or with short phrases of praise. When Alex and Maria were given a set of open-ended questions and allowed to select their responses, I learned a great deal about how teachers responded to them. When they answer a question incorrectly, they want the incorrect answer explained. When they answer a question correctly, they want more examples and explanation. Both Maria and Alex reported that teachers respond to incorrect answers by asking other students or giving nonverbal facial expressions. When they give a correct response, teachers give short phrases of praise like "Good job" or "Great." Clearly, my students have told me that they want to learn from incorrect responses and desire more explanations. From my classroom videos, I learned that my responses, although positive, were usually short and did not give more information about the topic.

Implications of the Study

In listening to what my LEP and bilingual students told me through interviews, open-ended questions, and videotapes, I became more aware of the kind of questioning atmospheres that help them learn. They often told me that they want more explanations, clear questions, and challenge. They also want the teacher's responses to be encouraging. Am I meeting these needs in my classroom? In looking at videotapes of my classroom interactions, I see questions that tend to be clear but less challenging. I see a teacher who gives lots of encouragement, but little explanation about the student's response. In reacting to a student's response, I often give a short "phrase of praise" rather than the detailed explanation that the students want. My questioning interactions often fell short of the learning experience they could become.

In reflecting on and analyzing my classroom interactions with the LEP and bilingual students, I have learned many ways to improve communication and stimulate questioning. I now make a conscious effort to take these new ideas into my classroom. I include my LEP and bilingual students in higher order discussions and give them a chance to answer more challenging questions. I am using more explanations and examples when I respond to students' questions. I think this is helpful to all my students and makes the classroom question and answer interaction a richer learning experience.

Other teachers can benefit from what I have learned about conducting qualitative research in my classroom. By using an emergent design in my study, I was able to analyze how I interact with my LEP and bilingual students. One of the most important aspects of my study was to see how much a teacher's response influences students' perception of themselves as a learner of science. I feel this is critical because of the alarming statistics of what is happening to bilingual, particularly Hispanic, students. According to the 1985 U. S. Department of Commerce Census (Rakow & Bermudez, 1993), only 49% of Hispanic students graduate from high school, while 79% of Caucasian students and 62% of African American students graduate. Why are so few Hispanic students finishing school? There are probably many different factors, but certainly a teacher's influence is one that must be considered.

In a survey by Rakow and Bermudez (1993), when students were asked what influences led them to pursue a career in science or technology, 75% of non-minority students stated that they had career counseling, while only 36% of Hispanic students received counseling. The non-minority group was also influenced by parents, friends, teachers, and counselors. The Hispanic group reported only personal interests influenced their choice. In a study by Ford (Rakow and Bermudez, 1993), teachers expectations were shown to influence Hispanic students in choosing scientific careers.

How can teachers use their influence to encourage Hispanic students to pursue science and counteract these alarming statistics? In Sutman (1993), strategies using content organized around themes, utilizing cooperative groups, and incorporating hands-on experiences help students learn difficult science material. Phrasing questions clearly and including English language development is also helpful.

Due to the current situation, where low numbers of Hispanic students pursue science and scientific careers, I think it is critical for teachers to examine how they interact with these students in the middle grades where science teaching becomes an integral part of the academic curriculum. In seeing how a teacher's response is important in forming students' perceptions of themselves as learners of science, it is crucial that we shape our responses to encourage, explain, and enlighten the Hispanic students. Teachers can either motivate with their responses, or they can tear students down. In order to fill the advanced science classes with bilingual students, teachers must mold their students early to view themselves as confident learners of science.

Learning from the literature and from my personal research, I have gained many insights into how I relate to my LEP and bilingual students. The most important idea in my study is that a teacher's attitude and response to the LEP and bilingual student can encourage these students to view themselves as successful students of science. I think that giving them this image will set them out on a journey of success instead of failure.

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"I'm a real child-centered type person, and I enjoy doing activities with children of all ages. I like being out of doors and sharing nature with my students."

"Doing action research was a real eye opening experience. Although it was difficult at times, it was definitely rewarding."

Conceptual Learning and Creative Problem Solving Using Cooperative Learning Groups in Middle School Science Classes

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Abstract

This research project was initiated to develop a model for middle school science teaching that utilizes carefully selected, heterogeneous, cooperative learning groups to enhance student motivation, conceptual learning, and creative problem-solving. Data collected from observations and student interviews show evidence that conceptual learning and problem-solving strategies were prevalent throughout the study.

I have been teaching seventh grade mathematics and physical science for eight years in a rural middle school (grades six-eight) with a population of approximately 1,000 students. Our school is organized in academic teaching teams consisting of two or three teachers. Each team of teachers is assigned a block of students (usually 34-35 per homeroom) and has the responsibility of scheduling classes for students. Team teachers have a great deal of flexibility in deciding which courses they will teach (depending on certification) and what period of the day they will teach them. Since most teachers teach two or three subjects, they generally see students from their team in their classrooms more than once per day. Student schedules can easily be adjusted within a team in order to meet a variety of individual student needs.

About six years ago, a majority of teachers from my school attended an intensive three-week summer workshop on teaching middle school mathematics. The mathematics content portion was an excellent re-

> ***"I tended to group students by gender and race."***

fresher course, but it also included a cooperative group learning component that was somewhat new to most of us. Since then, many teachers have had more training in designing groupwork, and virtually every teacher in the school now uses some form of groupwork in their teaching methods. Furthermore, the philosophy that groupwork is an effective technique for achieving many kinds of intellectual and social learning goals is shared among many of the teachers at my school.

Middle school science classes lend themselves particularly well to group learning. In our science department our teachers share a common philosophy that science classes should be active, and students should have hands-on experiences to build and reinforce concepts. Obtaining and preparing materials for science classes takes a substantial amount of time and planning, and it nearly always requires planning for groupwork so materials can be shared. In the past, this has added a significant time-consuming component to my planning. Decisions regarding who would be in each group, how many students per group, and where to locate each group involved many considerations. Also, depending on the activity and the materials to be shared, I frequently found myself rearranging groups. Sometimes I would even allow students to choose their own groups. But my decisions for group compositions were usually based on how well I thought the individuals would work together. I wanted the groups to consist of students who were compatible with one another so that more time might be spent working on the science topics at hand, and less time spent in arguments due to personality conflicts.

Several problems or dilemmas arose from my past methods of grouping students. By concerning myself with the compatibility of group members, I tended to group students by gender and race. My methods also allowed groups of friends or social cliques to form, which tended to amplify the status of those who did not seem to fit into any particular group. The groups of friends would often treat the laboratory or activity as "playtime" and would create classroom disruptions as a result. Finally, students who were in other classes together would tend to form groups, thereby creating extreme differences in abilities between groups.

Another problem I encountered with my former methods of grouping students was the inefficient use of planning time and classroom time. Each time the groups in the classroom were rearranged, the many decisions regarding group compositions, work stations, leadership roles, etc., had to be made. I generally found that at least two or three students would be extremely unhappy with their new group assignments or roles within their new groups, and occasionally I would make adjustments to appease them. All of this took a large amount of time out of our 45 to 50 minute class periods. It often seemed that the students were more concerned about whom they were or were not working with, than the task to which they were assigned. So, in addition to the inefficient use of class time, the focus of attention seemed to be diverted from the instructional objectives.

Although I have listed some problems related to groupwork that I have experienced in the last seven years, I have also recognized that groupwork can be a powerful teaching strategy that allows for a wide range of academic abilities. Several researchers have recognized and studied this as well. The ones I found that provided the best blend of theory and practice were Elizabeth Cohen and David and Roger

Johnson and E. Holubee. Cohen's book, *Designing Groupwork: Strategies for the Heterogeneous Classroom (1994)*, has been an invaluable resource that helped guide me through my own research project. The Johnson and Holubee book, *Cooperation in the Classroom (1988)*, along with other writings from their extensive research, has also provided me with many ideas and guidelines for implementing a cooperative group learning environment in my classroom.

Among the numerous findings of these researchers that effectively argue in favor of cooperative group learning in heterogeneous classrooms, several key features seem to stand out. One of these key features is the delegation of authority. When teachers give students a group task and allow them to make mistakes and struggle on their own, they have delegated authority. Delegating authority versus direct supervision in an instructional task makes students responsible for specific parts of their own work. Students are free to make their own problem-solving decisions, but they are accountable to the teacher for the final product (Cohen, 1994).

Another key feature of cooperative group learning is the idea that it is a superior technique for conceptual learning, for creative problem solving, and for increasing oral language proficiency (Cohen, 1994). The group situation is ideal for the development of thinking skills. Cooperative groups provide learners with the opportunity to practice generating causes and effects, hypothesizing, categorizing, deciding, inducing, and problem solving (Solomon, Davidson, & Solomon, 1992). When the groupwork assignment demands thinking and discussion, and when there is no clear, right answer, everyone in the group benefits from the interaction. Frequency of interaction on the task consistently predicts individual group learning when groups are working on discovery problems (Cohen, 1991).

One consistent finding of researchers trying to determine how talking and working together assist conceptual learning has to do with the student who takes the time to explain, step-by-step, how to solve a problem. This seems to be the student who gains the most from the small group experience. Putting concepts into words in the context of explaining to a peer is particularly helpful for conceptual attainment (Durling & Shick, 1976). Students can often address other students' questions more effectively than the teacher. In addition, discussion often captures various students' misconceptions that the teacher may never uncover (Bassarear & Davidson, 1992). They learn from each other; they are stimulated to carry out higher order thinking; and they experience an authentic intellectual pride of craft when the product is more than what any single member could create (Cohen, 1994).

Heterogeneous, cooperative groups can represent a solution to some of the problems associated with having a wide range of academic abilities within a classroom. Lack of skills in reading, writing, and computation need not bar students from exposure to lessons requiring conceptualization. These students can develop their basic skills with assistance from what is often an unused resource, the knowledge of their classmates (Cohen, 1994).

As I planned the types of instructional activities that would challenge my students intellectually and provide opportunities for creative problem solving, the idea to implement a long thematic unit of instruction began to emerge. The purpose for choosing a thematic teaching approach, rather than teaching isolated concepts, was to present problems to be solved as they related to the theme. This would also allow the cooperative groups to work together over a longer period of time than would normally be allotted using the isolated concepts approach.

At this point, it appeared that I had a clear, concise purpose for my research project. I wanted to see if my students' conceptual learning and creative problem-solving skills could be enhanced through the use of heterogeneous, cooperative groups. However, there seemed to be two other factors to consider: student motivation and patterns of student interactions. I felt that these were important behaviors to observe and collect data on because the conceptual learning and problem solving in the cooperative groups depended on a reasonable amount of student motivation and positive interaction.

Method

The qualitative research method I used most closely resembles an emergent design. At the outset my research design was not clearly focused. Instead, the questions I asked were broad and exploratory. These questions, however, did provide a strong beginning focus for my study. The idea of choosing a theme like rockets and using it to drive my physical science curriculum for an extended period of time really appealed to me. Then the idea of studying cooperative group learning in the context of an extended thematic unit enabled me to visualize a setting from which I wanted to make a detailed examination. My intention was to allow the research design to evolve as my questions became more focused and my data collection methods became more defined.

My first step was to carefully select groups for each of my three physical science classes. The cooperative groups were selected so that each group had a mixture of students by gender and race, but the primary consideration for group composition was to mix students by academic abilities. Once the groups were selected, I implemented the thematic unit on rockets. This required lots of creative problem solving and was conceptually challenging. Before the rocket unit actually began, the students were involved in a number of preliminary group activities that prepared them for rocket science. They also completed some cooperative group training exercises that were designed to teach them that their group successes depended on how well they interacted and assisted each other.

I collected data from four primary sources throughout this study. The source I thought would provide the most useful data came from the observations made by Marsha, a university professor of educational research, and one of her doctoral students, Nina. Together, they made eighteen formal observations in which data were collected on eight groups in my seventh period science class. The second source of data came from videotapes taken by a parent volunteer. The third source of data was in the form of student interviews, when one student from each group in each class was asked questions about how their groups worked together during the rocket science unit. Finally, I recorded many of my own observations and reflections, entered in the form of journal entries.

Assigning Groups

Each new school year, it usually takes about two weeks for our class lists to become stable, due to late enrollments. Since I intended to arrange the students into cooperative learning groups so that each group was heterogeneous in terms of academic abilities, I began analyzing grades and achievement test scores of the students from the previous year.

On a computer spreadsheet, I entered my class lists for my three science classes and the students' 1994 California Achievement Test (CAT) scores for reading, language, math, and science. About 10 percent of the students did not have CAT scores for a variety of reasons. However, I had administered a science and math inventory test to every student. These scores were also entered on the spreadsheet. Not surprisingly, when I ranked the students from highest to lowest in reading, I got a very different arrangement than the ranking of highest to lowest in math. In fact, each set of scores (reading, language, math, and science) showed remarkable differences in rankings from high to low. Since the unit of instruction that I had planned would involve precise measurement skills and mathematical calculations, I decided to use math scores as the basis for the heterogeneous groups.

I then selected the eight highest and the eight lowest math students in each science class. I chose the first highest and first lowest students to make up the first two members of each group, then the second highest and second lowest members for the next group, and so on until the eighth group had the eighth highest and eighth lowest math students. The remaining students were placed in the eight groups so that each group had four students (a few groups had three). The collective average math scores from each group were approximately equal. Also, I carefully mixed the groups by gender and race such that each group was as heterogeneously composed as possible. Then I showed the groupings to my team teachers and asked them for their suggestions. Since they taught the same students, they were able to make a number of useful suggestions.

Preparing for Data Collection

The activities conducted during the first two weeks focused heavily on measurement activities. Although the students were working in groups during these activities, they had not been assigned to their long-term, cooperative groups yet. I found that the majority of my students were quite deficient in measurement skills. Through-

out my teaching experiences, I have generally found these deficiencies to be typical for middle school students. My initial strategy was to inundate them with metric measurement activities. I placed a strong emphasis on identifying the differences between measuring length, mass, and volume.

By the third week of school, when the students returned from Labor Day weekend, the desks were rearranged from rows and columns to eight "quads" (four desks arranged so that students faced each other rather than the white board at the front of the classroom). The lab counters could now be used to relocate four of the eight groups (groups 1, 3, 6, & 8 or groups 2, 4, 5, & 7) to provide the maximum possible distance between the groups.

In the past I have had students arrange desks in groups as needed, but I always returned them to the "face-the-front" positions after class. This time I intended to leave the desks in quads for an indefinite period of time. Each desk had a label on it with students' names designating "who sat where" each class period. When each of my three science classes arrived, and the students found their assigned seats, I announced that these would be permanent groups and I assigned each group a number (Groups 1-8). Many students seemed surprised when they saw who their group members were. I had the distinct feeling that this was a different grouping arrangement than they had experienced in the past.

The first activity for the cooperative groups was a two-day project in which they were to determine the edible portion (by mass) of an average banana. This activity involved the precise measurement of mass, expressing masses as ratios (edible portion/entire banana), converting the ratios to percents, averaging percent calculations from all eight groups, using a calculator, collecting data,

> *"In the past I have had students arrange desks in groups as needed, but I always returned them to the 'face-the-front' positions after class."*

graphing results, and stating general conclusions.

On the second day of the banana laboratory, Marsha came to my class to observe the students working in their newly formed groups. Marsha and Nina had agreed to visit my classroom two to four times per week for nine to ten weeks. This opportunity drastically changed the scope and breadth of my study since two independent observers, each focusing on just four groups, could collect significantly more data than I could by myself.

Marsha, her husband Robert, Nina, and I met to discuss aspects of my study proposal, my classroom environment, my planned unit of instruction, and the focus for data collection. Robert, a secondary school science teacher, had volunteered countless hours in our school. He is very familiar with our student population and my own teaching style. He agreed to assist me with instructional tasks throughout the data collection period. We also discussed the specific types of behaviors to be observed and the type of data collection instrument we should design. Finally, we agreed to plan one more observation before beginning the formal data collection. I designed a trial data collection instrument for this observation, along with a list of individual student behaviors and group behaviors to be observed, and each behavior was assigned either a letter or a number code.

> *"I anticipated much discussion within the groups."*

For this observation, I decided to zero in on still another measurement skill weakness I have often observed in middle school students, correctly reading measurement scales. I chose four different sizes (10mL, 100mL, 250mL, and 500mL) of graduated cylinders for this activity. The volumes represented by the smallest increments on each of these cylinders were different and the numbers were only marked every ten to twenty increments. Since it would be necessary for the students in each group to extrapolate information from the volume marks with numbers to the volume marks without numbers, I anticipated much discussion within the groups as they went about the task of completing a group lab sheet. It was a good activity for Marsha and Nina to observe. They were able to identify all the groups and group members, familiarize themselves with the layout of the room, and let the students adjust to their presence in the classroom.

Marsha, Robert, Nina, and I made some final decisions about the data collection methods after this activity, and planned the first data collection for the next day. The group behaviors I decided to focus on were:

- Working together and taking a systematic approach to the task where each group member was involved in some way.
- Working together and devising a trial and error approach to the task.
- Asking the teacher or assistant to suggest an approach to the task rather than relying on resources within the group.
- No focus on an approach to the task.

The individual student behaviors I wanted them to observe were:

- Explaining directions or concepts to other group members.

- Asking questions of other group members.

- Encouraging other group members to get involved.

- Listening to other group members.

- Writing or recording data on the activity/lab sheet.

- Discouraging off-task behavior or playing.

Training Students in Cooperative Learning

It is a mistake to assume that children (or adults) know how to work with each other in a constructive, collegial fashion. Students must be prepared for cooperation so that they know how to behave in the groupwork situation without direct supervision (Cohen, 1994). For the purpose of training my students to work cooperatively and to rely on each other as primary resources, I devised some activities.

For the next three data collection days, the groups were engaged in a variety of problem-solving activities that required group decision-making. One activity that served to show aggressive or passive behavior was a vocabulary assignment. I wrote twenty-one physics terms on the board. Some of them were easy, everyday words like "weight" and "pressure," while others were harder terms like "buoyant force" and "center of gravity." The assignment was to pick any three terms and draw pictures representing those terms. However, a rule was imposed that no two students in a group could choose the same terms. This activity definitely stirred some commotion within the groups as the members quickly scanned the list of words and decided which ones they personally wanted.

Since the previous activity was designed to reveal the egocentric characteristics of individuals within the groups, it seemed logical to follow with an activity that required individuals to concern themselves with their group members to ensure their own success. Such an activity is called "Broken Circles" (Cohen, 1994). In Broken Circles, each group member is given an envelope containing pieces of a circle. The goal is for each group member to put together a complete circle. In order for this goal to be reached, there must be some exchange of pieces. Group members are not allowed to talk or to take pieces from someone else's envelope. They are allowed only to give away their pieces (one at a time). If the egocentric student finishes his circle before the others in the group, the "I'm-done-and-you're-on-your-own" attitude works against him. This activity seemed to have a profound effect on many students when they realized that they had to look beyond their own needs and see somebody else's needs in order to achieve the goals of the entire group.

Preparing for Rocket Science

By late September the groups had been working together for nearly four weeks. I was ready to begin the rocket unit, but I realized that there were still many prerequisite skills that had to be taught before I was ready to even mention the word "rockets." Meanwhile, I had announced to the science classes that they should start bringing in 2-liter plastic soda bottles because we would need many of them. They wanted to know what they would be used for, but I told them it was a secret. I like building up suspense and speculation in my science classes.

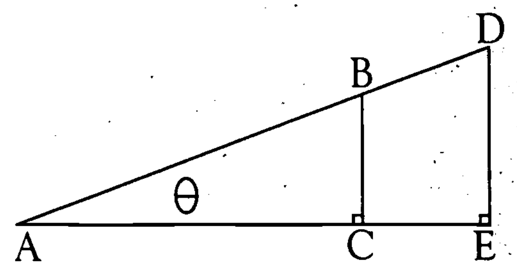
> *". . . they were going to have to understand what angles and right triangles were."*

Since they were going to have to use and understand a trigonometric function (the tangent ratio), they were going to have to understand what angles and right triangles were. The next step, then, was to teach the geometric concept of angles and have the groups use protractors to measure angles. This time I announced that there would be a grade given to the entire group for correctly measuring a page of angles (within 1 degree) and that each group member would receive the group grade. The purpose for this was that the students would realize that their own individual success depended on their group's success. If they did not agree, they would have to go back and remeasure the angle and try to determine where the error was. I observed that most group members were discussing the concept and trying to check each other's measurements.

Once the groups had demonstrated proficiency with their understanding of angles, it was time to introduce the trigonometric tangent ratio. I mentioned my intentions for doing this to some other teachers and non-teachers and I received an overwhelming response of, "Are you crazy? How do you think you can teach trigonometry to a science class where some individual students are operating on a math level well below seventh grade?" I think students who understand the concepts of angles, length, and ratios can also grasp the concepts of trigonometry. For example, students were able to understand that for any right triangle, if one starts at either of the two angles other than the 90 degree angle, the ratio of the opposite side over the adjacent side is always the same. For example, in the right triangle shown in Figure 1, the ratio of BC / AC = DE / AE, for any angle θ.

Figure 1

$$\text{Tan}\,\theta = \frac{\text{Opposite Side}}{\text{Adjacent Side}} = \frac{BC}{AC} = \frac{DE}{AE}$$



The groups were required to work under very structured conditions throughout the trigonometry lessons, which lasted for several days. It was time to provide another cooperative group training exercise called "Alligator River" (Cohen, 1994). This exercise required students to make moral judgments about the characters in a story and then rank them from best to worst. The activity required them to produce a group consensus and an explanation for their choices. Since this activity did not involve rigid calculations like the activities of the previous days, there seemed to be more contributions from certain group members than before. Marsha and Nina continued to collect data throughout all of these described activities.

In early October, as I continued to make preparations for the beginning of the rocket unit, it was time for the groups to construct inclinometers (instruments used to measure angles of inclination). I then told the students that we would use inclinometers, right triangles, and the tangent ratio to find the height of tall objects like flagpoles, buildings, pine trees, etc. I still had not mentioned the word "rocket."

After the construction was complete we spent two days practicing on a pine tree that was approximately twenty meters in height. This required a cooperative group effort since one student had to aim the inclinometer, another had to read it, and still another had to operate a calculator. Finally, a group member had to record all of this information on a group data sheet. I had each student practice these tasks several times until they demonstrated proficiency. Then, back in the classroom, we took each group's calculations and found an average for the height of the pine tree. Throughout this activity, Marsha and Nina continued to collect data on group behavior.

Beginning the Rocket Unit

Now the students knew how to use inclinometers to indirectly measure the heights of tall objects. Meanwhile, they had been bringing in 2-liter bottles for the past several weeks, and we had accumulated about 100 of them. Some students asked if the bottles had anything to do with the inclinometers. Finally, I introduced the "Panther Rocket Launcher," named after our four-teacher instructional team, "The Panthers."

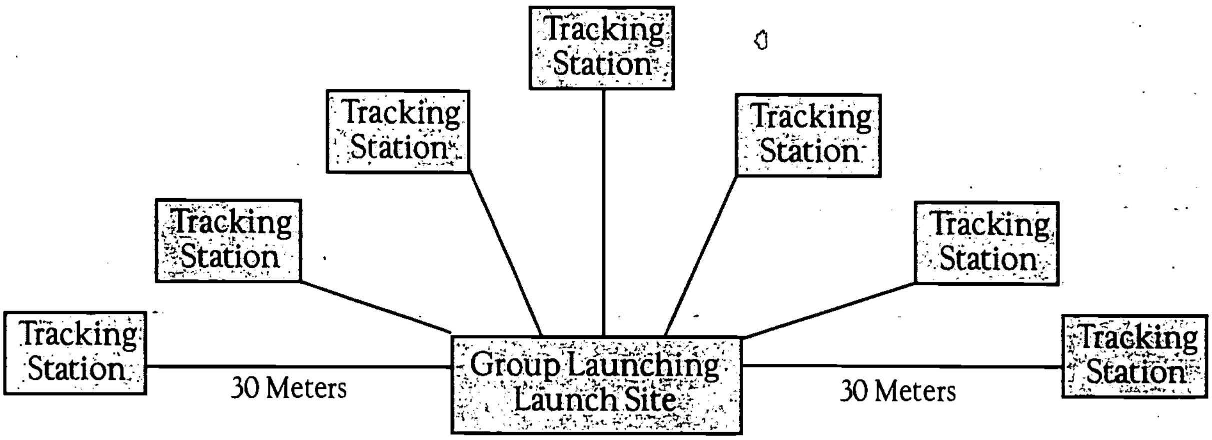
The Panther Rocket Launcher is a mechanical device designed to pressurize 2-liter bottles to pressures up to 100 pounds per square inch (psi). We used English system units for pressure (psi) because I couldn't find a pressure gauge that measured Kg per square cm. Since pressurized gasses are potentially dangerous I also designed the unit of instruction so that there would never be more than one group (4 students) near the launcher at any given time on launch days. The remaining seven groups would all be at designated tracking stations, each thirty meters away from the launch site. Figure 2 shows the locations of the tracking stations in relation to the launch site. I spent an entire class period with each science class discussing the potential hazards and safety procedures that must be practiced during rocket launch activities. I was emphatic when I stated that safety goggles must be worn at all times near the rocket launcher.

By the middle of October we had our first two rocket launch days. The students all seemed very excited and fascinated that a 2-liter bottle could climb so high. I limited the air pressures to 60 psi, but I left the decision for the quantity of water in each bottle up to each group. At the tracking stations each group was responsible for recording launch data for every launch on a group data chart. This data included launch numbers, the group launching, quantities of H_20 in milliliters, pressures (psi), the horizontal distance from the tracking station to the launch site (m), the angle of inclination ($^o\theta$), the eye height (distance from a person's eye to the ground) of the inclinometer operator (to be added to final calculation), and the altitude (rounded to the nearest whole number). In addition to recording the data, the group laboratory sheets had questions to answer and predictions to make. Since there was always some "down time" between launches there was ample time for each group to answer the questions.

After each launch day we had a data compilation day. Each group recorded the altitude calculations of the other groups and found the average altitude for each launch. They also recorded the group number that performed the launch, the date, the quantity of water, and the pressure. Unlike the group data sheet the data compilation was an individual data sheet. After the average altitude for each launch was calculated and confirmed throughout the class, that altitude would become the official altitude for that launch. Each student was then given a blank sheet of paper, a ruler, and a set of colored pencils which they used to construct a bar graph from the data. Using the bar graphs as references, several students commented on what they thought was the best quantity of water and the best pressure to achieve the highest altitudes. I did not tell them at the time that they were forming a hypothesis when they made those comments. I wanted to wait until the aerodynamic variables were introduced.

Figure 2

Locations of Tracking Stations in Relation to Launch Site



Assigning Roles Within the Groups

The data collection period still had about four weeks to go. It was time to assign each student a specific role or job to play in the cooperative groups (Cohen, 1994). The job titles I decided to use were: Principal Investigator (PI), Materials Manager (MM), Data Specialist (DS), and Safety Director (SD). Marsha, Nina, and I each assigned the students in each group a title and then met to compare notes. After some discussion about our decisions, we came to a consensus. We made many of our choices based on observed behaviors of the members of each group. For example, we gave the leadership roles to students who were displaying passive behavior and data specialist roles to students who resisted writing or displayed careless habits of writing. When I announced the job titles and their descriptions, I also presented the students with a badge that indicated their name and title. Some students seemed shocked and even upset at their role assignment, while others seemed genuinely pleased.

Designing Controlled Experiments

I asked students what factors or variables were the most important to achieving maximum altitude. We seemed to agree that the air pressure should be as high as allowable, but there was a wide range of opinions about the quantity of water, ranging from no water at all to more than one thousand milliliters. When several students said they thought the rockets would climb higher if they did not start tumbling at about 20 meters, we began discussing the aerodynamic shape of rockets. I then had them draw a 2-liter bottle upside down, and add components to it that they might like to build. For the next three days, we built many kinds of rockets with several different methods for attaching fins and nose cones.

Once the rockets were completed (including creative spray-painted designs), we set up a controlled experiment to test two variables: the quantity of water and the aerodynamic design. My fifth-period class did the experiment to find the best quantity of water and

"She then volunteered to write the questions and conduct the interviews for me!"

found it to be between 400mL and 600mL. From fifth-period's results, my sixth- and seventh-period classes decided on 500mL of water for every launch in their aerodynamic experiments. Unfortunately, we had an uncontrolled variable that adversely affected our experiments, Tropical Storm Gordon. The wind was blowing so hard on our launch days that our data was seriously skewed. Since we needed some data for our school science fair and we were running out of time, we had to launch our rockets anyway. I explained to my students that things like this probably happened to scientists all the time.

Completing the Rocket Unit

The last rocket launch day was also the last day that Marsha and Nina came to collect data. Although the experimental portion of our rocket science had ended, several students started exploring better ways to build new designs. The enthusiasm some students was so lingering that I continued to encourage them to try building new designs at home and bring them to school for testing.

An Additional Data Source

By the end of the first semester and before the Christmas holidays, I decided that I was through with the data collection phase of my study. I was fairly certain that the data collected by Marsha and Nina, my own reflections and observations, and the videotapes produced by my parent volunteer, Susan, during the unit would be enough to answer my questions. However, I soon realized that I was missing an important piece of the puzzle. That was, thoughts and reflections of the whole process from the students' perspective. I talked about this with one of my more outgoing students and she suggested I interview some of the students about their reflections of the rocket science unit. She then volunteered to write the questions and conduct the interviews for me!

The next day she presented me with an interview form she composed on her word processor called, "The Panther Group Efficiency Survey." The questionnaire consisted of eleven questions designed to elicit students' perceptions of how well their groups worked together from the beginning of the rocket science unit to the end. She then volunteered to randomly select one student from each group and conduct the interviews. She finished the task in two hours and presented me with twenty-four completed survey forms in which she carefully wrote down each interviewee's response to each question.

6 Results

Marsha and Nina made eighteen formal observations in which data were collected. The data collection instruments were designed so that each observer could focus on four groups. However, on six of the observation days, only one observer could be present, so data were not collected for some of the groups on those days. As Marsha and Nina observed the students, they added behaviors to the list which they thought were related to the questions being asked in the study. These additions were usually in written rather than coded form, so they were not added to the original list of behaviors.

Throughout the period of time in which data were being collected, I frequently wrote in a journal. My entries generally included my thoughts about student motivation and what activities were taking place in my classroom. My perceptions were that I had

never seen such high level student motivation in my entire teaching career as I had throughout the rocket unit. I observed students talking about the rocket unit between classes, and many students asked to come into my classroom during lunch to work on their rocket designs. I was certain that the cooperative groups had much to do with individual student interest.

Without initially having a clear plan as to how I might transcribe and condense thirty-four pages of coded and written data that covered a period of two months, I decided to select just four of the eight groups and track individual and group behaviors across the entire period of time. I selected two of the groups Marsha observed (Groups 1 & 8) and two that Nina observed (Groups 4 & 7). The method I used to transcribe and condense the data was to take one group at a time, list all of the activities for which data were collected on a computer spreadsheet, and write a brief description of individual and group behaviors for each activity. This allowed me to reduce the information to eight manageable pages so that I could easily read and compare the descriptions of behaviors for individuals and groups.

Group 1

Group 1 consisted of three boys and one girl. Initially, the members of this group accepted directions to work cooperatively with one another but often worked independently to complete tasks. For example, when I felt that the method for using the tangent function to calculate altitude had to be retaught and reinforced, I assigned each group to make calculations for the angles of 20 degrees through 89 degrees for a horizontal distance of 30 meters. When the papers were turned in, two of the group members had completed all 70 calculations, another had completed about half of them, and the fourth had completed less than one-fourth of the page with inaccurate calculations. This indicated a lack of sharing of information among the members of this group, as well as individuals working independently to complete tasks.

Most of the data sheets portrayed one of the students as being passive and unsmiling. She stated to one of the observers that she did not like group work. When asked why, she indicated the reason was because of her particular group assignment. When Group 1 was allowed to make decisions about who would do which jobs to complete an assignment, she always chose to fill out the lab sheet or record the data. However, when she was assigned the role of Principal Investigator, another of the students was very unhappy, as indicated in his journal.

Another group member was very outgoing and talkative. He raised his hand often and liked to participate in class discussions. During several of the group activities he was observed explaining directions to his group and initiating action plans. For example, when the task was to measure both the mass and the volume of a variety of solid objects, he attempted to explain his ideas of how the task could best be completed by the group. During other group activities, like the inclinometer construction activity, he sought feedback and approval from the teacher and assistant rather than from his group members. He also had a propensity for playing and being off-task.

The third member of the group was considered to be the main instigator of off-task behavior in the group. According to his CAT scores his academic skills were extremely low for his age and grade level. On some of the earlier group activities he was observed recording data on the lab sheets, but on almost every subsequent activity he was observed being disruptive to the other group members.

The final group member really became enthusiastic about the rocket unit. After the first launch day in which unmodified 2-liter bottles were launched, he began designing rockets at home and bringing them into class. He took advantage of an opportunity to attend a rocket demonstration day sponsored by Tallahassee's Science Odyssey Center. He built his own rocket launcher and began testing new designs on his own. Eventually he entered his own research in our school science fair.

Group 4

Like Group 1, Group 4 consisted of three boys and one girl. An early observation I made was that one student either would not turn in written work or would turn in very carelessly done, incomplete work. However, when his group was required to investigate something that involved a hands-on approach, he would become more involved. He demonstrated his mechanical abilities by volunteering to be the person who would transport and operate the rocket launcher, and after observing his techniques and safety practices near the launcher, I developed a trust and dependence on him.

The second group member was observed to be extremely passive, frequently off-task, and engaged in extraneous conversations that had nothing to do with the topic of study on at least six of the data collection days. Approximately one-third of the way through the study, she became very aggressive toward another group member, and pushed him out of his chair. On this same day, she became more involved with the group than was observed on the other days, she assisted in building the inclinometer. After that, she was absent from school during three of the rocket construction days and the last three launch days when the groups flew their new designs.

The third student started out to be competitive within the group, but on at least six observed activities he would appear to lose interest in the task at hand and would resort to playing. He showed more interest in the rocket unit later in the data collection period when he was recognized as having a creative idea for a method of attaching fins to the rockets.

Finally, the fourth student was slow to become interested in the rocket unit and was observed demonstrating passive or off-task behavior. He was absent (caught skipping) for three days during the instruction on how to calculate altitudes using the tangent ratio. Since his skills in math were already very low, when he returned and did not understand what we were doing, his motivation continued to drop. However, when he was appointed to the role of Principal Investigator his motivation took a major turn. He was observed asking questions, leading discussions, and offering ideas for improved rocket designs.

Group 4 showed evidence of improvement in their cooperative behaviors over the twelve-week period of time. Initially, the group members demonstrated a lack of focus in terms of how they completed tasks as a group. However, near the end, the group could be described as much more cohesive. They clearly demonstrated systematic approaches to their problem solving and they divided up tasks for completion.

Group 7

Group 7 consisted of two boys and two girls. The females seemed uninvolved during the first several weeks of the rocket unit as they were observed being passive and noncommunicative with their group members. The males, on the other hand, were extremely participatory. Both the observation records and the videotape records of classroom activities show them raising their hands to respond to almost every question. In addition, they were extremely engaged in the group activities and investigations throughout the entire rocket unit. About

the time when the cooperative group training exercises took place, the girls both took more active roles in the group. Both participated in filling out lab sheets and checking on each other's calculations, as well as making decisions about who would do each job. By the time the rocket construction and rocket launch activities began, this group had developed their own systems for sharing and rotating duties, and checking on each other for accuracy and completeness.

Group 8

Group 8 was another three-boy-and-one-girl group. The dominant member of this group was clearly the female. She was constantly observed leading discussions, initiating activity with data collection sheets, explaining directions to her group members, and keeping everyone focused. She always seemed to be aware of what was going on in the classroom. Generally, she was the first member of her group to understand a direction and was quick to convey what was expected to her group members. I observed her nudging her group members and cuing them as to what they should be doing.

One of the males was a relatively quiet group member but was observed working cooperatively with the group on most tasks. The group had a system for sharing the tasks to be completed and usually turned in lab sheets that were thoroughly completed. Although I encouraged groups to keep tabs on each other in this respect, the student still came up deficient when it came time to turn in individual work. He would neglect individual assignments like journal entries and his log of daily activities and assignments.

According to the CAT scores, the third group member was certainly the lowest of the group. He was extremely quiet, and when he spoke it was noticeable that he had a speech problem. He never raised his hand and volunteered information but would turn in his share of the work completed by the group. I asked if he liked the groupwork and his assigned group. He responded very positively. However, he also told me that he did not like being the Principal Investigator, the role to which he was assigned.

The fourth group member was also fairly quiet in the classroom. He had the highest CAT math scores of any of his group members and shared his skills with the whole group. He was observed during several of the activities taking charge of the lab sheet and trying to keep the group focused.

Another observation of Group 8 was that there seemed to be a lot of giggling going on during many of the group activities. However, the giggling never seemed to interfere with their efficiency in completing their tasks. As a group, they were very successful at completing all group assignments, developing systems for problem solving, and sharing information with each other.

> ***". . . data consistently indicated that the students were working together in their groups to overcome some of the obstacles to understanding."***

Discussion

Marsha and Nina systematically recorded data on eight cooperative learning groups in my seventh-period physical science class for twelve weeks. They were looking for specific behaviors that might indicate that conceptual learning and creative problem-solving skills were enhanced through the use of cooperative learning groups. Their data consistently indicated that the students were working together in their groups to overcome some of the obstacles to understanding and using the difficult conceptual material involved in the rocket science unit. Their data also indicated that sometimes there were strong disagreements among some group members, especially in Group 1 and Group 4. Interestingly, I observed many more instances of disagreement about concepts and approaches to problem solving in my fifth- and sixth-period classes than I did in my seventh period. This was not necessarily negative as I surmised from the results of Kathy's survey.

Although the results of Kathy's survey cannot be used directly to support the argument that conceptual learning and creative problem solving took place through the use of cooperative learning groups, it can definitely be used to argue that a significant amount of conflict and conflict resolution took place. According to some researchers, conceptual conflict, resulting from controversy in the group, forces individuals to consider new information and to gain cognitive understanding in a way that will transfer to new settings (Johnson & Johnson, 1990).

When queried as to whether or not there were any "fights" during the groupwork, 42% of the respondents. representing 10 out of the 24 groups answered "yes." Meanwhile, 71% of the respondents rated their group

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Years Teaching: 10

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"I've been a hang glider pilot for around 10 years now. I often share videos of myself and other pilots with my students. They usually say, that really looks like fun, but I wouldn't want to try it!"

"The action research was time consuming and involved some really intense writing. However, I've never had so much reflection on what's going on in my classroom."

performance as "good," and 88% reported it was "better" at the end of a semester of working together. This indicated to me that a certain amount of controversy took place during the semester of groupwork, but the large number of positive responses to the question of how they perceived themselves now in terms of working together indicated that many conflicts were resolved.

Another interesting result of Kathy's survey was that when asked which type of work they preferred, 25% said they preferred groupwork, 12% said individual, and 63% said they preferred a mixture. This information did not help me with my study questions, but it did inform me that I should provide a balance of types of work when planning for instruction.

One of my primary focuses for this study was to carefully choose my groups so that they were clearly heterogeneous from both an academic and cultural standpoint. Another main focus was to assign specific roles or jobs within the groups so that each member would be perceived as a valued player. The roles were also designed to make the group members more dependent on each other and less dependent on the teacher. However, according to the respondents of Kathy's survey, 92% indicated that they would have changed their jobs if they could. When the jobs were assigned, the intent was to "bring out" the very behaviors that were not being observed. For example, when one student was observed as being passive and unsmiling, we assigned her the job of Principal Investigator to bring out more assertive behavior in her. All of the roles were assigned to all of the students with similar objectives in mind. Perhaps allowing the students a part in the decision making for jobs would be a good idea next time.

Cooperative group learning is much more than just putting students in groups and giving them assignments to complete. In doing this study, I set higher expectations of my students than I ever had before. The conceptual learning and creative problem solving that took place was clearly indicated from the data sources. The rocket science unit of instruction challenged all of the students, especially in terms of the difficult mathematics concepts. However, all of the other aspects of the unit were equally challenging, and the sharing of ideas and group problem-solving strategies were prevalent throughout the unit. Student motivation was higher than I had ever seen when we were in the midst of rocket science. In fact, one student became so motivated about rocket science that he won third place in the 1995 State Science Fair and an overall "Best of Show." If anyone else can benefit from the model of middle school teaching that I developed, I would be ecstatic, but the model was truly for myself and the students that I teach. I certainly intend to keep improving the model in the years to come.

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Long-Distance Collaboration: A Case Study of Science Teaching and Learning

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Abstract

This research focused on the implementation of a school site study and model building project carried out by teachers and students in Florida and Connecticut. Despite problems associated with timing and coordination, the collaboration provided a relevant and meaningful learning experience which students found very enjoyable. Students received practice in the use of science process skills, as well as scientific attitudes of imagination, openness to new ideas, and skepticism.

I am a sixth-grade teacher in the only middle school of a rural North Florida county. As a member of a three-teacher interdisciplinary team, I teach three life science classes as well as two other subjects. All classes of about 30 students are heterogeneously mixed by ability and gender. Our team plans together daily, integrating curriculum in all school subjects as much as possible as we share experiences and discuss ways to maximize student learning. In addition to five academic classes of 50 minutes each, all team teachers teach a 45 minute "advisement" class three days a week to 10-12 students from each of our homerooms. This is a time of more relaxed and personal interaction than regular classes allow, where problems related to social and emotional growth and academic success can be explored. This student-centered, interdisciplinary organization has earned praise from our local community and recognition around the state and nation.

In 1990, my team was invited to join thirteen other teams of teachers around the country in the Human Biology Middle Grades Life Science Curriculum Development Project (HumBio) of Stanford University. For four summers we attended summer institutes at Stanford, reviewed the HumBio

". . . teachers created 'wish lists' of information they would like to share with other schools."

curriculum, met with the authors of the curriculum, tried out new teaching activities and techniques, and planned our implementation of the curriculum units.

During the school year, we pilot-tested the curriculum and provided feedback to the HumBio staff. From the beginning, plans were made to facilitate communication by electronically networking all of the pilot sites with one another and the project staff at Stanford. This goal was finally accomplished in the spring of 1994 using EcoNet and Alice Software. Alice Network Software's goal is to simplify telecommunications for middle and high school teachers and students, and to provide affordable software with a full range of tools essential for collaborative science investigations to all schools (TERC, 1993).

At the beginning of the 1994 Summer Institute, a brainstorming session was held to stimulate interest and ideas for fully utilizing the network. Over the next few days, teachers created "wish lists" of information they would like to share with other schools. Two eastern seaboard schools, a middle school from Connecticut, and a middle school from Virginia, expressed an interest in designing and carrying out collaborative projects with our school. Valuing the collaborative nature of scientific work (Rutherford and Ahlgren, 1990) as I do, I was anxious to see the student collaboration I had achieved through cooperative group learning extend beyond the walls of my classroom. I had also read and heard about telecommunication projects in Florida utilizing the Florida Information Resource Network or FIRN (Barron, 1993) and was eager to experiment with it. On the last full work day of the institute, teachers from the other two schools and I met informally to discuss the types of things we might do. As principal players in the telecollaboration, the science teachers at the schools led the discussion, but other team teachers, namely the media specialist from Connecticut and the language arts teacher from my school, provided helpful input and support.

Three collaborative projects were planned, each one utilizing electronic mail for routine communication and data sharing. After our planning meeting, we discussed our plans with the HumBio networking director, then shared them with the other HumBio participants. A description of each project follows:

Project # 1–Estuary Study

One of the reasons the three schools banded together in the first place was our commonality of being close to the coast and near important estuaries. The Connecticut school is located near the mouth of the Niantic River Estuary. The Virginia school is near the Chesapeake Bay Estuary, and our school is only an hour away from the Apalachicola Bay Estuary. The first project involved an estuary study complete with field investigations, the results of which would be shared with the two other schools for comparisons and contrasts. Since this project was planned to be carried out at each school in the spring of the year, we did not give it much structure, hoping to do so during the school year through e-mail.

"Three collaborative projects were planned, each one utilizing electronic mail for routine communication and data sharing."

Project # 2–Roadkill Data Collection

Intrigued by the data table and graphing capabilities of the Alice Software, the second project we planned focused on the collection of quantitative data. Almost immediately, the idea of recording roadkill in our respective areas was chosen for three main reasons. One, it was data accessible at all three school sites and easily observed and recorded by students on the way to school and home each day. Two, it would probably appeal to the exotic interests of middle school-aged students (Egan, 1992). Three, a comparison of roadkill in three diverse areas of the country might garner some unexpected results, and would enable students to gain insights into the diversity of animal life in each area.

We decided to have students begin reporting roadkill sightings as soon as was reasonably possible after school began. The data would be entered daily on an Alice data sheet, and e-mailed to the two other schools each week. The spreadsheet template we developed required columns for animal species, quantity, date, location of the sighting, and weather conditions. It was suggested that topographical maps of each school's local area would help create a more complete picture and should be provided to the other two schools. We decided to continue the reports for as long as interest in the information remained high.

Project #3–School Site Study

The third project was designed to exercise the deductive reasoning abilities, ecological knowledge, and imagination of our students. Each school would complete a series of quadrat studies on each of the four directional sides of the school's building. An inventory would be made of the biotic

> *"How would students benefit from a project conducted in collaboration with a distant school?"*

(living) and abiotic (nonliving) factors found in each plot, and samples of organic and inorganic matter would be collected and placed in labeled bags. All of this would then be mailed to the other two schools, and used by the students to create a visual picture of the other school environmental settings. Once completed, a video would be sent so that students could really see what the school was like. This project was planned to be carried out simultaneously at all three schools in the early fall.

Purpose

The research presented in this report is a case study of the implementation of Project #3, the school site study and model-building project. The purpose of my research was to assess the benefits to students of a project completed in collaboration with a distant school.

Increasingly, schools are becoming equipped with the latest in technological tools, and teachers are working hard to learn how to use the technology as an integral part of the learning program. My own school has experienced tremendous growth in technology in just the last three years as we have added an integrated learning systems laboratory, vocational technology laboratories, and science technology laboratories. Each lab is equipped with enough computers to accommodate 30-35 students, and features software packages that provide a wide range of experiences including tutorials, references, publishing, graphics, simulations, animation, video production, and internet surfing. Also, new computers have been added to teachers' classrooms, and four teachers in the school, three of whom teach science, have modems. With the ability to instantly communicate with other computers all over the world while sitting in our classrooms, what kinds of activities do we do?

Collaboration among students and teachers is certainly one of the possibilities that exist. Already, teachers and students have come to understand the benefits of interdisciplinary team structures that are a hallmark of the middle school movement in our country (Arhar, Johnston, & Markle, 1992). No longer teaching in isolation, teachers interact to plan for instruction and to facilitate student learning, often forming strong bonds of support for one another. Teachers also prize collaborations with students on tasks that have been cooperatively defined and carried out (George, Stevenson, Thomason, & Beane, 1992). The concepts of working together toward common goals is at the heart of cooperative group learning models that have become recommended instructional strategies in today's classrooms, and are touted as having the potential to improve achievement, attitude, and interpersonal skills (Florida Science Framework Commission, 1993). Telecommunications technology makes it possible to extend the field of collaboration beyond school walls, to involve teachers and students in distant locations.

How would students benefit from a project conducted in collaboration with a distant school? Because the availability of modems and network software in classrooms is new, there is little to be found in the research literature today—particularly written from a teacher's perspective. My research aims to begin to provide answers to this question.

Methods

The school site study was carried out in all three of my science classes. The first phase was a model-building activity. The second phase was represented by quadrat studies performed at our school, and the third phase was the viewing of the videotape from the distant school. During the duration of the research period, which lasted from October to February, I collected data to be used to ascertain the benefits associated with collaboration over long distances. I had the plans for the project, and kept hard copies of all e-mail correspondence between the schools. Student work such as drawings and models was also kept. My own observations and reflections were recorded throughout the school year in the form of brief "memo" type notes and journal entries. A videotape of student groups presenting their school models was made and served as data, as did the written reflections that were solicited from the students after each implementation of the three phases of the project. These reflections were free response comments regarding each student's opinion of the value of the project. Together these data allowed me to describe the school site project and the benefits of the project to my students.

School Site Project

On September 24, 1994, I received a large box from the Connecticut middle school that contained 14 sample bags of biotic and abiotic things taken from quadrat studies at their school. The bags were clear, plastic, sandwich-size bags with zipper closures and each was labeled with the side of the school from which the sample had been taken and the names of the students that had completed the quadrat study. Attached to each bag was an inventory of its contents. Extra space in the box had been filled with clean paper trash that appeared to be the contents of a teacher's trash can. Close inspection of the filler paper revealed a wealth of information about the school. Discarded school newsletters, assignment calendars, class rosters, and homework papers held the serendipitous potential of providing extra information about this "mystery" school.

The arrival of the box caught me at a time when science classes were wrapping up an ecology unit by creating books on local Florida ecosystems. Since students were working to meet a deadline, I could not stop everything and introduce a new activity, so the box had to wait two weeks. This was unfortunate since the box was quite smelly due to the decomposition of organic matter that had occurred after being packed. Some of the once-green leaves were so decomposed that identification would have been

> *"I stressed to the students the importance of basing their assumptions on the evidence presented in the sample bags, just as scientists base their own ideas on evidence."*

difficult. An e-mail message from Connecticut had suggested refrigeration of the sample bags containing organic matter. This slowed further decomposition, but so much had already been done that it was not a great help.

I first presented the "mystery" box, as I called it, to science classes on Friday, October 7, and explained that we would be using the evidence in the sample bags to create a model of the immediate environment of the middle school. This would be followed by a video from the school so we could see how closely our models matched the real thing. The students were immediately intrigued and excited, wanting to view all of the contents of the box immediately. Since the students were arranged into cooperative groups of four to five students, I distributed two bags to each of the seven group tables, gave them two-three minutes to inspect the bags, and then asked each table to rotate their bags in a clockwise fashion. By the end of the period, every student had been able to view all of the bags, but no work toward creating a model had been done. In order for this to happen, I knew students would need access to all of the bags at once. I spent some time over the weekend developing a plan for providing such access and defining the product I wanted the students to complete in the model-building activity.

Phase 1–Model Building

I decided to write the inventory list from each sample bag on four large sheets of chart paper, one for each side of the school (north, east, south, and west), and posted them in the front of the room. I used a different color of marking pen for each bag. In that way the students could easily distinguish the contents of one bag from another and count the number of sample bags taken from each side of the school. (We found the fact that six bags were gathered from the east side of the school, four from the north, and only two each from the south and the west to be possibly significant.)

Listing the bag inventories on chart paper solved the problem of making all of the evidence visible and accessible to everyone at once. Meanwhile, the actual sample bags were displayed on the back counter and made available to anyone who wanted an up-close look. We kept the bags closed because the decomposition in some of the bags created nasty odors.

I had decided that students would be creating models of the school environment as cooperative group projects, and that the model would take the form of a large two-dimensional color drawing of the school site as if viewed from the air. Before the students began to work in their groups, I thought it best that they spend some time as individuals thinking about the models. So, the first assignment on Tuesday (we had a three-day weekend) required students to work independently to create their own map on notebook paper. In addition to the map, I asked them to create a table describing in words each side of the school in one column and listing the evidence to support that "vision" in a second column. I stressed to the students the importance of basing their assumptions on the evidence presented in the sample bags, just as scientists base their own ideas on evidence.

On Wednesday, with individual maps and ideas on paper, the students began to work together in groups (4-5 students), sharing their maps with one another. The students were surprised to find that almost everyone had interpreted the data differently. I emphasized that consensus be reached based on rational argument supported by the evidence, and they began to work on developing a group model that everyone could agree with.

Overall, I was impressed by the degree to which students participated in group discussions and by the quality of their interactions. Notes taken from my observations in the second-period class showed only one of the seven groups having problems with bickering and off-task behavior. Redirection on my part, followed by periodic checks, helped keep them focused. No problems were recorded in the third-period class, and only one table in fourth-period needed my intervention. In that case, a boy at the table was unhappy and sullen, refusing to participate. As it turned out, he became upset because he felt the other group members were not using the evidence to support their ideas and would not listen to him. I suggested that the other students hear him out, and when they did, he was able to convince them that some of their ideas were misguided. They wound up starting again from scratch, giving him equal time in the discussion and decision making.

On Thursday, the students came in and went right to work. Poster size sheets of white paper and colored markers were the materials they used to make their site maps. On the first day I had announced that Friday's class time would be devoted to group presentations of their models, so with little time, everyone worked industriously. All but two groups were finished by the end of period, and the groups not finished simply lacked some color on their maps (see Figures 1 & 2).

As the students worked on Thursday, I also made the trash paper that had filled the box available for the first time. At least one student in each group sifted through it, and many of them made interesting finds. For example, a school newsletter made reference to the "bus ramp," thus answering a question many students had about whether or not the school had a bus loading area. A discarded homework assignment sent students to a "white ash tree" by way of the "soccer field." This proved to be helpful to the

Figure 1

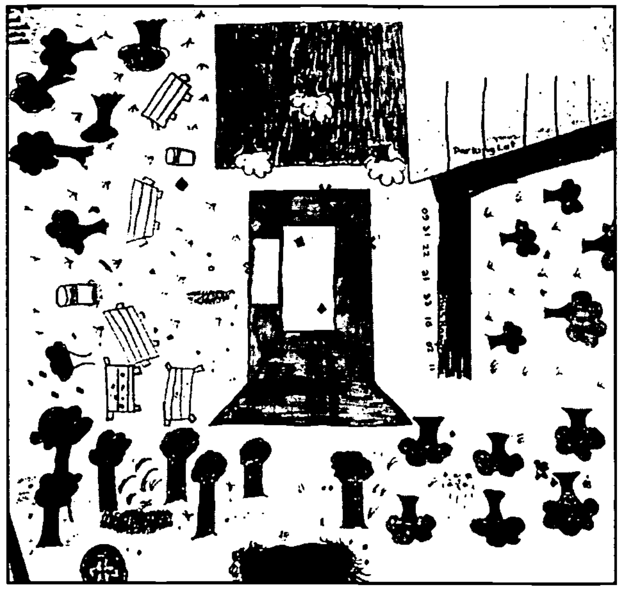
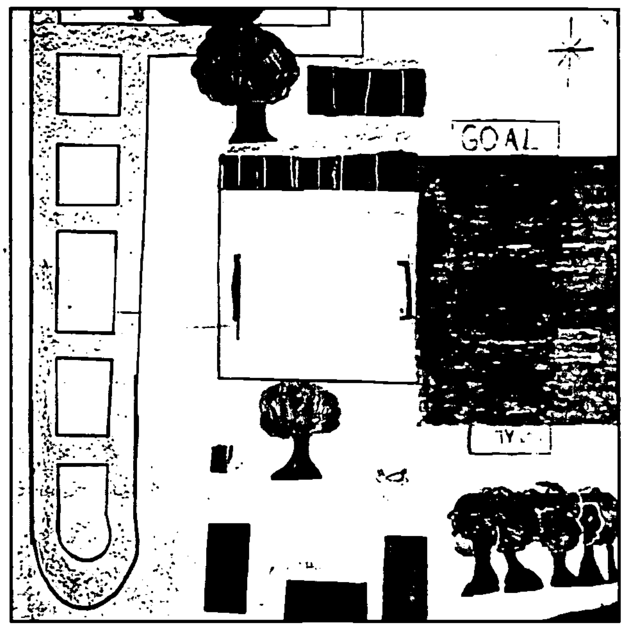


Figure 2



many students who had wondered if the "painted grass" in one of the bags on the north side of the school could have come from an athletic field. One group even found a school map! While the map didn't provide any clues to the school's outside area, it did give students a school layout so that they would know, for example, if the cafeteria was on the front, side, or back of the building. None of the information in the trash provided any definite answers, but it did offer support for some of the assertions that groups were making. Several students commented that they felt like real detectives, sifting through clues—even garbage—as they tried to solve a mystery. I seized the opportunity to compare this activity to the work of anthropologists and archaeologists who use artifacts of many kinds to create theories of civilizations and people long gone.

On Friday, each group took turns presenting their map to the class and explaining how they had interpreted the evidence to support their conclusions. After each presentation, the rest of the class had an opportunity to ask questions of the group. I stated that the criteria for a good map would rest in its ability to stand up to the scrutiny of others and pointed out that the same was true for the research findings of scientists—their conclusions must stand up to the scrutiny of other scientists. The presentations were videotaped. I was pleased to see that students were quiet, attentive, and thoughtful throughout.

As I listened, I realized that students were basing their models on assumptions and assertions coming from five different sources. The first source was the content of the bags. When rabbit scat was found in a bag on the east side of the school, students drew rabbits on their maps on the east side. When many different leaves were found, students drew many different types of trees. The second source for assumptions came from the number of bags found on each side of the school. Many students assumed that the west and south sides were smaller areas and largely paved, since only two bags were taken from those two areas unlike the larger number of bags and organic matter in the north and east side bags. The third source for their assumptions came from their own experiences and their preexisting knowledge of what schools are like. For example, a few students drew in portable classrooms on their maps even though there was no evidence in the sample bags to support their existence. It was their prior experiences with schools, both our own and the elementary schools in our county, that led them to think that all schools must have portable classrooms. Students also concluded that the east side of the school must have been closest to the cafeteria, lounge, or eating area since there seemed to be a lot of trash in the bags on that side, and prior experience has told them that much trash is produced where people eat. The fourth source for their assumptions was the waste basket paper packed in the box. As I mentioned earlier, reference to a soccer field in an old newsletter led many groups to include a soccer field in their drawing. The fifth source for their drawings was their imaginations. No student had ever seen the middle school and traveling all the way to Connecticut to see the school was a pretty remote possibility, so the site maps depicted the school as the students imagined it to be.

Overall, the students did a good job of explaining their maps, usually taking turns so that all members of the group would have an opportunity to speak. The brief question/answer session that followed each presentation was interesting. Many of the questions sought clarification for findings not presented clearly, but other questions were more challenging. For example, one student group chose to include a soccer field in their model, but not a pond. This was the exchange that occurred in the question-answer session after their presentation:

Student 1: Why didn't y'all draw a pond?

Student 2: We thought there might be a pond, but we didn't have that much evidence.

Student 3: Yes, the goose poop wasn't enough. The goose could have just flown by and had a little you know...

Teacher: So you didn't feel there was enough evidence to support placing a pond on the school grounds?

Students 1 and 2: Yes.

Student 4: How do you know that it's (the soccer field on their map) not a football field or a baseball field?

Student 2: We found evidence in the paper trash packed along in the box where they talked about a soccer field.

I found students were very open to criticism and readily admitted that they could be wrong because they had looked at the evidence differently. Each map was unique, although many shared similarities. No group expressed confidence that they knew their map was correct, for there were too many elements to pin down. Instead, students simply expressed a hope that their map was close, and anticipation of the video was high.

Phase 2–Our School Survey

On Monday, we performed quadrat studies of our own school and collected samples to ship to the Connecticut middle school. Each student group was given paper, pencils, four wood splints (to use as stakes) string, a meter stick, and a plastic sandwich bag. Each science class was responsible for a different side of the school, and the fourth remaining side was completed by a mixture of students from the three classes. Earlier in the year, we had made quadrats on the school grounds and studied them, so the students were familiar with the procedure. I remembered being disappointed in that activity as a whole because many students had been off task and had not been seriously observant of their quadrat. They had failed to see all of the diversity that I had wanted them to see and did not react with the wonder and awe that I had anticipated.

This time out was very different. Each group quickly scouted out an area they felt would offer interesting and descriptive variety in their sample bag. They were very thorough in their survey and surprised by many of their finds, particularly the trash that wasn't visible with a passing glance at the area. I think knowing that the bags were being prepared for the other school established a clear purpose that made the activity more meaningful and relevant to the students. Field guides were used to identify the less familiar plants found in the quadrants. Inventory lists were attached to the sample bags which were labeled with student names and the side of the school from which the quadrant had been framed. At the end of the day, I sent off an e-mail message to let the school know our samples were in the mail.

Having looked at all of the samples collected from around our school building, I began to appreciate how difficult a task the model-building activity had been. In thinking about the rationale the students had used in creating the Connecticut school maps, I realized that employing the same reasoning to our samples might not create a school environment that looked much like

> ***"When the answers were revealed, many students were surprised to see that they were wrong about their own school!"***

ours. Furthermore, I became skeptical of the students' abilities to recognize each side of our own school given the inventory lists from the sample bags. Feeling that it would be worthwhile to do so, I created four lists of all of the items in the sample bags, one list for each side of the school, but did not label the lists with the direction.

The next day, students spent time in their groups looking at the lists and trying to decide which direction outside the school each represented. When the answers were revealed, many students were surprised to see that they were wrong about their own school! I then asked the students to reflect on their Connecticut school maps again and consider how right or wrong they thought they were. As shown by their comments many students were now less sure of their models than they had been on Friday.

Phase 3–Viewing the Video

As excited as the students were to see the video of the Connecticut middle school, they had to wait a long time to do so. E-mail messages from the school let us know that a student would be making the video as part of a project, but we could not expect it until early December. As it turned out, the student did not follow through and the video was not completed until February. By that time, our video had been made, mailed, and reviewed by the Connecticut students. They responded by e-mail to let us know that they had figured out the grounds plan very well. The biggest surprise had been the size of the school and expanse of the grounds. They were most confused about the "wood from a bridge" in one of the sample bags. This had led them to expect a body of water rather than a drainage ditch.

Before we viewed the Connecticut video, I passed out the maps so the students could review their models. So much time had elapsed since their presentations that many students could not remember them very well, and a "refresher" was needed. The two students who made the video had a tendency to scan the camera over an area very quickly, thus making the viewer feel a little dizzy. Even so, we were still able to tell a lot about their school. As an added bonus, they took us on a tour of the inside of the school, showing us the media center, gym, and several classrooms. The biggest problem with the video was that the boys did not clearly announce which side of the building they were filming, leaving us a little confused about the south and west side of their school.

My students watched the video very intently. Snow covered the ground, the pond (yes, there was a pond) was almost completely iced over, the wind could be heard whipping in the background, and the boys making the video explained that the temperature was about twenty degrees. For my Florida students, the weather conditions were as intriguing as getting the answers we had waited for! Even though the school grounds looked very different than they had in September when the quadrant studies were performed, we were still able to discern a lot about the grounds plan to see how accurate our models were. Later in the day, I sent an e-mail message of questions about things we still weren't sure about. After viewing the video, I again asked students to reflect on the activity as a whole and tell me how they thought they had benefited.

Benefits to Students

The collaborative project carried out with the Connecticut school yielded five benefits for my students.

(1) Students had fun while learning. Admittedly, having fun does not ensure that learning will occur, but activities that

students enjoy stimulate student motivation to learn (Good & Brophy 1990), and contribute to positive attitudes about school and learning. My notes showed that student enthusiasm remained high throughout every phase of the project. Students eagerly entered the classroom each day, listened to directions intently, and participated in the activities without complaint. Even though the activities called for a high level of student interaction, I found that students cooperated well with one another and remained very focused on the assigned task. Written feedback from students also showed that they enjoyed the project. In free responses solicited from students regarding their thoughts and feelings about the project, 29 out of 78 students included some kind of specific comment related to having fun or enjoying the project, such as:

What I learned when we were sharing our school with East Lyme Middle School is that you should do things like that more often. It is very fun which (when) I thought it would be boring, but I was wrong. It was the funnest activity I have ever done in science. It was exciting...

It's really fun (to) make a map of a different school and guess where stuff is, like the gym, lunchroom, and track. The projects are educational and interesting at the same time. I hope we have more projects like this. It is the most fun stuff I have done in the past years in science.

Well, I learned that science is not so bad. I always thought that science was bad. But now science is fun.

(2) Makes learning more relevant and meaningful to students by providing a practical, "real world" purpose for the learning experiences. This has been touted as a need by many middle level educators involved in the curriculum reform movement (Beane, 1990; Erb, 1991) and was made strikingly clear to me while completing this project. Our involvement with the Connecticut school created a very clear purpose for carrying out the learning activities—we were collecting and sharing data in order to learn about one another. I do not think the enthusiasm, focus, or depth of thought that I observed in students throughout this project would have been as great if I had enacted a similar school model activity based on a fictitious school. My students made reference to the other school often and clearly sensed that the classwork they were completing was purposeful, as shown in some of the questions they posed:

I wonder what kind of an idea they're getting about our school? I also wonder when we'll finally see if we were right or wrong about the other school?

How are we going to know where their parking lot is when we have no evidence it's there?

How are going to know what kind of trees are there when they just put "leaves" (without identifying them)? What do we do if they don't give us enough data?

The quadrat studies completed for the Connecticut school were carried out much more enthusiastically and seriously than they had been earlier in the year when we did it as part of a unit on ecosystems. Students were far more observant of their quadrat and careful in their inventory because they knew the information would be used by the other school.

(3) Provides practice in the use of science process skills. This project provided opportunities for students to practice using science process skills such as making predictions, observations, interpretations of data, conclusions, and communication (Florida Science Framework Commission, 1993). Student comments related to the use of process skills were:

What I think we got out of this project is how to take information and put (it) together to make it say something.

I am learning how to give reasons for what I think. Like when we made the maps and I had to give a reason why I thought things went (in certain places). I am also learning to look more closely.

(4) Extends cooperation and collaboration among students by expanding the field of interaction beyond the classroom, school, and state. Cooperative learning is recognized as a recommended practice in science instruction today (FSFC, 1993) and serves to reinforce the collaborative nature of scientific work (Rutherford and Ahlgren, 1990). Not only did students work in cooperative groups during all facets of this project, but the project itself was based on a collaborative relationship with the Connecticut school. When asked what they thought about working with another school, 68 out of 78 students responded favorably. Of the ten who did not enjoy working with the other school, most explained that they didn't like waiting so long for the video to arrive. Some of the favorable comments were:

I like working with the other schools because it let us know about other kids about our age in other parts of the country.

I liked it because I got a chance to see what a school from another state looked like and what the kids were like.

Now that we (have taken) our survey, I realize that East Lyme and our middle school are very different. Because of our climates, animals and environments are very different. I think you should do this next year to prove all schools are different.

Many students offered suggestions for further collaboration such as comparing foods commonly eaten, popular clothing styles, and videos of local wildlife or ecosystems. The most popular suggestion was a field trip to Connecticut for a face-to-face meeting. For rural schools such as ours, with students who have had little travel experience, partnerships with other middle schools ease feelings of isolation and help students realize that although we exist in different places, essentially we are very much the same.

(5) Fosters the development of the scientific attitudes of imagination, openness to new ideas, and skepticism. This project provided opportunities for students to practice all three. *Science for All Americans* (Rutherford & Ahlgren, 1990) as well as *Science for All Students: The Florida Pre K-12 Science Curriculum Framework* (1993) recognize that science education is in a particularly strong position to foster attitudes and values. The development of the school models relied heavily on the use of the imagination of the students. The very fact that the school they were attempting to model was so far away ruled out the possibility of anyone actually seeing the school. The model building was therefore based on the evidence sent from Connecticut, each student's preexisting knowledge of school sites, and imagination.

From the beginning, the importance of using the data from the quadrat studies in designing the model was stressed to students. In their presentations, students were expected to do the work of scientists by backing up their explanations with evidence. However, the evidence was not sufficient to create a clear picture of the school site, thus creating a situation where different interpretations of the data could be made. As students worked in groups to develop the school models, they were required to listen to and analyze the different ideas and predictions before arriving at a group consensus. Openness to alternative explanations was again required as students listened to group presentations. The ques-

tion/answer sessions after each presentation provided opportunities to voice and explore alternative explanations. The prediction of an athletic field on the north side of the school based on the presence of "painted grass" in a north side sample bag, proved to be controversial. After one group's presentation, the following exchange occurred:

Student 1: Everybody could be wrong about the painted grass. Painted grass could be from like painting a picnic table and specks of paint got on the grass.

Student 2: Yes, and lots of time when construction is going on, the workers paint numbers and letters on the ground.

While students accepted some alternative explanations, they challenged and dismissed others, thus exercising the scientific attitude of skepticism. During presentations, one group was challenged on their placement of portable classrooms in their school models. When they could not offer anything from the data lists to support the portables, particularly when their explanation for placing them on the west side was "they took up a lot of room on the paper and that was the only place to put them," they drew 'boos' from the other students.

A recognition of the respect for evidence and the importance of skepticism in science was reinforced when so many students failed to identify the sides of our own school from the lists of quadrat study bag items. Only 15 out of 87 students responded that they felt their models were pretty good and their predictions were accurate. Everyone else expressed uncertainty in the accuracy of their models, and three students suggested that the data presented in the sample bags could be interpreted in many different ways and that evidence alone was insufficient to create a really accurate model of the school.

I think that our map was full of mistakes. I think we could have weighed the evidence better than we did, and today helped me realize that.

I had been really sure about the drawing. But now, I don't (feel that way) because I have just done the same thing with my school and I was wrong about it...I could be wrong about everything, but it helps me understand that things aren't what they seem.

You cannot always tell stuff just by getting a few clues.

All in all, students found the collaboration with the Connecticut school to be an enjoyable and meaningful experience. The school site project provided opportunities for students to practice science process skills while exercising important scientific attitudes.

Discussion

When the school site project was planned, it was to be one of three telecollaborative projects involving two other schools. The purpose was to assess the benefits to students of collaborative projects involving schools separated by long distances. From the beginning, the telecommunications element of the project created problems that led to difficulty in implementing the projects as planned. Electronic mail is wonderfully convenient, messages can be sent at any time, but there is no assurance that messages are picked up or received in a timely manner, if at all. Therefore, collaborations that utilize e-mail as the primary mode of communication require shared commitments from all participants to send and respond to messages with agreed upon regularity. Had that situation existed among the three schools involved in this project, many problems could have been circumvented, particularly those involving the timing and coordination of project implementation.

Collaboration, which was a major problem in the estuary and roadkill study, was also a problem with the school site project, but a relatively minor one. After the quadrat studies were completed and the sample bags were sent, the success of the project required very little in the way of ongoing communication between the participating schools. (The third school is not mentioned in this case study, but did participate in the collaboration.) A solution to the problem would be to discuss a schedule for routine e-mail checks with collaborative partners, and follow-up with telephone chats or regular mail correspondence when e-mail is not answered.

Another annoyance occurred in waiting nearly four months for the video from Connecticut. When it did arrive, it captured the school environment in a different season than the one my students had tried to illustrate in the school models. This problem could be remedied with better planning. Filming the video on the same day as the quadrat studies (or at the same time) and mailing it along with the samples is one possible solution.

As a teacher, I found the project exciting for the insights into student learning it provided. As students developed their models, it was interesting to observe the role played by their preexisting knowledge of schools. Even though all groups were presented with the same data, each group's interpretations were different, and each group's model was unique. Analyzing the quadrat studies performed on our own school challenged the reasoning used in interpreting the Connecticut data. Most students recognized the conflicts in thinking, and suggested that they would need to change their models in order to make them more accurate. I now realize that seizing the opportunity to point out these steps in the learning process could make students more aware of their own metacognitive processes.

I also see how this project could serve as a good model for the scientific enterprise, if pointed out to students as such. During its duration, students moved through the steps of gathering and organizing data, interpreting the information, and discussing it with others as they developed ideas that had to stand up to the scrutiny of others. In completing the site study project, my students were provided the experience of doing what scientists do. The big difference was that while, in the end, the students were given a video to check their accuracy, scientists seldom have their theories and models confirmed in such a way.

A natural extension would be to compare the student work in this project to the work of anthropologists and archaeologists. Integrating this project with social studies lessons on, for example, prehistoric Florida and early Indians, would help students better understand the work of social and natural scientists who specialize in constructing knowledge of early cultures and environments.

I will definitely be completing the school site project again next year. I was very pleased with student response to the project and with the scientific skills and attitudes they were given a chance to model during its duration. However, I was disappointed that students did not seem to build on or use ecological knowledge to a greater extent. Aside from realizing how much biodiversity exists in one square meter and how much trash can inundate a school yard without seeming obvious, I did not see students building on ecological concepts. In constructing their models, students focused more on placement of aspects of the school plant facility rather than living communities. Perhaps if the sample bags from Connecticut had not been so badly decomposed, more could have been done with the examination and identification of leaves, flowers, and other organic material. Next year, better coordination and planning may put the bags into use before decomposition occurs. Another thing to consider would be the addition of soil samples along with the quadrat study bags. Students could then analyze the soil, and use that information in their predictions as well.

A further extension would be to collaborate with a school in a very different geographic region, such as New Mexico or Arizona. Then students would be motivated to learn about that region in order to make the most accurate models possible. The differences between our two areas might reinforce the concept of how climate influences living things.

Angie Williams

Years Teaching: 11

Present Position: 6th grade Life Science/Social Studies/Math

"I really have an interest in finding out how kids think and learn. My goal is to take teaching to another level and have my students think with scientific attitudes."

"I think action research is, in a way, what I have always done in my classroom. I enjoy sharing ideas with my fellow teachers. The difference now is that I have a more formal avenue and a larger audience to share my ideas with."

Motivating students is not always easy, but the school site project motivated my students to do the work of scientists. The collaboration with the distant school made the learning purposeful and special. Telecommunications technology opens the door for classrooms separated by long distances to engage in collaborative projects. My research shows that doing so can be enjoyable and beneficial to students.

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So You Want to Do Action Research?

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If, after reading about classroom-based action research by science teachers, you think this is something you want to do in your classroom or school, this chapter is for you. It is organized into three sections. The first, a definition of action research, briefly traces the evolution of the concept of action research. This section is presented in a rather formal style. The second section presents some guidelines for doing action research. The third, using statements from the Science FEAT teachers who did research and from their administrators, provides advice. If you want to learn *about* action research, read the sections in the order presented: if you want to *do* action research, read the sections in reverse order.

A Definition of Action Research

Action research currently is an important genre in the field of education. However, it is a genre that has and continues to evolve. Kurt Lewin (1946), a social scientist concerned with major social problems of the period, is credited with coining the term *action research* in the years after the Second World War. He argued that through action research advances in theory and needed social changes might be simultaneously achieved. Lewin described action research as a spiral of circles of research that each begin with a description of what is occurring in the "field of action" followed by an action plan. The movement from the field of action to the action plan requires discussion, negotiation, exploration of opportunities, assessment of possibilities, and examination of constraints. The action plan is followed by an action step which is continuously monitored. Learning, discussing, reflecting, understanding, rethinking, and replanning occur during the action and monitoring. The final arc in the circle of research is an evaluation of the effect of the plan and action on the field of action. This evaluation in turn leads to a new action plan and the cycle of research begins anew. The value of action research in educational situations was almost immediately apparent. Through his book, *Action Research to Improve School Practice* (1953), Stephen Corey at Teacher's College, Columbia University, was influential in introducing action research into mainstream education.

Robert Rapoport (1970), still focusing on general social problems, added an element of ethics to the definition of action research when he claimed that it "aims to contribute to the practical concerns of people in an immediate problematic situation and to the goals of social science by joint collaboration within a mutually acceptable ethical framework" (Rapoport as cited in Hopkins, 1993, p. 44). In 1983, Stephen Kemmis defined action research as:

> *a form of self-reflective enquiry undertaken by participants in a social (including educational) situation in order to improve the rationality and justice of (a) their own social or educational practices, (b) their understanding of these practices, and (c) the situations in which practices are carried out (Kemmis as cited in Hopkins, 1993, p. 44)*

By this time, the place of action research in education was clear. With the inclusion of a focus on justice, the current close relation between action research and critical theory was introduced. In 1985, Dave Ebbutt solidified the role of action research in education when he stated that it "is about the systematic study of educational practice by groups of participants by means of their own practical actions and by means of their own reflection upon the effects of these actions" (Ebbutt as cited in Hopkins, 1993, p. 45). Ebbutt quotes Kemmis when he continues that "Action research is trying out an idea in practice with a view to improving or changing something, trying to have a real effect on the situation" (Ebbutt as cited in Hopkins, 1993, p. 45). John Elliott (1991) states that action research aims to feed practical judgment in concrete situations, and the validity of the 'theories' or hypotheses it generates depends not so much on 'scientific' tests of truth as on their usefulness in helping people to act more intelligently and skilfully (sic). In action research, 'theories' are not validated independently and then applied to practice. They are validated through practice (p. 69).

It is not surprising that, in the fifty years since Lewin introduced the idea of action research, the genre has developed and changed. Action research is seen to complement and blend with other modes of inquiry. For example, Lawrence Stenhouse (1975) pointed out that action research and the idea of teacher as researcher, an idea he introduced as a way to improve education through empowering teachers by engaging them in curriculum development, were closely related. Also, as disciples of action research developed, implemented, and refined models of this mode of inquiry, terms were created to distinguish variations of the method. In his book on action research for teachers, which he terms classroom research, David Hopkins (1993) describes at least four variations of action research. All models include cycles in which a situation exists (a field of action) where a practitioner desires to make a change, an action plan, an action, and an evaluation. All variations of action research described by Hopkins require reflection.

Possibly Virginia Richardson (1994) best captures the spirit of this form of research when she says that practical inquiry, a term for one variation of action research, "is conducted by practitioners to help them understand their contexts, practices and, in the case of teachers, their students. The outcome of the inquiry may be a change in practice or it may be an enhanced understanding." Whether it is termed action research, classroom research, or practical inquiry, the genre formalizes an aspect of teaching that expert teachers have known about and employed for a long time. They observe situations in their classrooms that are less than optimal, they identify the problem, they think about what and how to change, they make the change, they evaluate the impact of the change on the situation and begin again.

6 A Description of Action Research

Identifying a Problem

In education, the classroom and the school provide the situation, using Lewin's term for context or setting, for action research. As described in this monograph, action research begins with thoughtful reflection on classroom practice. This thoughtful reflection might be initiated by an observation by one teacher of another teacher's classroom practice, by a conversation with a colleague, by viewing and reviewing a videotape of some lessons, by a student question or behavior, or by a parent comment. Alternatively, the thoughtful reflection might be triggered by reading a book or attending a course or seminar on science teaching and student learning. An outsider cannot tell a teacher what is the appropriate action research for her classroom. Action research in classrooms must be teacher initiated.

Observation and reflection help identify a problem. In daily use the term problem describes a situation in which something is wrong, something needs to be corrected. In action research the term problem describes the focus of interest. Often the problem is something that, while it is quite all right, the teacher judges is less than optimal. The teacher might wonder if student achievement could improve if she tried a new instructional strategy. Student achievement was not bad, but could be improved. Sometimes in action research the problem is termed the purpose, the topic, or the issue, to avoid the negative connotations associated with the word problem. In choosing a problem, a teacher needs to be sure there is a close relationship between the problem and the proposed change. Further, the problem needs to be something that is within the teacher's power to change. While changing the school's budget might improve student achievement, teachers today rarely have the authority to make budget changes. Even if a teacher had budget authority, she would need to make a strong case for the relationship between budget and student achievement if these were the two concerns in her action research.

Making a Plan

The next step in action research is to plan the action. The plan needs to conform to some existing method of research and to rely on good research tools. If the teacher chooses to survey students' opinions, the survey must be constructed properly. The wise action researcher begins by looking for existing tools that meet the needs of the research, or that can easily be modified to meet those needs before trying to construct original research tools. If a teacher chooses to do interpretive research such as a case study, she must adhere to the guidelines of interpretive research. For example, if a teacher is doing a case study, she must define the system that is being studied and its boundaries. She must plan to collect information about the system and search that information for patterns that are meaningful to the problem being researched. She must plan to return again and again to the system to look for confirmations, exceptions, and variations of the patterns that are emerging. If a teacher chooses an interpretive research method, the tools of interpretive research must be employed. A prime tool of interpretive research is triangulation. Triangulation requires that the situation in which the change is being made is examined multiple times in multiple ways. A teacher might triangulate by gathering the same information from a number of students on different occasions, several weeks apart. A teacher might plan to triangulate by collecting information in different ways such as from interviews, from observations, and from test scores. A teacher might triangulate by getting information from different people in the situation such as students, administrators, and parents. Books on research methods such as *Complementary Methods for Research in Education* (Jaeger, 1988) provide a good primer for planning educational research.

When doing an action research plan, the more a teacher can anticipate the action, the more detail she can include in the plan. The more detail in the plan, the less likely the teacher will have to make instantaneous decisions without the benefit of reflection. In planning action research a teacher might ask: Which class or classes shall I study? Which student or students? What types of information will I collect–paper, audiotape, videotape? How frequently will I collect information? What is the duration of each data collection activity? What is the duration of the study? How will I keep all the information I collect stored and organized? If I am keeping a journal myself, what will I give up to make time to write in my journal? Doing an action research plan requires reflection.

Taking Action

Having made a plan, the teacher begins the action research. Even the best plan will be modified as the research continues. There will be unanticipated events that must be accommodated. As information is collected and patterns begin to emerge, different information than what had been anticipated in the plan may be necessary. During the action phase of action research, a teacher must make time to carefully examine the information that is being collected. This careful examination is both analysis and reflection. As the information is organized and examined in relation to the original problem, the raw, unexamined information becomes data to support assertions about the effect of the changes in the classroom. An assertion is a statement that expresses what has to be learned through the action research.

The masterful action researcher will have included the data analysis procedures in the plan. While the circumstances of the action may change the planned analysis, it is a real predicament to have carefully gathered extensive classroom data and not have any idea what to do with it.

Evaluating the Effect of the Action

As the action period comes to an end, it is time for evaluation and more reflection. Questions that a teacher might ask to stimulate evaluation include: What impact has this change had on my students? On their learning? What have I learned about students? About learning? About the subject matter, in this case science? Should this change become a regular feature in my classroom? How can I make this change a regular feature? Is it cost effective? What new problems have emerged that I now want to research?

Communicating about Action Research

Action research by classroom teachers includes the need to communicate with others about the research. This requirement comes from fundamental beliefs that both teaching and research are activities that occur in communities, and that valued knowledge in those communities must be public. In order for knowledge to be public, it must be shared. Some use the term persuade to describe the manner of sharing that is part of action research. It is more than just telling; it is not telling a story and it is not telling everything. It is telling the important points in a manner that is lucid, concise, explicit, and in a way that shows a logical relationship between the problem, the action, the information collected and analyzed, and the evaluation of the action on the situation. This public sharing of action research is not easy. In order to articulate their ideas, teachers need to think critically and systematically about their practice. While national reform movements in education such as the National Board for Professional Teaching Standards (1991), and leaders in education reform such as Shulman (1987) make it clear that teachers need to be able to articulate their professional knowledge, sharing ideas about teaching (other than recipe swapping such as "have you tried this") has not been part of the common practice of teaching. Further, the skill of sharing substantive ideas about teaching generally has not been taught in teacher education programs.

Whether writing or talking, deciding what to say and how to say it requires effort. The teacher as action researcher must decide how much to say about the original situation—the classroom. Other decisions involve how much to say about the research plan (including when it was followed, when the research deviated from the plan, and why), what information was collected, how the information was analyzed, what new insights were gained during the action research, what new understanding the teacher has achieved, what changes the teacher will make in her practices, and what recommendations she might make to others in a similar situation. All of this knowledge must be shared in a clear, precise manner. And it must be pleasing and interesting to read or hear.

More and more frequently, teacher researchers have opportunities to share their research publicly. The journal *Teaching and Change* only publishes research by teachers. Even as this monograph is being prepared, other journals about research and science teaching such as *Science Education* and *Science Scope* are considering regular sections that include classroom research by teachers. The annual meetings of national and regional organizations of science teachers—such as the National Science Teachers Association, the Florida Association of Science Teachers, and the Florida Educational Technology Conference—provide teachers opportunities to share their research. Teachers also have opportunities to share research through workshops and local research activities.

Maintaining Collegiality

If it were possible to publish the next sentence in flashing neon lights, that still would not be sufficient to highlight its importance. *Action research cannot be done in isolation.* While research is a solitary activity and reflection done by oneself is an essential component of action research, teachers, or anyone else for that matter, cannot successfully engage in action research without support. This support comes from others—teachers and teacher educators—who have or are engaged in action research. This support is in the form of opportunities to discuss the problem situation, the action plan, the analysis, and the communication in a critical but non-judgmental environment.

Teachers engaged in action research also need support from administrators who recognize that it is demanding. Different schools will need to work out different forms of support. Reduction in committee work, an additional aid, or the use of inservice time for research are some possibilities. Schools in which teachers, with the support of their administrators, are engaged together in action research within the classrooms and across the whole school are moving toward the vision of the school as a community described recently in the National Science Education Standards (National Research Council, 1994).

While it is relatively easy to describe the phases of action research in sections in a paper, in practice the distinctions of the phases blur and overlap. The variety of topics, methods, approaches, and presentations in this monograph reflect only some of the variations in action research by classroom teachers.

Some Advice on Doing Action Research

Teaching is a demanding and complex activity. Doing research also is a demanding and complex activity. The melding of the knowledge and skill of both teaching and research required to conduct action research in a classroom situation can be daunting in the demands and complexity presented. It seems that some advice from those who engage in action research would be useful to classroom teachers who are considering an action research project. This section will share advice from three points of view: a university-based instructor who works with teachers engaged in action research, the classroom science teachers who have just completed an action research study, and some administrators of schools where action research has occurred.

Advice from the University

David Hopkins published his first edition of *A Teacher's Guide to Classroom Research* in 1985. At that time he had been working on projects that engaged classroom teachers in Canada and the United Kingdom in action research for almost ten years. The second edition of his book, *A Teacher's Guide to Classroom Research — Second Edition* (1993), reflects insights from additional years of experience. For those interested in conducting action research, the book is well worth reading. In Chapter 4, he presents six criteria for classroom research by teachers. These criteria provide some good advice to action researchers.

Teaching. Hopkins reminds readers that a teacher's first responsibility is to teach. Any research should not interfere with or disrupt this primary responsibility. With this advice he includes an ethical dilemma about teaching. If a teacher is trying a new instructional strategy for the first time, her presentation is likely to be ragged. Is a teacher remiss in her responsibilities if she replaces an adequate instructional strategy with one in which her performance may be less than adequate? Or is she remiss if she does not attempt new strategies which may eventually improve student learning? He resolves the dilemma by relying on the professional judgment of the teacher. If the teacher is so committed to improving teaching and learning that she is willing to engage in the rigor of action research, those outside this classroom must rely on her judgment to do nothing that will harm students.

Time. Hopkins' second criterion is that the method of data collection cannot demand too much of a teacher's time. This implies that the teacher needs to be certain of the details of the data collection method before she begins. For example, if a teacher chooses to audiotape classroom discussion, she needs to be aware that it takes about twice as long to listen to a tape as to make it and about four times as long to transcribe it. The teacher engaged in action research needs to plan and use efficient data gathering techniques and a reasonable data gathering and analysis timetable. Here, administrators can provide some time to a teacher engaged in action research by such support as a reduction in extracurricular responsibilities.

Method. The method of data gathering needs to be sufficiently reliable that the teacher is able to formulate hypotheses and/or assertions with confidence. The teacher must have sufficient confidence in the research method that changes in classroom practice based on information from the method can be undertaken without undue concern.

Problem. The teacher engaged in action research must be committed to the research problem. It seems self-evident to state that it is difficult, if not impossible, to sustain the energy required to engage in research on a problem if the concern is not real and personal. Further, the problem needs to be definable and solvable. As Hopkins says, dealing with amorphous and overly complex problems that have no solutions only leads to frustration.

Community. In so far as possible, engaging in action research to improve teaching and learning should take place in the context of a school community that shares a common vision.

Ethics. Doing action research presupposes ethical behavior. Hopkins relies on the ethical guidelines for action research presented by Kemmis and McTaggart (1988). Some of these ethical guidelines that impact classroom research include:

- Observe protocol. Make sure that all relevant persons are informed and all necessary permissions and authorizations are obtained. For example, permission might be required to videotape students, to use student work samples, or to audiotape interviews. Obtain explicit permission before using direct quotes.

- Confidentiality. Accept the responsibility to maintain confidentiality and act accordingly. For example, use pseudonyms in place of actual names.

- Negotiate with those affected. Consider the wishes and responsibilities of others who are in the situation where the action research will occur. This might include the students, other teachers of the same students, administrators, or parents. Allow others whose work you describe to challenge your interpretations. Allow those involved in meetings and interviews to add to or edit their original statements. Such practices increase fairness, accuracy, and relevance.

- Report progress. Keep the work visible and share expected and unexpected outcomes or insights with others interested in the problem.

- Make your principles binding and known. While the researcher wants to encourage others who have a stake in the outcome of the action research to get involved, all people engaged in action research must agree to the principles before the work begins; all must understand their rights and responsibilities in the research process.

Advice from Classroom Teachers

Each of the Science FEAT teachers engaged in action research during the 1994-1995 academic year was asked to put in writing some advice to another teacher who might be considering an action research project. The advice they gave is not substantively different from the advice of the university-based action researcher, but it is captured in the words of the classroom teachers. Their advice is a product of their experience and comes from the heart. It is not easy to capture in typeface the emotion presented in oversized letters, different colored inks and multiple exclamation points. The following section, organized by themes, weaves together the direct quotations from the Science FEAT teachers. The themes which emerged from reading and organizing the advice are research: choosing your topic; designing your research; conducting your research; communicating your research; gaining support; and surviving. These themes are addressed in the teachers' own words.

Choosing your topic. Think a lot about your research topic. Do something that is relevant and meaningful to you personally. Choose a subject you are very interested in exploring, or a question you have a burning desire to answer. Make it relevant for you. It is really important to do research on a topic that interests you, something that you have been curious about. You will find yourself "married" to your research, so that choosing a subject you really want to "spend time with" makes the union easier and more enjoyable.

Identify a question that you would like to investigate about your teaching style, methods, or classroom environment. Focus on your classroom and students. Choose a topic that will have force in the way you teach and the way students learn. For the research to be useful to you it needs to be something that will improve your teaching and something that will have meaning for your particular situation. Choose a topic that will be personally beneficial for you to explore. Choose a topic that will help you to become better in your profession. All that hard work will then be worthwhile. Consider your individual interest, time required, participants.

Spend lots of time narrowing your choice of topic down because you will spend lots of time with it. Keep it narrow. Narrow it down to one or two things. The narrower the better. The narrower the subject the easier it will be. It doesn't have to be something too involved. Try to limit the scope of the research. The project tends to grow and become more and more complex. Make sure you have focused or zeroed in on your actual question before you begin the study. Otherwise you will have trouble narrowing your search and wind up with too much irrelevant data.

Keep it simple. Keep it simple. Keep it simple. Keep it simple. Keep it simple and precise. Keep it direct and simple. Simple is not bad. Think small. Don't try to answer more than one question and try to make your question as basic and measurable as possible. Design your study so that you are concentrating on one facet of your problem. Stick to one variable. You will discover many other questions that concern your topic—you need to stick to one. Don't bite off more than you can chew.

Observe videotape footage of yourself engaged in teaching to identify aspects of teaching which could benefit from being the focus of research. Make some journal entries after every day of teaching and audiotape or videotape two or three lessons to look for strengths and weaknesses. Read research done by other teachers. Read recent research literature to find out what others are thinking. Read as much literature as possible. Put sufficient time into planning functions. During this phase research is the key. This must include more than library research; talk to others who have done it, to experts in the field, seek community help.

Designing your research. Carefully plan the data collection process. Define data collection and analysis clearly from the outset and solicit one or more people to assist you in data collection. I did this and it was extremely helpful. Be sure that the methods used to study the question match the purpose of the study. Make a trial run beforehand. After my first attempt this year it would be much easier to do again.

Conducting your research. Jump In! If there is an area in your classroom you'd like to investigate, a technique you'd like to try, or something you wonder about in your teaching practice, think about how you might investigate your question and start. Don't put off getting started. Just as soon as you know what your question is, start planning to collect your data. Start early in the school year to be sure there is plenty of time to update and follow up on the results you may get. Continue the research for a long enough time to be able to draw some conclusions.

Make sure you are clear in your own mind about the data collection: keep a notebook with you at all times to jot down notes about classroom occurrences. Collect feedback from students—it can be formal or informal; if data about attitudes is being collected, use some videotapes—body language is important. Prepare well in advance. Make sure you have all the necessary materials. Organize your materials so they are readily accessible. Have all your equipment ready and working when videotaping and audiotaping. If videotaping your classroom, I found it more useful when someone came in to run the camera. When the camera was just mounted on a tripod, much of the class action was lost. On any survey or interview include as a final comment, "Any other comments, observations, questions and suggestions?"

Don't be surprised if your research takes several turns and twists before completion. Look for the unexpected. Be flexible. Be prepared to reflect frequently on how the research is going. Don't feel that you must remain true to your original statement. If data or experience lead you in a new direction, give serious consideration to following it. Accept the fact that your research may change (your method or your focus) once you have begun. You may find that certain constraints dictate this. You may find that your data causes you to look at your question in another way. Certain aspects of your study may be better 'dropped' since they offer no insight into your revised focus. [But] after you have reached your research question and completed gathering your data, if you find new data don't try to add it after your paper is complete or you will work yourself to death. I did this and it was extremely hard (no matter how good the information is).

Organize! Organize your personal life. Time will be short. Spend a few extra minutes getting organized. Get a box and keep all research documents together. Have a special container on hand (a bin, a folder, a file drawer) to drop student work in. Set up a special file cabinet drawer to keep all of the material you collect. Prelabel your folders. Have one for method, data, student work, journals, literature, etc. Review data frequently and label it clearly. Be careful to keep your notes together. I used several legal pads scattered around my classroom. If I had used one, it would have been easier to compile notes in my journal.

Analyze data as you get it, record it as you go. Only analyze the data you need. Work with a small sample of students to keep the work manageable. Develop a timeframe to follow and then maintain it. Always write down everything. Regardless of the type of research, a journal is of great use in recalling what happened. Make one. Keep a journal. The journal should be written in every day. If not, you will forget some very important insights and events that may be important to your final paper. The journal will not only help you on your paper, but help you realize your own personal growth as you learn from your research. Your progress and change will be more evident to you.

Communicating your research. Be sure to have someone review your work, especially someone with a 'scientific' mind and an English background. If you can't find one person with both strengths, you will need to have two people. One must read for content and the other for grammar. Find a slash-and-burn editor. You will be so emotionally tied to your writing and the story behind the words that you cannot be objective. You don't need a "friend" who is afraid to say "I didn't understand what this part is doing here," or "Your sentences are too wordy." Find someone who has both the competence and the assertiveness to really edit your paper. Don't take the criticism personally. And if the suggestions for change alter your fundamental feel for the writing, don't make them.

Do not extend the writing phase too much or you will lose your focus.

Keep updated versions of your paper on the hard drive and 2 or 3 disks.

Gaining support. Administrators should be briefed on the facts of the process and understand thoroughly how much is involved in the preparation of a quality project. They should put in writing that they are aware of it so they can be reminded when it slips their mind. It takes a lot of time and effort to do research in a classroom. Gain support from the administration so that the obligations outside the classroom are severely limited. This should include not teaching new subject matter. Do not take on new teaching assignments when beginning to do research. It would be valuable to have a lighter teaching schedule, due to the amount of time needed to do research. Don't volunteer for extracurricular activities.

Talking to others helps even if they are not doing research. Share your research with colleagues and mentors. Their suggestions and opinions can be valuable. Review data the first time in the presence of a supportive partner. Pace yourself and take advantage of the assistance being offered.

Surviving. Remember to consider the workload demands of conducting classroom research when doing your classroom planning. Use your free time and planning time well. Don't take on any other outside tasks—avoid serving on school committees, taking that office at church, or anything that you can defer until later on. Your study will take up more of your time (and even your emotional energies) than you think. During the research time it is hard to find the life outside of teaching and research. Remember family and friends.

Go easy on yourself, if you see flaws in your practice. Don't get discouraged. Get lots of input but trust yourself. This is your personal journey. If it doesn't fit someone else's vision of what 'research' is, fine. But it's your journey and you are the only one who knows what you are seeking. Enjoy the experience!

Advice from School Administrators

The administrators of the schools in which the Science FEAT teachers work were invited to make recommendations to other administrators at schools where teachers are considering action research. While not as extensive as the teachers' advice, it is powerful.

An administrator needs to celebrate what a teacher has done. Be tuned into teachers that seem to be asking questions and suggest they get together with another teacher who has done action research. For teachers who want to try it out, use action research as the teacher assessment tool instead of the traditional form.

Administrators must provide resources to teachers who show promise through action research. Allow the teacher the freedom to explore and the time to implement action research. Expecting them to grow without providing enough resources is ludicrous. Provide additional planning time. Provide more teacher assistant help. Allow flexible curriculum.

6 A Very Personal Conclusion

I have been privileged to work with the teachers participating in the Science FEAT Program since its inception. I have worked with them as they learned research methods, as they developed the action research plan, as they initiated and followed the plan, as they analyzed the data, as they evaluated their classroom practice, and as they prepared written papers. I have watched and listened as they have formally shared teacher initiated and designed, classroom-based action research with one another in a university-based colloquium. While many experiences with these teachers doing action research bring me joy and hope, allow me to close by sharing one. Daily a Science FEAT teacher will say to me something like, "I know so much more about classroom research, next year I am going to redo my study but just focus on...," or "I have so many more questions now than I did last summer, I am not sure which one to research next year," or "My study for next year is already set; I plan to...". With teachers with such knowledge, skill, and dedication, I am confident that the future of science education is in good hands.

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"Action research is valuable for I feel it provides teachers one structure for professional growth."

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