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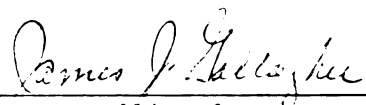
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**IMPLEMENTATION OF A SCIENCE COURSE
FOR POORLY MOTIVATED LOW ACHIEVING SCIENCE STUDENTS
A CASE STUDY OF TWO TEACHERS**

presented by

ROBERT LOUIS LISKE

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**IMPLEMENTATION OF A SCIENCE COURSE FOR POORLY MOTIVATED LOW
ACHIEVING SCIENCE STUDENTS: A CASE STUDY OF TWO TEACHERS**

By

Robert Louis Liske

A DISSERTATION

**Submitted to
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ABSTRACT

IMPLEMENTATION OF A SCIENCE COURSE FOR POORLY MOTIVATED LOW ACHIEVING SCIENCE STUDENTS: A CASE STUDY OF TWO TEACHERS

by

Robert Louis Liske

Research indicates that the science curriculum reform movement of the 1960's and 1970's accomplished little to meet the needs of poorly motivated, low achieving science students (Levin, 1987) and the curricula actually developed were not used as intended (Smith and Neale, 1988; Carlsen, 1991). Consequently many of these new materials were quickly discarded, and instruction for these students continued to use the transmission view of teaching and the absorptionist view of learning (Prawat, 1989).

Using a qualitative approach, this dissertation is a case study of two different high school classrooms, investigating various factors that are involved in the implementation of a new science curriculum. In the first classroom, the teacher used the materials as written, without assistance, and in the second classroom a "scaffolding model" (Jones, Palincsar, Ogle, and Carr, 1987) was used as a means of achieving a greater degree of implementation.

Findings show that all teachers observed were very directive and didactic in teaching, and used a limited and repetitive repertoire of activities quite different from classrooms for the average to above average students. This limited range of teaching activities was justified by a concern for classroom control, by beliefs about the abilities of students, by the philosophy of teaching and learning, and decisions about the appropriateness of content for poorly motivated students. The beliefs and procedures which teachers felt "works with these students" and were used for control hampered

both learning and the implementation of the new curriculum, much of which was adapted or dropped. On the other hand, when teaching strategies were employed that were consistent with the new program, student engagement in learning increased, students sought help in completing their work, and they displayed greater satisfaction and pride in their work, as well as a higher level of self esteem. Moreover, the procedure recycling and scaffolding used in one classroom resulted in a higher level of implementation than in the classroom where scaffolding was not used.

DEDICATION

Dedicated to the students who struggle most in school,
who often give the appearance they do not care about learning,
but who, having been so discouraged, having failed so often
having been hurt so much,
that they protect their tender spirits
in the futility of not trying anymore,
but underneath really do care,
and given loving patience, and extra help
will settle down, stay on task,
will try their best to do quality work,
will smile as they are successful, and
will take pride in their accomplishments
as they see hope restored.

ACKNOWLEDGEMENTS

The research study associated with this paper was part of a broader curriculum development project which involved many teachers, graduate assistants, secretaries, and professors. Consequently, I am merely giving a report on the work of many people, and am thankful for the encouragement, ideas, and camaraderie we shared.

I am especially grateful for the support, ideas, and patience from my graduate committee, Dr. James Gallagher, Dr. Glenn Berkheimer, Dr. Edward Smith, and Dr. Ralph Putnam. Their direction in creating a meaningful, logical summary report on this project has been invaluable. Not only have I learned a great deal about research, but have been carefully tutored in the art of competent writing. Their suggestions have always been valuable toward the development of a better dissertation.

My research assistant, Odette Lawrence, has served a crucial role in providing field notes, interview notes, and observations to give a second validating perspective and complete the data record, especially when I moved from the role of observer to observer/participant.

I appreciate the willingness of the teachers and students at various research sites to give up valuable time, to share honestly with me, and allow me to work in their classrooms. I need to maintain anonymity and cannot include their names, but their cooperation and friendship has contributed much to make this study possible.

Finally, I wish to thank my family for their support. Special thanks to my wife Helga for the many hours of proofreading and to my children Michael, Angela, Ursula, and Kent for their continual encouragement.

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CHAPTER ONE – INTRODUCTION

A Window Into A Classroom

The twenty-five minute drive to Cranston High School offered a quiet time for ruminating the plans and possibilities for the coming events of the day. Today is the time to try out my new idea of using Post-Its to develop concept maps.

Post-Its! What a flexible method to allow students to manipulate ideas in small groups until a logical flow of ideas begin to make sense. And then for these poorly motivated, low achieving science students, this technique will not even require the writing, erasing, rewriting they are reluctant to embrace and in some cases downright disdain.

Now Mr. Lindeman has shown no inclination to use experimental work or small group activities with these students. To me, the development of a concept map with Post-Its seems to offer an excellent opportunity to demonstrate that small group work and experimental work are both possible and profitable with the poorly motivated, low achieving science students. Moreover, as we use concept maps to link all these ideas together, it is possible that the student understanding will develop and their faces will simply light up with appreciation.

As we arrive at Cranston High School, it is time to come back to the reality of classroom life and see what the events of the day will bring. Class begins and I accept the responsibility of introducing concept maps to the class by taking my position at the overhead projector in the front of the room. We begin by brainstorming for the factors, instruments, and units necessary to make a weather forecast. The students offer ideas and I write them on an overhead transparency.

Note: Names of persons and schools have been changed to protect the identity of individuals.

Next, we discuss what factors affect the weather, how we can measure the factors, and what indicators suggest rain or clear weather, warm or cold weather, slow rain or thundershowers. Deciding to work one strand of the concept map with the students, I list wind direction, air temperature, and air masses on little transparency squares, arrange them on the overhead projector screen, and draw lines connecting them to show how a northerly wind may bring cold air and a southerly wind can bring warm air.

The students are now given instructions to copy the listed factors, instruments, units, and resultant weather patterns on Post-Its. Students are divided into groups, issued large sheets of paper while they copy the items onto the Post-Its. Being in groups, it seems everybody is expecting someone else to do the work. After a slow start, some words are written on the Post-Its. Mr. Lindeman and I sidle up to the groups to see how things are going. Quite a number of Post-Its have been pasted on backs of other students with messages of "Kick me ... I'm dumb ... I love Andrea".

The drive home is a time for reflection. I had expected the students to be enthusiastic about making concept maps. What went wrong? Were the directions not clear enough? Did I expect something beyond the capability of the students? Today, I have looked through the window of reality and gained a new insight into the life of teachers who exhibit a reluctance to use small group activities with the poorly motivated, low achieving science students.

THE PROBLEM AND ITS SIGNIFICANCE

One of the greatest problems in American science education to date has been the failure to meet the needs of the majority of its students in the area of science preparation, especially those in the middle and lower ranges of achievement. In a summary report on the Secondary School Science Project, Gallagher (1985d) concluded that present science instruction serves only the students in the top 40% of

achievement. Instruction for the average and below average students was found to often be simply watered down versions of higher level courses, giving a smaller dose of the same materials at a slower pace with little emphasis on helping students understand the knowledge taught and develop confidence to do so. Since instruction was abstract and remote, students quickly lost interest and subsequently their skill development, self confidence, and total achievement declined accordingly. A related study by the National Academy of Science, the National Academy of Engineering, and the Institute of Medicine (1984) depicts much of the current instruction as little more than memorization of terms and principles which have limited application to the real world as experienced by students (Anderson, 1987). Consequently many of these students give science a low priority, viewing it as detached from their everyday lives (Simpson, 1982; Yager & Penick, 1983).

In evaluating science education for the Michigan Science Teachers Association, Berkheimer and Maxwell (1986) concluded that the basic problem is not with the top 20% of our high school graduates who understand and remember. The real problem is with the other 80% who simply memorize and quickly forget. This division of our students into two groups – the learners and the non-learners, is both a function of different classes within schools, and diversity between schools themselves. America has some of the best schools, some good schools, many mediocre schools, and many very poor schools (Tamir, 1988).

This situation is especially disheartening when one recognizes that in spite of the tremendous effort expended and the financial investment of \$750 million of NSF funds during the 1960's and 1970's, we find that little change has taken place in the mode of science instruction (Fullen, 1985), and it is still viewed as "deficient in purpose, scope, and style of teaching" (Hurd, 1986), and most of the materials

produced during this era now stand idle on shelves, unused and eventually discarded.

First of all, science curricula developed during this era for the general school population did little to meet the needs of poorly motivated, low achieving science students, even though many were initially promoted as being beneficial to this population of students (personal experience of the author). Three main thrusts characterized the development of science curricula for the overall school population: experiential science, individualized science, and modular/unified science. On the experiential level, an attempt was made to bring the "process skills" into science classrooms, and give students firsthand concrete experiences with science objects. Discovery approach, inquiry learning, and hands-on activities became the buzz words of the day. While some individual studies did show that the discovery method can enhance thinking skills (Marek, 1978; Unan, 1979), and concrete experiences are beneficial for the low-achieving student (Schneider-Livingston, 1978; Okebukola, 1985), the overall pattern of science achievement did show some improvement on the elementary level (Bredderman, 1980). However, on the junior high and high school level, Idar & Ganiel (1985) noted that superficial memorization of terms, knowledge of formulas, and some manipulation ability was "usually sufficient to mask the lack of understanding" (p. 129). Somehow the students were now "doing science" but still not really understanding (Roth, Anderson, & Smith, 1983; Smith & Anderson, 1984).

The second thrust was the development of specialized programs to meet the individual needs of every student. These took the form of programmed instruction, auto-tutorial methods, computer assisted instruction, and comprehensive prepackaged science programs like the Intermediate Science Curriculum Study (ISCS), all involving students interacting with the materials. In most cases, programmed instruction, audio-tutorial methods, and computer assisted instruction were found to be no more

effective than conventional instruction (Moore, 1973; Lehman, 1980; Staniskis, 1977). Individualized instruction was found to favor the higher ability students (Tate & Burkman, 1981; Howe and Stanback, 1985). In all of these modes of instruction, the lower ability student was hampered by a low reading ability.

The third thrust was the development of modular/unified programs in which various subject matter areas (as science, math, English, and social studies) were combined to form interdisciplinary instruction organized around broad themes. Some success with the low motivation student was claimed by the LAMP project, described by Higgins (1978). However, the indicator of success was a lower dropout rate and little evidence was given for increased academic achievement. In other programs, little evaluation was done, making it difficult to appraise the results.

An Appraisal

Where does this leave us at the present time for the poorly motivated low-achieving students? Even though most of the National Science Foundation Programs developed in 1955–1975 were promoted to reach this segment of the school population through self-pacing, hands-on discovery method, individualized instruction, independent learning, the end results were designed as a reaction to the perceived technological challenge of the post-Sputnik era, and were most beneficial to the high ability students on the high school level (Lorenzo and Lisonbee, 1963; Burkman et al, 1982). Levin (1987) claims that the reform movement has "systematically neglected the educationally disadvantaged student" (pp. 19–21).

Moreover, the entrenched pedagogical methodology (lecture, drill, review worksheets, and testing) of teachers continues to impact the learning of students, who rely on factual recall and fail to integrate the knowledge they receive, devising all sorts

of coping behaviors designed to complete work rather than understand the material (Anderson, 1983; Roth 1985).

While science scores in general have declined both on a national scale and internationally compared to other countries (Nation at Risk, 1983; Mullis, 1988), the proportion of low-achieving students has increased in America. When I first started teaching in a large suburban high school near Chicago in 1976, we offered one section of general (low-level, remedial) science. Five years later, with approximately the same total school enrollment, we were offering and filling three sections of general science. Moreover, an increasing portion of academically incapable science students seems to characterize only a few of the modern technologically advanced nations, United States and Great Britain in particular (Erickson, 1985). This same large segment of students – the one's achieving in science, and the ones dropping out of science is not characteristic of nations such as Japan and Israel. This suggests that a qualitative study involving the practices and beliefs of both teachers and students may give insight into this growing segment of poorly motivated, low achieving science students.

This rise in the portion of low achieving students is especially critical when one considers the rapidly changing pace of our technological society. The proportion of jobs is declining in the manufacturing sector and the unskilled labor sector, while positions requiring technical training are on the increase. Students today will need an understanding of basic science and training in technology, not only to be participants in the work force, but as wise consumers and decision makers in a democracy. Knowledge of basic science has been affirmed by both the Michigan Science Teachers Association (1983) and the National School Board (1983).

As one reflects on over thirty years of sustained attention to science instruction, many questions come to mind, "What did we miss? Did we spend so much time on

the methods, materials, and curricula that we neglected to understand the learner? Were global applications as to teaching philosophy and methodology invalid for the great variety of students encountered? Were workable ideas and good programs simply not implemented on the local school level, and if so, why not?" Although each of these seem to partially account for the lack of impact of new science curricula on the methods of teaching and on science achievement in general, more recent research (Posner et al, 1982; Anderson & Smith, 1984) points to the importance of the thinking of individual students, their prior knowledge, their perceptions and misconceptions, their beliefs about themselves and learning, and their ability to synthesize information into coherent, meaningful explanations.

In addition a number of studies have investigated how teacher's beliefs and contextual constraints on them affect the implementation of new curricula in schools (Orpwood, 1985; Cronin-Jones, 1991). Consideration of this research suggests that an in-depth qualitative study of what actually happens in classrooms during attempts to implement a new curriculum may give valuable insights into why new curricula are not implemented as intended. The developments of the past thirty years suggest that the problem stems not only from the lack of appropriate curricula for these students, but also from a failure to implement curricula as intended.

The MDE Project – A Present Response

With a growing public recognition of declining achievement in science in the early 1980's, societal pressure influenced many school districts to upgrade graduation requirements for high school science. Following the release of "A Nation at Risk" (1983), many school districts and the Michigan Department of Education required two years of high school science for graduation. In response to these initiatives and in an attempt to provide a more suitable curriculum for high school students with poor

motivation and low achievement, Michigan State University in conjunction with three Michigan school districts, forwarded a proposal to the Michigan Department of Education in late 1985 for funding to develop science curriculum for this target population. The funding was partially granted, and during the course of the 1985–86 school year, six teachers (two from each school district), two graduate students in science education, and Dr. James Gallagher from Michigan State University worked as a team to write the first draft of two technology units, entitled *Wheels* (addressing the physics of cars and bicycles) and *Muscles and Bones* (addressing exercise physiology, physical health and appearance). These two units were trial tested in two of the participating school districts during the winter of 1987. At this time data collection for phase one of the dissertation was completed at Western High. Using feedback from the trial testing, these two units were rewritten during the summer of 1987.

A second proposal was submitted to the Michigan Department of Education for the completion of the three remaining units. Again funding was only partially granted and during the summer and fall of 1988, Dr. Gallagher, six teachers, three graduate students, and one high school student worked to complete the three remaining units of a year-long high school science course for students with poor achievement and motivation. These units, entitled *Weather*, *High Tech Communication* and *Chemistry for Keeping Clean*, were ready for trial testing in the fall of 1988 and preparation was being made for the dissemination and implementation of the entire program during the 1989 school year. At this point data collection for phase two of the dissertation was completed at Cranston High School.

The initial project outcomes as stated in the 1985–1986 application (Gallagher, 1985c) included:

- 1) The development of a new course entitled *Science and Technology in a Changing World*.
- 2) Development of a teacher orientation program.
- 3) Field testing of the modules.

However, the program was actually funded at approximately one third of the level requested. Therefore, we were not able to achieve all the goals set forth in the proposals. Revised plans were submitted to match the budget funded.

The 1988–89 application (Gallagher, 1988) added:

- 1) Revision of two units already field tested.
- 2) Writing of three additional units.
- 3) Field testing of these three additional units.
- 4) Dissemination of the new curriculum across Michigan.
- 5) Establishment of resource centers for trial teachers.

Dissemination of this new technology program included presentations at the Michigan Science Teachers Association Convention as well as a series of five teacher training workshops geographically distributed across Michigan. The purpose of these workshops was to introduce teachers to this new curriculum, familiarize them with the philosophy and methodology, demonstrate some lessons and activities, and in general develop interest in the program.

Program Characteristics

A number of assumptions are necessarily inherent in an effort to develop a science curriculum for low-achieving, low-motivated students. First of all, the implication was made that the needs of these students can at least in part be met by the development of a curriculum. Secondly, it was assumed that teachers would adopt the strategies and methodology built into the curriculum. Thirdly, it was expected that

the new curriculum would give teachers the knowledge and materials necessary to change teaching methodology, and finally, that the design of a curriculum would contribute to motivation of students and to the development of deeper understanding of concepts.

Specific design characteristics in the development of this curriculum (Gallagher, 1985c) included:

1. Selection of topics that are of high interest to this target population.
2. Development of materials that include a high degree of relevance to the daily lives of students with emphasis on the practical rather than the theoretical aspects of science, "a strong emphasis on applications ...to help students see the utility of scientific knowledge." (Gallagher, 1985c).
3. Development of materials that demonstrate internal coherency – in which teaching methodology is consistent with program objectives, in which activities work toward achieving learning goals, which provide a continuity from lesson to lesson, and a direct applications in the real world.
4. A greater variety of shorter activities tied together into a longer module.
5. A high degree of student engagement in activities.
6. Cooperative rather than competitive activities.
7. An attempt to incorporate small group activities.
8. Activities that allow a high degree of success.
9. A commitment to teach basic science and skills, using technology to create interest and relevance.
10. Emphasis in helping students construct meaning from reading, lab activities, and personal experiences through writing and small group work and whole class instruction.

The importance of teaching basic skills such as reading comprehension, clear written expression, and accurate mathematical computation was affirmed by two data sources. A study conducted by the Carman–Ainsworth School District (1985) together with twenty–one leaders from business and industry compiled a list of necessary but

deficient skills and attitudes needed by workers in today's marketplace. This study substantiated the position taken by the National Academy of Science, the National Academy of Engineering, and the National Institute of Medicine that the teaching of basic skills is of great importance in preparing our young people for the present technological society. The focus of this research project was specifically designed to address a set of educational and personal deficiencies that are characteristic of this population as set forth in the following chapter. A natural consequence of the decisions to incorporate the above characteristics in the course being developed at MSU is that the character of all the units tended to reflect a scientific and technological approach, rather than a purely scientific approach.

Specific Curriculum Objectives were Stated as Follows:

1. Students will learn how to apply principles from science and technology to familiar problems of daily life.
2. Students will learn how to use basic principles of science and technology as tools for understanding real problems that influence their daily life.
3. Students will learn and develop skills in using basic processes of science and technology.
4. Students will practice and enrich their basic skills.
5. Students will develop occupational awareness.
6. Students will develop increased self confidence.
7. Students will learn to work cooperatively in groups.

During the development and implementation of this technology curriculum, many questions came into consideration: Will all this work have been in vain? Are these materials also destined to reside on a dusty shelf for a time, eventually to be discarded and forgotten? Why are teachers reluctant to adopt new materials and their accompanying methods of teaching? Are the materials simply not better than former

materials? Do we not understand the perceptions, assumptions, and fears of teachers? Do we not recognize the constraints under which they operate? Are implementation procedures inadequate or simply way off track? Why has the least change in mode of teaching and curriculum taken place for the poorly motivated, low-achieving students (Liske, 1987; Levin, 1987)? It may be too early to reach a final conclusion, but present indicators suggest that few schools and few teachers will actually be using these materials from the Michigan Project on a continuing basis (Interview with Gallagher, June, 1991). These questions were part of the motivation in structuring this dissertation.

The Development of this Dissertation as part of the MDE Project

This dissertation ended up as a case study comparing the implementation of two science units, developed by the MDE project, in two different classrooms. However, this is not how it started. While the general area of interest has always been on implementation of the new curriculum, the purpose and focus changed a number of times during the course of development.

Phase one of this study was designed as a qualitative study to determine how the new technology curriculum is used and viewed by teachers and students. Observations and data collection were completed during the spring of 1987 at Western High School as the unit *Wheels* was taught for the first time. During this time, I took the role of an observer as we (the project developers) were interested in how the teacher would use the materials depending on written instructions from the Teacher's Guide alone. The findings of this initial study included massive adaptation of the material as written. On the basis of data from this and other field tests, the first two units were revised and the last three units completed.

With the completion of the last three units ready for trial testing, a dissertation proposal was submitted to determine if the contextual and conceptual links designed into the *Weather* unit would enhance understanding during the teaching of this unit. Data collection for phase two began in the late fall of 1989 and was completed in the spring of 1990 at Cranston High School. During the early stages of teaching the *Weather* unit, the same pattern of modification appeared as was noted at Western High School. Out of necessity, my role as a researcher changed from a pure observer (as at Western High) to that of a participant-observer, which changed the design of the study into a two-phase project, one without intervention and one with intervention. The intervention used to increase the potential of implementation as intended was a scaffolding model (Anderson, 1987b). Primary data, collected by direct personal observations, consisted of field notes, audio tapes, and interview recordings. Supporting data consisted of pretests, posttests, samples of student work, and printed school documents.

Analysis of data during the summer of 1990 determined that the collected evidence was insufficient to support conclusions to questions generated for the dissertation proposal. Only a portion of the unit has been taught, modification had been quite extensive, and my role as a researcher had changed.

Under consultation of the graduate committee, an evaluation of collected data did generate some interesting observations and the design of the dissertation was restructured to its present form – a comparative case study of two classrooms, one without intervention and one with intervention.

The Organization of the Dissertation

Chapter one of this dissertation gives the reader an introduction to the status of science education for poorly motivated, low achieving students and develops the

significance of the study. It also describes the Michigan Department of Education Technology Curriculum Project, the relationship of this dissertation study to the project as a whole, and the evolution of this dissertation during the course of this project.

Chapter Two gives an overview of literature pertaining to the characteristics of low achieving students, traditional teaching and learning for these students (with an overview of specialized curriculum developed), and attempts to implement these curricula. The second section of this chapter give the theoretical overview, with the first part describing traditional teaching and the second part describing the theoretical rationale on which this study is based.

Chapter Three details the design of the dissertation including the nature of the study, specific research questions, and assertions developed.

The collected data are presented and interpreted in three chapters. Chapter Four presents the data on the characteristics of students, while Chapter Five describes implementation of the unit *Wheels* at Western High in 1987 and Chapter Six describes the implementation of the unit *Weather* at Cranston High in 1989–1990.

Analysis of data and the comparison of the two schools is given in Chapter Seven, and the conclusions and summaries are given in Chapter Eight.

CHAPTER TWO – REVIEW OF LITERATURE

The nature of ethnographic study is to enter a situation with an open mind, free from preconceived notions, hopefully understanding the biases involved, and without guiding hypotheses that frame the investigation. Various assertions are generated from observations, then either confirmed with further substantiating evidence or modified with counterinstances from forthcoming data.

As such, a review of related literature for this type of study does not focus on a particular concept or question, but attempts to familiarize the researcher with various aspects of education directed toward the poorly motivated, low achieving science student to help develop an understanding as to what is really happening in a classroom, and what beliefs and circumstances underlie each situation.

Consequently, this review of the literature involves a rather wide range of topics divided into two main sections; first the historical background and secondly the theoretical background. The historical background characterizes education for the poorly motivated, low achieving science student as traditionally and presently constructed. This includes: the characteristics of the poorly motivated, low achieving science student; traditional teaching and learning for these students; and previous attempts to create and implement new curricula for this population of students.

The purpose of the theoretical portion of this review will be to place the interpretations and recommendations into a logical framework and undergird the rationale of the argument to broaden the generalizability of this study. In that the establishment of meaningful learning and effective teaching for the poorly motivated, low achieving science students is the underlying motivation behind curriculum development, a review of learning as applies to these students will be included. The failure of these students to connect various concepts into meaningful understanding

suggests developing an argument under the constructivist perspective. Finally, the failure to implement most new curriculum for these students necessitates a look at the beliefs of teachers and students.

After searching various indexes and data bases, it became apparent that the amount of research and meaningful literature directly related to the poorly motivated, low achieving science student is very limited (Levin, 1987). To further complicate matters, the research that is available is in many instances not very helpful. For instance, carefully designed studies with valid statistical results showing a high correlation between attitude and achievement (Brewster, 1976; Willson, 1983) or between motivation and achievement (Ururoghn & Walberg, 1979) or between mental ability and achievement (Denkworth, 1970; Lehman, 1980) are interesting but not enlightening to the practicing teacher.

A review of over 200 studies on the low-achieving science student (Liske & O'Halloran, 1985) indicated a complex issue with many factors involved, including such variables as cultural factors, home and community, student characteristics, and school factors. Each of these factors in turn contained many variables. For example, in the area of student factors, intelligence (Denkworth, 1970; Anderson, 1977; Lehman, 1980), reading level (Mayer, 1970; Scrivastova, 1977; Rossock, 1982), math proficiency (Baker, 1985), cognitive style (Ogunijemi, 1973; Brewster, 1976; Poslock, 1982) are related to specific abilities, while self-concept (Handley & Morse, 1984; Kramer & Walberg, 1981), locus of control (Burow, 1978; Rossock, 1982; Bradshaw, 1984), and anxiety point to emotional and psychological factors. Even personal factors like gender (Smail & White, 1982; Lo, 1982) and adoption (Scrivastova, 1977) correlated with achievement. In the past much effort has been directed toward the study of factors (such as SES) that are to a large extent beyond the control of

educators. In order to make significant gains in educational achievement, it will be necessary to analyze a variety of impinging causal factors, in contrast to correlational facts, and focus on those that contribute to understanding these relationships and are amenable to educational intervention. Probably the most helpful research will come out of the constructivist perspective, helping to devise teaching strategies that will help bring understanding and self-esteem to these students.

A Profile of Poorly Motivated, Low Achieving Science Students

Clegg and Morley (1980) give a profile as follows:

These pupils are characterized by low motivation, an inability to concentrate on any one topic for more than a short period of time, low powers of thought and retention, frequent aggressive behavior and a resentment of authority, particularly that of the school teacher. They are frequently absent from school (p. 454).

Anderson (1987b) notes that this group, which we are not reaching by present educational programs consists of the passive learners, who are often disabled or handicapped, usually deficient in reading or writing skills, and due to developing frustrations frequently absent from class.

As can be noted by comparing these two profiles, poorly motivated, low achieving science students do not fit one profile, but include a wide variety of individual, circumstantial, and historical factors.

First of all, low achievement is not a distinction of only low ability students. Low achieving students range all the way from special education students to very capable students, who for some reason neither care about or are interested in school. Often these students are very capable, but deficient in some specific area, that in turn hampers growth in other areas. Reading difficulty (Mayer, 1970; Srivastova, 1977; Rossock, 1982) and low math ability (Baker, 1985) are two of the more obvious deficiencies that contribute to low science achievement. Moreover, many of these

students seem to have acquired misconceptions about science that interfere with further understanding (Mentzes, 1984, Idar & Ganiel, 1985).

Secondly, and probably more significant than specific subject matter deficits is the lack of metacognitive skills among low achieving students. Dweck & Elliot's (1983) division of metacognitive skills into task analysis, strategy planning, and performance monitoring illustrate the range of skills involved. Cullen (1985) defines metacognition as "one's knowledge concerning one's own cognitive processes or products" (p. 267), and divides them into cognitive monitoring, strategic action, and coping responses. She indicates that achieving students are able to cope with ambiguity and error and many non-achieving students develop such anxiety and frustration that they exhibit "learned helplessness" (p. 272). She asserts that impaired performance on the metacognitive level will interfere with cognitive functioning, even if there is not a deficit on the cognitive level itself. In describing negative coping, she states that "in order to complete assignments, low achieving students developed strategies that contributed to task completion, but did not necessarily contribute to the mastery of the content or the acquisition or maintenance of adaptive learning-to-learn skills" (p. 290).

A third characteristic often found with the low achieving, poorly motivated students is a negative self-concept (Kramer & Walberg, 1981; Bradshaw, 1984; Handley, 1984). This low self-esteem takes various manifestations ranging from judgments of lack of competence, external locus of control, to negative self-attribution. Dweck & Elliot (1983) note that "achievement motivation may be viewed as involving goals related to competence – increases in competence and judgments of competence" (p. 645). A history of failure for these students has convinced most of them of their own incompetence which directly contributes to their increasing lack of self-esteem and the tendency to resort to negative coping behaviors in an effort to

salvage the remaining bit of self-esteem.

Fourthly, research has shown a strong correlation between achievement and what is called "external locus of control." These students feel their effort has little affect on the outcomes of their own lives (Burow, 1978; Rossock, 1982; Bradshaw, 1984; Sherris & Kahle, 1984) and circumstances beyond their own control determine the future potential of life possibilities. According to Weisz and Cameron (1985), this control over events or various situations is dependent upon two things; 1) contingency – the degree to which an event can be controlled, and 2) competence – the individual's capacity to influence the events. They equate a person's view of self with what they call "self-efficacy", the ability to influence events and outcomes.

Most of these students have a history of failure which colors their expectations of present success. Through a variety of previous experiences (performance accomplishments, verbal and social interactions, and evaluative cues), the student develops an expectation for either success or failure in regard to future events. McCombs (1986) asserts that in the face of failure, there is an "inherent need to establish and maintain a positive self-image and a sense of worth" (p. 7). As a result, we find many students resorting to all kinds of adaptive and maladaptive actions to maintain a positive self-evaluation.

One of the most common tendencies for these students is to adopt performance goals rather than learning goals. As explained by Dweck & Elliot (1983), performance goals are motivated by value judgments of peers, teachers, and parents, in which the student attempts to obtain favorable judgment of competency and avoid an unfavorable judgment of inadequacy. These students with performance goals exhibit greater anxiety toward tasks, avoid challenges, and show less generalizability and transfer of learning. In contrast, children with learning goals see the long term

benefit of the task, and will complete the task for understanding and for its own inherent value. Ames and Archer (1987) confirm the importance of this distinction in saying that "a performance goal orientation may actually provide a context that is not conducive to developing a positive achievement orientation and longer term interest in learning" (p. 413)

As previously indicated, students' self-perception and emotions have a long-term affect on learning. For instance, a high level of anxiety is directly related to low science achievement (Dhaliwal & Saini, 1975; Gabel, 1983; Trout and Crawley, 1985; Napier & Riley, 1985). Cullen (1985) asserts that anxiety, frustration, and anger about school often develop as early as eight years of age, and continuing negative affect of these emotions continue to interfere with the child's effective use of metacognitive strategies. The profile of the low achieving student then is one of unclear or maladaptive goals, low self-esteem, external locus of control, weak metacognitive skills, and in some cases weak cognitive skills. Repeated failure has ingrained a low expectancy for success and causal attribution of failure to uncontrollable factors.

Traditional Teaching and Learning

Traditional teaching for the poorly motivated, low achieving science student has to a large extent been fashioned by experiences of teachers with these students and secondly by consequent beliefs about students' ability and motivation, arising out of these experiences.

Due to the difficulty in teaching these students, one of the primary concerns for these teachers has been on management and control (Doyle, 1986), with management concerns taking priority over instructional effectiveness (Cusick, 1983). The classroom becomes a system of structured routines aimed at maintaining order (Gallagher, 1989;

Liske, 1989). In fact, the management concerns often dictate and restrict the choice of educational activities used with these students. Student-centered work and lab activities are rarely used while lecture and seatwork predominate (Gallagher, 1989).

The traditional methodology (textbook/lecture/review/test) that epitomizes a large portion of education today is particularly evident in classrooms that contain poorly motivated, low achieving science students. This mode of learning depends highly on the organizational, analytical, and communicative skills of the teacher, reflecting what Prawat (1989) calls the "transmission view of teaching" and the "absorptionist view of learning" (p.318). In this mode of instruction, the teacher becomes the dispenser of information and the student becomes the repeater of the same information with both assuming relatively passive roles (Lockhead, 1985; Doyle, 1986; Cohen, 1988).

Emphasis on this mode of instruction will focus strategies toward content acquisition (Anderson, 1987b; Tyson-Bernstein, 1988) that finds its roots in the additive view of learning (Roth, 1985; Prawat, 1989). Research also indicates that content is highly sequenced into a hierarchal progression (Prawat, 1989). According to this common hierarchal view of learning, certain prerequisite facts and skills need to be mastered (using lecture, drill, review, and quiz procedures) before higher order thinking skills can be realistically developed with the students (Prawat, 1989). This regimen has been found to achieve a measure of success with these students and over time has become more deeply embedded in the teaching routine.

This additive view of learning is reflected in the manner in which textbooks are used in these classrooms. Science curriculum is primarily textbook driven. Gallagher (1989b), using data from the Secondary Science Teaching Project, asserts that "science teachers, and even curriculum directors, strive toward coverage of the content with little regard for student learning" (p. 6). Tyson-Bernstein evaluates present day

college textbooks as follows:

They take on too many topics and treat them superficially; there are too many unexplained facts, and there is not enough content; new knowledge is more often piled on than assimilated; the prose is dumbed down to accommodate the poorer readers of today's undergraduates; faddist and special interest group messages, however notorious, appear as bulges or snippets of content; flashy graphics and white space further compress the already compressed text (p. 194).

What has been stated about college texts, applies equally well to high school textbooks. Anderson (1987b) explains that boldface type (in textbooks) is used to emphasize new words, not necessarily important ideas; in most cases the main ideas listed for each chapter are usually facts and not concepts. Roth (1985) has demonstrated how this textual structure impacts readers of these texts. Poor readers, with the direction of the teacher end up memorizing lists of facts, consistent with the additive notion of learning. Students would focus in on "big words" (bold words) and learn them in isolation, being familiar enough to repeat them for an answer, but not understanding them well enough to connect them to other facts in the generation of conceptual understanding (Roth, 1985). For the lower achieving students, much of science instruction is characterized by copy-matching (copying answers from the text using various clue strategies, without understanding the relationships between these facts (Anderson, 1987b). Overreliance on prior knowledge further complicated understanding and simply ingrained misconceptions.

Rowe (1992) substantiates this rote learning of facts as a consequent of "America's fantastic drive to do testing" (p. 53). Her calculations yield an impressive array of 2500 to 3000 new terms in a textbook, an average of 20 new terms per class period, leaving almost no time for discussion or inquiry. She describes a frustrated student, slamming down a thick textbook, crying, "It's a damn dictionary? Who reads dictionaries?" Anderson (1987b) characterizes the teaching of science as a simple

transfer of facts, rules, and definitions from the textbook to the student.

The long standing complaint emanating from this traditional approach to education is the production of students who know a lot of information, but cannot apply the information in an effective and useful manner once entering the job market (Carman–Ainsworth School District, 1985). It may be argued that substantial content is necessary for functioning efficiently in any analytical, synthetical, or creative manner, and as such needs to be a goal component in any educational philosophy, but content acquisition as the primary goal in education failed to develop understanding of science concepts in students or relevance to the real world.

The move toward discovery learning with "hands-on" science activities during the 1960's and '70's also failed to meet the needs of the poorly motivated, low achieving science students. It was assumed that students could formulate meaning on their own (Smith & Anderson, 1984; Roth, 1984) and ignored the importance of prior knowledge (Eaton, Anderson, & Smith, 1984; Gil–Perez & Carrascosa, 1990). The conclusions and concepts that developed from these activities often were unscientific and in some cases blatantly incorrect (Smith, 1985). Moreover, many of the teachers were unprepared to help students analyze and interpret observations from experiments and left students to formulate their own conclusions. Using research from Roth (1984) and from Smith & Anderson (1984), Anderson (1987b) concludes that the "research evidence suggests that hands-on activities or instruction in the process skills will not ensure meaningful learning, either alone or in combination with conventional fact-based instruction" (p. 77).

Students did find interest in the materials, but the role of the teacher was changed from directed inquiry to a manager of materials and learning activities. Direct teaching was largely discarded in a philosophy that encouraged teachers to get the

material into the hands of the students, get out of the way, and let them mess about. And this is exactly what many of the poorly motivated, low achieving science students did with the materials, although the intention was to create opportunity for exploration and investigation. The "messing about" approach (Hawkins, 1965) created a management and control problem for many of the teachers and with control taking a higher priority over instruction in the priorities of administrators (Cusick, 1983), discovery learning for the low achieving students was up for reconsideration.

Finally, discovery learning demanded a much greater time commitment from teachers in material acquisition, preparation, and cleanup. And so by the end of the 1970's, one by one of the new National Science Foundation programs were discarded and again replaced by traditional teaching. Thus we find that discovery learning, in part motivated or at least justified by its potential to allow slower learners to learn at their own pace and hopefully help them conceptualize and develop meaningful science understanding, also failed to offer genuine science understanding to the poorly motivated, low achieving science students.

Implementation of Previous Science Curricula for Poorly Motivated, Low Achieving Science Students

The development of science/math curriculum in response to the launching of Sputnik in 1959 primarily targeted the average to the above average science students and gave little attention to the poorly motivated, low achieving science students. Levin (1987) concludes that the "reform movement has systematically neglected educationally disadvantaged students" (Pp. 19–21). For these students only two major curriculum projects and a number of local minor programs were developed and of these only one received national prominence and survived the test of time, that being *Investigations in Science*, written by Dolmatz and Wong.

The major focus of this section of the literature review is on the implementation failure of new science programs for the poorly motivated, low achieving students and an attempt to understand the reasons why this is occurring. It will first give the results of some general implementation studies, include some of the explanations given by these researchers as to why implementation failed, and finally include some of the recommendations for future studies. The second section will give a brief overview of various curricula specifically developed for the poorly motivated, low achieving science student. The attempt to implement each curriculum into the existing school structure will be examined in an effort to understand why so few of the curricula developed for these students were not implemented as intended.

An overview of the research regarding the implementation of new curricula for the poorly motivated, low achieving science students indicates that almost none of the new programs were implemented as written or intended to be used. General research overviews affirm that most programs were adapted or modified to fit the teacher's belief system, and were eventually dropped as the teacher returned to the traditional mode of teaching. Cronin-Jones (1991) completed a survey on implementation and cites Clark & Elmore (1981) who conclude that "teachers adapt curricula to fit their knowledge, priorities, and unique classroom settings. . . (with) teachers deciding which topics and activities are appropriate for students (p. 236). Prawat (1991) indicates that factors other than the quality of the curriculum must be considered in the implementation failure of new programs. Citing studies by Carlsen (1991) and Smith & Neale (1988), he claims "research demonstrates that even the best curriculum material is modified to fit the practitioners' views of teaching and learning" (p. 316). Anderson and Smith (1984) report a distinct difference between what the curriculum developers intended and the curriculum actually implemented by teachers. This difference between the

intended and implemented curriculum has diluted the effectiveness of most of the new programs, substantiating the original teacher's belief that new curricula are just a fad from the central office, not practical for real classrooms. Consequently, like most other new reforms, the program was usually dropped within the first year after attempted implementation. Fullen (1972) concludes that "despite massive inputs of resources during the last fifteen years and despite numerous 'adoptions' of innovations, very little significant change has occurred at the school level corresponding to the intended consequences of these innovations" (as quoted by Dynan, 1985).

What does the research offer in explanation of continued implementation failure?

The question still remains, "Why have these new curricula made very little impact on changing science education?" Is there something inherent in the design of the curricula themselves? Can some of the responsibility for lack of change be attributed to the implementation process? Available research suggests four areas for further investigation relative to implementation: structure of schools, the mode of implementation, teacher training, and finally the beliefs and values of teachers. Of these four, the strongest connection emerging from implementation studies is the link to teacher beliefs and values.

Citing reports from the Carnegie Commission (1986) and the Holmes Group Report (1986), Prawat (1989) asserts that implementation will require drastic changes in the structure of schools (how they are controlled, organized, and administrated). Little (1982) attributes the failure of implementation to "teacher training and lack of concern to the social organizational features and contexts in which the changes were attempted" (p. 326). Using "successful schools" as a model (where implementation was successful), she points to collegiality among teachers, willingness to try experimental approaches, structured observations, shared planning, and good

communication with other teachers and administrators as critical factors in successful implementation. These changes involve new roles for teachers (Clark & Peterson, 1986), including them in curriculum design and development, providing them with time and support during the implementation phase. On the more practical side, while teachers operate with functional autonomy in their own classrooms, school-wide professional agreements set boundaries on the time, curriculum and resources available to teachers. Mojkowski (1991) details new roles and relationships necessary for restructuring schools as follows:

1. Site autonomy, shared decision making, enhanced roles for teachers.
2. Regulatory simplicity.
3. Networks of flexible groups rather than hierarchies.
4. Encourage risk taking and innovation.
5. Invest heavily in staff development.
6. Focus on the teaching/learning process (p. 13).

The second factor affecting implementation of new curricula suggested by researchers is the mode of implementation. Historically, the most common mode of curriculum implementation has been the top-down approach with state agencies and the district superintendent providing the driving force. Conversely, some schools have used the "bottom-up" approach where curriculum change is initiated and planned by local teachers on the school level. Larry Cuban (1984) concludes that it is still not clear which mode is most effective

as few researchers have investigated the connections between strategies and outcomes...(On one hand mandates) can produce compliance with the letter of the law without leading to improvement (p. 141),

while on the other hand, a bottom-up approach can produce a diversity of programs from school to school, a lack of consensus in the district, or possibly no reform at all.

One thing is clear however. In spite of mandated curricula, each teacher essentially determines his/her own curriculum. Cusick (1983) claims that there is no

direct connection between what is written in curriculum guides and what is actually taught in classrooms (pp. 84–86). Teachers functionally work in isolation and consider classroom teaching their domain and any attempt to impose a pre–designed or other–designed curriculum is often met with outright hostility and subversion. Cuban (1984) proposes an implementation model that involves a multi–level approach with broad involvement in policy setting, long range development, and evaluation, but gives a more direct responsibility to educational leaders in the development of vision, generation of resources, and finally in the implementation and administration of new programs.

Must teacher education assume some responsibility in the failure to implement new curricula? Cronin–Jones (1991) outlines areas of involvement by making the following recommendations:

1. Provide students with opportunities to review a variety of intended curriculum materials.
2. Provide in–depth exposure to the rationale and theoretical perspective underlying a curriculum's choice of objectives, content, and instructional strategies.
3. Focus on identifying existing teacher beliefs and stimulating teacher candidates to examine, and perhaps change their beliefs about how students learn, and the teacher's role in the classroom (p. 248).

Looking at the total body of research, the most powerful factor that seems to influence curriculum implementation is the beliefs and values of teachers (Cronin–Jones, 1991). Having surveyed various studies, she concludes that "teachers have difficulty on implementing curricula which emphasize values different from those the teachers customarily held" (p. 236). The larger the discrepancy between existing teacher beliefs and the change required by the new curriculum, the less likelihood for successful implementation (Cronin–Jones, 1991).

The differences in values and beliefs between the curriculum developers and the teachers most often concerned the concept of learning and the nature of science. More specifically, these included beliefs about the role of the teacher in the classroom, the ability of students, and the relative importance of topics (Mumby, 1983; Cronin-Jones, 1991). Of these, the teacher's ability to decide which topics and activities are appropriate for students will to a large extent determine how much of a new curriculum is actually adopted as intended (Brophy & Good, 1974; Doyle, 1979; Rosaen, 1987).

Cronin-Jones describes how teachers altered the intended curricula to "make them more congruent with their own teaching contexts and belief systems" (p. 245). She illustrates this with an example of a teacher personally observed:

During the lesson, she (the teacher) carried the cognitive load of the class and reduced most of the material presented to small, simple bits of factual information. As a result, other student outcomes such as problem-solving skills and attitudes were not stressed. ... In both cases, beliefs and attitudes exerted a strong influence on implementation.

This observation agrees with Clark & Peterson (1986), reporting a study by Olson (1981), that "teachers transformed and distorted new curriculum to fit their implicit theories of teaching" (p. 288).

Research Recommendations Regarding Implementation

With teachers having the greatest impact on implementation or lack of implementation, it makes sense that most recommendations for future implementation concern teachers in some way. First of all, it appears basic that strategies be devised to understand the beliefs and values of teachers and then construct procedures to bring their beliefs and those of a new curriculum into alignment. Cronin-Jones (1991), citing work done by Orpwood (1985) suggests that "more detailed case studies are needed to find out exactly how teacher beliefs and perceptions influence the process"

of implementation (pp. 477–489).

Furthermore, a number of researchers recommend that research needs to be conducted in classrooms. Cronin–Jones (1991), basing her assertion on work completed by Davis (1981) and Barnes (1982) concludes that "in order to understand exactly what happens to curricula when they are put into teachers' hands, researchers need to observe lessons, interview teachers and students, and look at the work done to piece together a complete description of the implementation process" (pp. 1–12). Gage (1979) specifies that research on curriculum implementation needs to proceed by observing what teachers actually do with curriculum programs in their own classrooms.

Finally, research implies new roles for educational leaders, particularly principals and curriculum consultants. Mojkowski (1991) envisions a principal working as a coach – creating vision, analyzing concerns, providing motivation, monitoring progress, building communication links, providing encouragement and support, forging interdependencies, and creating opportunities. Dynan (1985) would transfer curriculum consultants from the central office to school buildings where they "can work with the teachers in a school rather than ahead (of them) or outside of them" (Personal notes from a seminar at MSU on Oct. 14th, 1985). His observations have led him to believe that effective implementation of new curriculum will not be possible as long as the centralized model of curriculum development is maintained.

An Overview of Curricula Developed for the Poorly Motivated, Low Achieving Science Students

One of the earliest attempts (1962) to develop a program for the low achieving science students was *Patterns and Processes* by the Biological Sciences Curriculum Study (BSCS). This was an attempt to introduce the inquiry method using highly structured teaching strategies in which information was presented in small sequential

steps. The attempt was made to include variety in the form of lab investigations, demonstrations, short readings, linear programmed material, class discussions, and written review material. The reading level of the material was purposely kept low to avoid frustration. The text included five units which means that students did stick with one topic for at least six to seven weeks (BSCS, 1985).

However, in spite of the new content and the attempt to introduce the processes of science to the poorly motivated, low achieving science students, testing indicated no significant difference in either achievement or interest between students using the BSCS Patterns and Processes and those using the traditional text based program (Lorenzo & Lisonbee, 1963; Liebherr, 1966; Welford, 1969).

During the early 1970's, a number of attempts were made to develop curriculum for the less-able science students both on the local and on a commercial level. McGraw-Hill published *A Man-Made World* in 1971 with the assumption that science should be fun, easy, and apply directly to the lives of students. It was organized under some broad themes as modeling, decision making, feedback and stability. However, like most commercial published programs, evaluation was neither planned or completed, and consequently contributed little to long range understanding of science for these students.

Interestingly enough, another commercial textbook that received national prominence and wide acceptance has very little written about its development and even less research about its effectiveness. *Investigations in Science* (IIS), by Wong and Dolmatz, operates on a philosophy of great variety, both in activities and content. A topic will normally be treated for about five lessons, and then changed. The program is designed for students to complete investigations daily, but personal observation indicates that many teachers use the textbook as a content guide, omit the lab

portions, and fill in missing information by lecture. Most of the investigations are too short-term to permit the designing of real science investigations, collection, and analysis of data. Not only were the units designed to be short, but even the lessons were conceived with the Wong philosophy of "the longer the lesson, the higher the rate of failure (Wong, 1978). To keep students from getting lost, the text integrated reading material, investigative procedures, and discussion questions in the same text. To keep students from getting bored, the text was written with slang, profusely illustrated, and structured around the here and now. However, the objective to increase the success rate of students has been counter-productive to a certain degree. Some students feel that the IIS program is an affront to their dignity, "treating them like 6th graders" (Teacher interview, 6/27/89, Record # 189).

Even though this program does provide many topics of high interest, my personal belief, based on teaching the course myself, is that it does not really effectively teach students the processes of science or allow them to use their own creative abilities. This was further substantiated by Mrs. Krauss in the study at Western High who claimed that there is not enough content in the program and additional material is needed and will have to be added by the teacher (Liske, 1989).

Another curriculum project during the early 1970's entitled *Intermediate Science Curriculum Study* (ISCS) was written with the hope of meeting the needs of all students in the classroom by allowing individual pacing in the progress of students. This program, designed for grades seven and eight, was completely student centered with all concept development emanating from daily lab work and developed with a series of questions in the Student Activity Book. A complete set of activity materials was supplied with the written materials and allowed the simultaneous and independent operation of different investigations. Over \$3,000,000 was spent in the development

and implementation of this program and by 1977 reached second place in adoption of textbooks used in junior high school. However, the management of materials and the need for continuous correcting and record keeping made it very difficult for a teacher to effectively teach this program without a full time aide in the classroom. Consequently, in most cases it has again been replaced by traditional textbooks.

Evaluations of the ISCS program and its high school successor and equivalent *Individualized Science Instructional Systems* (ISIS) indicate that individualized science is not the solution to education for the low ability students. A study by Burkman et al (1982) shows that individualized science favors the high ability students, with Howe & Stanback (1985) reporting that achievement is more related to students' reading and math level. Additionally, their study identified success as being more related to the competency of teachers than to the curriculum design. Using formal testing procedures, this study reported no significant difference between ISCS materials and traditional textbooks in student achievement, student attitudes, or critical thinking skills.

One program that has given some insight and direction to the present development of curricula for the poorly motivated, low achieving science students is the DISCUS program developed at the University of Florida (Bingham, 1968; Bingham et al, 1970; Bingham & Bridges, 1974). The development of this program was based on the premise that educationally deprived students have had limited experiences both socially and experientially which has inhibited their conceptual development. Thus a program for these students will need to include concrete materials and relevant events that relate to their present and past experience. To help these students overcome a feeling of fatalism, dependence, and inferiority, the investigations were structured around directed inquiry rather than unassisted discovery. To help students contextualize the material, these investigations involved students in actual generation,

collection, and interpretation of data. Small group work was used to structure activities and to allow actual student involvement in both the collection and analysis of data.

The success of the program was measured on various dimensions (Bingham, 1974). The Teacher Practices Observation Record (Brown, 1968), upon analyzing video tapes, showed an increase in active student involvement, less need for discipline, and more student directed activity than groups not using this program. Achievement was measured by the Sequential Tests of Educational Progress (STEP) and indicated that treated groups achieved more than non-treated groups. Attitudes of both teachers and students were measured by written paragraphs, response to pictures, and in using the Battle Student Attitude Scale (Battle, 1954), and indicated that the treated groups developed a more positive attitude toward themselves and toward school personnel.

The success of this program was attributed to a variety of factors, of which the teacher training course may have been the most important. Teachers were trained to pre-teach material necessary for functioning of small groups, assist students during the lab sessions, help students analyze the data, and develop concepts from this data. Secondly, the use of concrete experiences, and directed inquiry with actual data collection, analysis, and the group development of concepts helped make science meaningful to disadvantaged junior high school science students.

An interesting variation of a science curriculum program for unmotivated underachievers was developed in England with a design to teach science in breadth rather than depth. The assumption was made that most of these students would end up on the unskilled or semiskilled labor force and would have increasing leisure time due to coming automation. Primary goals of this course, *Science for Leisure and Science for Citizenship*, included preparing students for increased leisure time and

participation as citizens in society. In support of these primary goals, the development of competence, cooperation, and confidence became secondary objectives.

Twenty-four modules, each six week in length, were developed on topics chosen by the teachers and students. Students were given a choice of modules, but were required to complete four modules per year. These modules integrated science from various disciplines and included titles such as *Motor Car Science*, *Cooking, Science*, and *Gardening Science*.

Unfortunately, formal testing to evaluate the effectiveness of this program is not available. Students did complete the Combined Science Examination and teachers completed a Module Terminal Report. Results were not reported and apparently were used only for final student grades and assessment. An interesting dimension would be further information on attendance. At the beginning of the project daily attendance averaged between 60–65%, with attendance on Friday between 45–50%.

Another program, developed specifically for the pupils of low achievement aged 14 to 16 years, was the LAMP project in the Doncaster area of England. The design of this program was a modular format written in a series of worksheets. The main focus of this project was to develop an applied science curriculum with the following criteria (Clegg & Morley, 1980, p. 455):

- 1) It had to demonstrably be of use to the pupils.
- 2) It had to provide them with a sense of achievement.
- 3) It had to carry a certain prestige...not be regarded as a dumping ground for those who could not manage other science courses.
- 4) It had to be examinable at CSE.
- 5) It had to embrace all branches of science.
- 6) It had to be practically based.
- 7) It had to provide practice in the skills of reading and writing.
- 8) It had to be child-centered.....recognize the wide range of interests and abilities of those taking it.
- 9) It had to be interesting.
- 10) Groups had to be small...fifteen pupils or less.

The interesting aspect of this program is that its design included many of the same criteria set forth in the development of the Technology Curriculum at MSU – students working with materials, relevant and high interest content with a certain prestige, and organization to work in small groups. Furthermore, in the desire to satisfy the above criteria, the organization of the course ended up as a series of modules, each half a term in length. The course was designed as a two year course in which students had some choice as to content to be studied. Sixteen units were developed, of which at least ten could be considered technology units.

Informal evaluations (teacher reports, teacher notes, and a student attitude questionnaire) as reported by Higgins (1978) indicated some weaknesses and strengths in the design. The worksheets were too long, too abstract, and complex to sustain interest, but on the positive side, it was clear that students did appreciate the variety in content and activities, and did value the practical work.

Although no systematic student achievement evaluation was conducted, various indicators suggested that some of the original goals were met. Clegg & Morley (1982) reported that attendance increased to above 90%, dropout rate decreased from 15% to 0%, difficult students were easier to handle, and teachers "felt the exercise worthwhile" (p. 462). From a developmental standpoint, this project demonstrated that the skill of the teacher is of paramount importance and the investigative process must include more than a cook-book approach to involving students (Ainley, 1984).

A somewhat parallel project was developed by the Wausau West High School called the *Unified Science Modules for High School Students*. The project was developed out of the assumption that most of science taught in schools today is inappropriate for the majority of high school students, resulting in a declining participation in science classes (Harkness & Norton, 1981). According to their

analysis, the focus on the academic disciplines has resulted in a disjointed and compartmentalized understanding of science. The goal was to produce an interdisciplinary curriculum that was context-bound rather than discipline bound, from pure science to a curriculum linking science, technology, and society, from lab based experiment to investigations involving life and living. Four major components were adopted including: 1) science concepts, 2) science processes, 3) the nature of science, and 4) the cultural implications of science. Thirteen modules were developed with titles ranging from specific topics (Sunshine, UFO, Fire, and Waste) to more traditional topics as Air, Food, Systems, Disease, and Earth.

In an effort to break free from a textbook determining the content and introduce science related to life, society, and careers, the decision was made to initially create twelve modular units to help prepare students for life rather than university entrance. Local development of materials would allow teachers and students to directly relate the content to current issues in the community and in the lives of students. In addition to the investigative portion of the materials, a set of readings were produced for each module. The source of these readings included sections from textbooks, science journals, newspapers, and special bulletins.

A number of parallel features between this *Unified Curriculum Project* and the materials developed at MSU are of special interest. Both projects attempted to link science to the lives of students and investigate cultural implications with an emphasis on technology. In both cases the materials were locally developed for freshman and sophomores in high school with the direct involvement of teachers on the writing teams. Modules were created to last about six weeks.

Little formal evaluation of the materials was completed as to its effectiveness in reaching goals set forth. An evaluation during the 1977-78 school year did include a

treatment group and a control group and claimed that students in the Unified Science Curriculum "seemed to be working at least as well as, and perhaps better" than the students using the IPS program. (Harkness & Norton, 1981, pp. 38–42).

One program, *Individualized Guided Instruction* (IGE), using the Adaptive Learning Environments Model for economically disadvantaged students did achieve a relatively high degree of initial implementation as evaluated by Wang & Walberg (1983). Significant differences were noted across school sites, although a 92% overall degree of implementation was claimed. The factor that seemed to contribute toward success in this program was training of both teachers and students in metacognitive skills necessary for the programs success.

However, the question may be asked, "What is meant by a 92% implementation level?" Corno & Snow (1986) describe an evaluation of the IGE program completed by Popkewitz, Tabachick, & Wedlage (1982) as follows:

This program "highlights the environmental constraints that operate when innovative programs are implemented in existing school systems, and demonstrates the manner by which practitioners may compromise developers best laid plans by revising both the technology and goals of IGE to fit their own school environment ... implementation of this school reform program in practice actually maintained existing patterns of activity and belief instead of reforming them (p. 611).

This particular situation illustrates the dilemma of internal evaluation giving a project a perspective of success, while an external evaluation gives a different conclusion.

One of the developments during the period between 1960 and 1980 was a growing interest in dealing with the relationship between science, technology and society. In spite of much rhetoric however, little material has actually been created that involves students in this dimension. Rosenthal (1983) analyzed the literature on Science/Technology/Society between the years of 1962 and 1981 and found 227

articles published on STS between the years of 1962 and 1971. However, during the next five years, the number of articles published showed a marked decrease. Rowe (1980) reported that science courses "attentive" to technology existed in only 6% of secondary schools. While the need for technology and its impact on society seems to be well established and even caters to the interests of students (Rowe, 1980), there is no consensus whether to incorporate it into existing science classes or develop specialized classes in technology. Woolnough (1975) argues that all students should be exposed to technology and it should become a part of the application and appreciation of existing courses. On the other hand, Galey (1986) has proceeded to develop a specialized program entitled *You, Me and Technology*, which deals with current problems as fossil fuels, population growth, world food supply, high tech communications, the impact of the automobile, urban problems, and high risk behaviors like smoking.

After examination of all these attempts to make science relevant to the poorly motivated, low achieving science students, one conclusion seems clear from the research. Most of these programs have done little to implement them over a broader range of students and districts and like a fourth of July fireworks, have had their moment (at least as long as the funding lasted) and then have virtually disappeared from the educational literature.

What have we learned from looking at these experiences? Gleanings that apply to the MSU project include the following:

1. Low achieving students appear to have a greater interest in technology than in science.
2. The modular format, with units of about six week in length, allows the development of topics of interest to these students, is sufficient in length to

permit investigations that involve data collection, analysis, and interpretation, and is well adapted to incorporate issues relating to cultural and societal implications.

3. Activities that involve students more directly in learning have produced better results than teacher dominated activities. The organizational mode that appears to be most productive is the small group.
4. The role of the teacher is critical to the implementation of new curriculum materials. A teacher training program and a continued teacher support program will increase the likelihood of implementation.

Theoretical Rationale

Learning and associated instruction for the poorly motivated, low achieving science students has not only been impacted by teachers' prior experience and beliefs, but to a large extent influenced by a theoretical foundation. In this section, a review of the theoretical basis of knowledge and learning will first hopefully illuminate existing conditions related to instruction for these students. Secondly, some of the emerging changes in views on knowledge, science, and learning will be considered as a basis for establishing some of the choices in the design of the technology program written and in verification of the route of action taken in the classrooms of this study.

Historical Review

Historically, the generation and accumulation of scientific knowledge has been attributed to a positivistic methodology (Glasson & Lalik, 1993). The inductive approach gathers bits and pieces of information to ultimately form generalizations, often spending a lot of time looking at pieces without seeing the whole. The deductive approach operates on a principle of hypothesis verification, setting forth theory and then attempting to support this theory experimentally. This positivistic mindframe,

which has resulted in presenting both the teacher and the textbook as authority, tended to support didactic teaching and limit discussion and clarification of ideas by student questions.

This view of scientific knowledge discovery has influenced the presentation of science and students' view of science in a number of ways. Inductively, students have often been given bits and pieces of information without seeing how they fit together, or unable to fathom the total picture and meaning. On the other hand, a deductive presentation of scientific material has resulted in students receiving a theoretical abstract concept, decontextualized from reality. Rutherford & Ahlgren (1988) describe instruction for the low achieving students as one of "parsimony" (less detail) and "accretion" (keep piling up the words and definitions) where students are supposedly learning the answers without even knowing the questions, or understanding the relevance, importance, and application of knowledge presented (Anderson, 1987b).

Another historical prevailing view of science among teachers has been a hierarchal structure of science knowledge (Karplus, 1964; Prawat, 1989). The net result of this view has been a careful sequencing of science concepts into prerequisite skills and knowledge, which theoretically need mastery before students are able to move on to more sophisticated work. Consequently, many of the low achieving students have been completing the same type of low-level work for years, bored to death, and embarrassed by the "baby type" content presented, meanwhile watching regular students participating in investigations and laboratory work (Gallagher, 1989).

Not only has learning and teaching been influenced by a view of knowledge, but also by a view on learning and teaching. The "transmission" view of teaching and the "absorptionist" view of learning (Doyle, 1986; Cohen, 1988; Prawat, 1989) has generated a teaching/ learning style for these students where basic facts are

presented, drilled, and tested in a decontextualized manner. Words are known by definition, without meaning to most of these students. Roth (1985) outlines various text processing strategies used by students and finds that many rely on simple factual recall and fail to integrate disciplinary knowledge with their real world knowledge. She explains how these students survive by tagging on to the "big words" and remembering them long enough to survive the next quiz.

The developmental stages, as presented by Piaget, has historically given some justification to a mode of instruction that limits both the types of activities and the kinds of materials used with the low achieving science students. Considering these students not developmentally ready for "formal operations" (Duckworth, 1964), textbooks have been "dumbed down", the use of mathematical analysis has been limited, and creative investigation has been virtually eliminated.

A review of some of the publications of the 1960's reveals another side of the work of Piaget, who believed that the transition from preoperational (stage of concrete operations) to formal operational could be hastened by planned experiences. In the words of Duckworth (1964), these experiences include involvement of the students with materials and with each other:

The children use the materials themselves, individually or in small groups, often raising the questions themselves, answering them in their own way, using the materials in ways the teacher had not anticipated, coming to their own conclusions. In Piaget's terms, they are acting on things, transforming things, and learning about them by seeing the effects of these actions and transformations... We try to create situations where the children are called upon to talk to each other (p. 121).

Thus while the philosophy of Piaget and Bruner in the early 1960's ushered in an era of student involvement by the development of specialized programs for the general to advanced school population, the impact on instructional change for the poorly achieving science student has been minimal. What needs to be demonstrated

is that the "active mental involvement" of low-achieving students with both materials and other students may be the very things that will enhance the quality of their science education.

Parallel to the "rediscovery" of Piaget in the late 1950's and early 1960's was the development of a range of federally funded curriculum projects that attempted to involve students in gaining scientific literacy (understanding the structure of science) and developing the capacity to work with the processes of science. The key word of the day was to "do science" rather than just read about science. Except for a few high school programs like PSSC, most of these "discovery learning" programs have passed out of existence. We may ask, "What happened?"

Anderson & Smith (1985), completing research with one of the SCIS units, found that the implemented use of the materials was not consistent with the intent of the developers. The original units contained a three-part learning sequence – exploration, invention, and discovery. The invention phase was to be used by the teacher to make sense of observations, analyze experimental results, and present the abstract concepts that tie the new ideas in with prior learning. The intent of the discovery phase was to allow application of the new idea to other contexts – to the real world, to their present and past experiences. However, in actuality, the role of the teacher was minimized in helping students make sense of their observations and experiments. The assumption was made that students could interpret and analyze the results of experiments and come up with scientifically correct conclusions. More recent research (Toulmin, 1972; Nussbaum & Novick, 1982; Anderson & Smith, 1983; Eaton & Anderson, 1984) has found that students developed misconceptions from their own observations and experiences, that these naive conceptions caused confusion (Smith, 1985), and consequently students simply did not progress with scientific understanding

to the degree expected. This explains, at least partially, why these highly financed, well researched, trial tested programs virtually passed out of existence.

The promotion of "direct purposeful experiences" involving students was not confined to science curriculum. In the area of media communications, Dale (1969) developed the "Cone of Experiences" in which he depicted learning proceeding from the concrete to the abstract. Bruner (1960) has previously characterized this progression as beginning with the enactive (direct purposeful experiences), proceeding to the iconic (representational as pictures), and finally developing the symbolic (verbal and visual symbols). This direction of instruction has long been a part of education, beginning with the Swiss psychologist and educator, Pestalozzi in the 19th Century. As we shall see in the next section, there is validity to this position (Schneider-ivingston, 1978), but used in isolation does not bring understanding and meaning to students, especially those who are struggling for whatever reason.

Modern Perspectives on Constructivism

A review of the teachings of Piaget indicate that much of his later work actually laid the foundations for the present dominant theory of constructivism. Piaget, Dale, and Bruner all felt that students need to be intellectually involved in learning, that the social dimension was important to the development of cognitive functions, and that the development of language was basic to development of concepts and thought. Thus the era of the 1960's could be considered transitional in the development of modern learning theory.

Recent curriculum development and work in the area of learning has been based on a constructivist view of learning with a nonpositivistic view of knowledge. According to Kuhn (1970), observation is theory-laden and science develops (or is often inhibited) more by competing paradigms than by simple accumulation of facts

and theories. Knowledge then becomes a product of a culture, the procedures and assumptions of a research program, and the interactions and intentions of people who are working in the present scientific field. A positivistic view of science sees knowledge as the cumulative building acquisition of information, which supports the transmission view of teaching and the absorptionist view of learning. In contrast, the contemporary constructivist view of knowledge sees meaning as dependent upon the perspectives of the research community and suggests that for science information to be meaningful, it must be understood where embedded.

According to the constructivist theory, knowledge cannot be simply presented and internalized by the learner. Rather, knowledge must be actively and individually constructed and reconstructed (by assimilation and accommodation) into conceptual schemata or networks, which include categories, concepts, images, and theories (Fosnot, 1993). For students to gain scientific literacy, they must be involved in the process of knowledge production and accumulation. Understanding of science will involve helping students make connections, linking new ideas to prior knowledge, forging links between concepts, and linking concepts to their immediate environment and personal lives.

This knowledge consists of various levels of knowledge. Both Resnick (1983) and Shulman (1986) divided knowledge into declarative (content) and procedural knowledge. Jones and Palincsar subdivide knowledge into declarative knowledge (consisting mainly of facts and concepts), procedural knowledge (how to do something) and finally conditional knowledge (when, where, and how to apply this knowledge to individual situations. The point is that knowledge is now considered much more than accumulation of information, but a much broader ability to generate new information, and use the information in a productive way.

Finally, the constructivist theory holds knowledge as interrelated (Inhelder, 1977; Saunders, 1992). This takes the form of both conceptual and contextual links. On the level of conceptual linkage, knowledge must be first assimilated and then accommodated into prior knowledge. This prior knowledge often includes misconceptions which interfere with the integration of new concepts into existing schemata (Toulmin, 1972; Posner, 1982; Eaton, Anderson, & Smith, 1984). Secondly, the relationships between new bits of information must be developed; that between facts and concepts, between concepts and concepts.

The second level of developing constructivist relationships is what I call contextual linkages. This includes linking new information to present life experiences, noting various applications in technology, pointing out societal and cultural relevance, and future applications.

Closely related to the constructivist theory of knowledge is the constructivist theory of learning. Learning can be defined as a creative constructive process requiring active participation on the part of the learner to create meaning and understanding (Inhelder and Piaget, 1958). In the area of science, this involves a process of conceptual change (Driver & Ball, 1986) that will need to involve both the students and the teacher (Duckworth, 1986). While some of the newly developed programs (such as SCIS) recognized the role of the teacher in helping students construct concepts, others (like ESS) left the tasks of analyzing and interpreting data, concept formation, and organization of knowledge to the students.

For a number of years, educational psychologists like Dale, Ausubel, and Piaget have viewed the development of concepts as unidirectional, proceeding from the concrete to the abstract. However, the recently translated work of Vygotsky (1987) indicates that the formation of concepts may actually involve a bidirectional process.

He recognizes the role of concrete objects and experiences in the development of what he calls "heaps" and "spontaneous concepts," which are based on direct perception. On the other hand, he also recognizes the role of abstract ideas (to be supplied by the instructor) in framing observations and helping students make sense of their observations. These abstract ideas, which he calls scientific concepts "in turn supply the structures necessary for the evolution of the child's spontaneous concepts toward the conscious and deliberate use" (p. 94). He proposes a bimodal direction of instruction, alternating from the particular to the general, and from the general to the particular:

It is of principal importance that such an organization of the experiment arrange the pyramid of concepts "upside down." The problem solving in our experiments follows the same path as it takes in real life, where the movement from the top of the pyramid to its bottom is no less important than the ascension from the concrete to the most abstract (p. 105).

Vygotsky refers to his simultaneous use of the concrete and abstract as the "method of double stimulation" in which "two sets of stimuli are presented to the subject, one as a set of objects of his activity, the other as signs (concepts) that can organize that activity" (p. 103).

The process of concept development involves generalization and abstraction, but the concept emerges only when the abstracted trait can be viewed separately from the context, and can be applied to new situations. Vygotsky (1987) notes that:

The formation of the concept is followed by its transfer to other objects; the subject is induced to use the new terms in talking about objects other than the experimental blocks, and to define their meaning in a generalized fashion (p. 105).

Application of concepts to new situations thus in itself becomes a stage in the further development of a concept.

Because of this bimodal direction of learning and teaching, Vygotsky (1987) is becoming a pivotal figure for reintroducing the teacher as a central figure into concept formation. He goes on to explain how these scientific concepts develop "under the conditions of systematic cooperation between the child and the teacher . . . benefit(ing) from the systematicity of instruction (p. 148) which in turn contributes to the mental development of the child. On one hand "spontaneous concepts" (developed by the child himself from his own observation and experience with concrete objects) do not give the child the ability to use these concepts and form abstractions. On the other hand, the abstract "scientific concepts" are to many children simple verbalism, "detached from reality" (p. 148). This is why Smith and Anderson (1984) assert that children do not acquire much of the conceptual knowledge needed for understanding by simple observation and discovery. The teacher is needed to supply the theoretical framework for understanding. While Anderson (1987b) sees explanation as one of the four primary functions (explanation, prediction, description, control) of an actively involved student, Gallagher (1989), thinking more in terms of the low-achieving students would focus primarily on observation and description, saying that "too much explanation before children are ready is problematic, self-defeating, and damages their self-esteem (Personal interview on 11/13/89). A critical role for the teacher will be to help these students make accurate observations, record meaningful descriptions, select relevant portions, with the teacher developing the bulk of explanation with them.

Furthermore, Vygotsky (1987) maintains that the instruction of the teacher will actually further intellectual development. He claims that "instruction is good only when it proceeds ahead of development. Then it awakens and arouses to life an entire set of functions which are in the stage of maturation and which lie in the zone of proximal development" (p. 71). He defines the zone of proximal development as a type of

activity that a student cannot accomplish alone, but is able to complete with some help. Assuming that the zone of proximal development is an area where learning takes place at an accelerated rate, and the research of Brown and Ferarra (1985) seems to support this position, the theory has real implications for teaching and for the creation of textbooks. Rather than "dumbing down" the textbooks, they should be targeted just above the understanding of students.

Vygotsky's emphasis on language in the development of thinking implies that concepts are intertwined with words, which then in turn form the organizing structure of knowledge. He explains that

at any age, a concept embodied in a word represents an act of generalization. But word meanings evolve. When a new word has been learned by the child, its development is barely starting; the word at first is a generalization of the most primitive type; as the child's intellect develops, it is replaced by generalizations of a higher and higher type – a process that leads in the end to the formation of true concepts (p. 149).

The development of word meaning in children takes place through a series of "successive approximation" (p. 107) in which their hunches are "faint and tentative ... children test these hunches ... (and as they) have them confirmed by experience, the hunch process becomes a bit stronger to the point of conviction" (p. 138). Levy (1987) sums up the interdependence of thought and speech by saying that "not only does thinking influence the development of speech, but speech influences the development of thinking" (p. 100).

This testing of word meaning is by its very nature a social process. Wertsch (1985) asserts that "children do not select the meaning for a word. It is given to them in the process of verbal social interaction" (p. 107). By interacting with adults and each other, children infer the meaning of words and the structure of concepts. Rogoff et al (1984) note that:

the structuring provided in communication serves as a scaffold for the novice, providing bridges between the old knowledge and the new ... (and) as individuals actively seek bridges from one situation to another are greatly assisted by others who have more or different experiences and make the analogy intelligible to the newcomer (p. 559).

Furthermore, Wertsch (1987) claims that the social involvement of students needs to go beyond the verbal interaction and include goal-directed tasks. He asserts that "rather than understanding the tasks and then doing it, the children seem to have done the task (as a participant in interpsychological functioning) and then understood it" (pp. 165–166).

Implications for Teaching

Finally, the question needs to be asked, "What does all this have to do regarding teaching and learning for the poorly motivated, low achieving science students?

First of all, a constructivist approach to teaching would, in the words of Driver and Oldham (1986), include a program "not seen as a body of knowledge or skills but as a program of activities from which such knowledge or skills could be constructed" (pp. 105–122). This implies that the old didactic methods will not work with the low achieving students. Vygotsky (1987) warns:

Practical experience also shows us that direct teaching of concepts is impossible and fruitless. A teacher who tries to do this usually accomplished nothing but empty verbalism, a parrotlike repetition of words by the child....when you explain a word ... you put another incomprehensible word, or a whole series of words, with the connection between them as incomprehensible as the word itself" (p. 150).

The implication of the above observation is that contextualization, using concrete objects, direct sensory experiences, and examples must be a starting point for the low-achieving students (Schneider–Livingstone, 1978; Saunders, 1992). Little generalization can take place unless the child is first exposed to concrete experiences

(Gega (1986). Not only does the visual image help students in concept formation, but it also increases retention. Vasu & Howe (1989) found that children represent more information in pictorial form than in verbal form and the visual images were retained longer than the verbal images.

On the other hand, these concrete observations will have little meaning unless the teacher helps students develop abstractions, using the organizing power of concepts (Resnick, 1989; Roth, 1985). Many science concepts are not directly observable, are theory based, and years of observation and discussion would not generate the same level of understanding that has taken scientists hundreds of years to attain. Skilled teachers use various devices like graphic organizers and graphic outlining systems for summarizing information and creating valid conclusions (Jones & Palinscar, 1987). Through the use of explanation, diagrams, concept maps, advance organizers, demonstrations, discrepant events, contrast/comparison, the teacher can show relationships among concepts (Roth, 1985) and so help create genuine understanding.

What is the meaning of all this? Abstract concepts should be introduced much earlier and concrete experiences extended much longer in the learning process of an individual. Teachers need to develop concepts through the use of concrete, contextualized experiences, but simultaneously present scientific concepts that organize these experiences through direct instruction (Vygotsky, 1987).

In this conceptual linking, new knowledge is tied in to previous lessons and contrasted with prior knowledge. Hopefully, the students will become dissatisfied with misconceptions. The teacher must help students at least minimally understand the new conceptions and find them plausible and fruitful to present applications (Posner, Strike, et al, 1982).

On the level of contextual linkage, the teacher must help students see connections between concepts and their immediate environment, between science and technology, and between technology and future potentials. Concepts are first presented in specific familiar settings. As the concept is developed, students are given the opportunity to apply these new concepts to unfamiliar and hypothetical situations. This application of knowledge to a variety of contexts actually develops a higher level of understanding in which the concept is decontextualized and further abstracted (Wertsch, 1985). This may have special implications for the low achieving science students. Jones, Palinscar et al (1987) hold that the low achieving students need diverse opportunities to practice and apply skills to a variety of contexts with corrective feedback . . . as well as sustained explicit instruction with strong metacognitive components.

Thirdly, learning must directly involve student in active mental processing. This may be accomplished in a variety of ways that enhance both the mental development of the child and also his conceptual development. Development of a learning system that parallels the development of language would include opportunity for students to first express themselves on the verbal level and then on the written level. Oral communication includes the development of students' ability to ask clarifying questions, give oral descriptions, reports, and planning ideas. Anderson ((1987b) asserts that

"the path to improvement does not lie in special programs, particularly for the low-achieving students. Instead, we need to find ways of creating classroom learning communication in which all students are full participants. Low achieving students need very much to practice expressing their ideas, to listen to the ideas of others, and to have others listen to them (p. 89).

Written communication, in addition to the above, include bulletin boards, displays, predictions, and some explanation. Writing requires a higher form of mental activity (Vygotsky, 1987) and as such is quite difficult for low-achieving students.

However, writing is a conscious deliberate task requiring analytical action, and abstract thinking. DiBello and Orlich (1987) explain that writing "makes one's current understanding explicit . . . and one's concepts accessible to the kind of processes necessary for reorganization" (p. 98). Consequently, omission of writing as an activity with these students will hamper the very skills needed in their development.

Introduction of the social dimension into the classroom will further both the communicative skills needed by these students and help them construct scientific concepts necessary for understanding. This again happens on various levels. The first level is pupil-teacher interaction. The role of the teacher is to provide verbal information about concepts, sequences, and relationships; especially in relationship to the contextual and cultural environment. In spite of the overabundance of direct teaching in classrooms for the low-achieving students, in many cases the clear sequential presentation of fundamental ideas that tie much of science content together is lacking (Smith and Anderson, 1985; Roth, 1985).

The second level of the social dimension of the classroom is pupil-pupil interaction. This happens primarily in small groups. Jones and Palinscar (1987) conclude that "consistent evidence indicates that constructing graphic organizers and outlines is more effective when done as a social activity involving the whole class or in small groups, rather than when it is completed as an individual assignment (p. 49, citing Darch, Carnine, & Kameeniue, 1986). Small groups also allow students to become involved in planning, to design and conduct experiments, to help each other with procedures, to generate more questions needed for understanding, and finally to discuss the meaning of observations and data collected, reducing them to concepts that encapsulate the relationships of individual events.

However, a problem still remains. Poorly motivated, low achieving science students who have difficulty following directions do not function well in small groups (Brophy & Good, 1986; Blumenfeld & Meece, 1988). This presents quite a dilemma, which in the past has denied them a mode of instruction that they so desperately need. The answer may partly be derived from a statement by Anderson (1987b) in which he states:

students initially learn new concepts in specific task contexts and often have difficulty transferring what they have learned to other contexts. ... Thus students cannot fully master a new concept or appreciate its significance until they have successfully used it in a variety of different contexts (p. 87).

Drawing a parallel with Anderson's mastery of concepts, students can be introduced to procedures in one context and then be given opportunities to use these in a variety of different set-ups. The mastery of a set of procedures allows them to participate in experimental work and creative activities. The idea of using a concept in a variety of different contexts has formed the basis for the coining of a new term I call "procedure recycling", which consists of practice in varied set-ups. This could include developing a set of procedures for an activity or an experiment, demonstrating these procedures, and then having the students use these same procedures over and over again in a variety of different situations until the procedures are mastered. A simple example would be teaching students how to make concepts maps. Students first make concept maps to explain weather forecasting, then to explain why the wind blows, and again to explain why the seasons change, etc.

An associated technique that has been used to teach the procedures of a new activity is what Jones et al (1987) call "scaffolding." Just as a scaffold assists a builder during construction of a building, so scaffolding in teaching gives support in learning procedures and skills which go beyond present capabilities when attempted alone.

Support is provided by the teacher in a variety of ways which are usually subdivided into three phases called modeling, coaching, and fading (Collins, Brown, and Newman, 1987). First the teacher models the skills by use of demonstrations, diagrams, think aloud operations, correct use of language, and training in metacognitive skills. During the second stage of coaching a transfer of task responsibility shifts from total teacher (modeling) to the final application when the teacher direction fades out as the student gains the ability to complete the task alone. During this phase, the teacher needs to get out and circulate among the students, ask probing questions to help clarify procedures in the minds of students, and monitor the frustration level so as to give direction and help when needed, but still allow the students the opportunity to work on their own. Pearson & Gallagher (1985) compare scaffolding to the apprenticeship system where the master demonstrates the skills of a trade, monitors the work of the apprentice, and finally approves the trainee as a journeyman. Brophy & Good (1986) describe this process as follows:

Students learn more efficiently when their teachers first structure new information for them and help them relate it to what they already know, and then monitor their performance and provide corrective feedback during recitation, drill, practice, or application activities (p. 366).

Research indicates that feedback that is immediate, informative, specific, and non-normative tends to increase the intrinsic motivation of students indirectly through helping establish learning rather than performance goals (Butler & Nisan, 1986; Corno & Rohrkemper, 1985; Ryan, Connell, & Deci, 1985).

The scaffolding model has been used with varying success in a number of educational applications from teachers training teachers (Tobin & Espinet, 1989; staff development (Moore & Moore, 1992), and teachers coaching students (Rosaen, 1987). Sizer (1990) sets forth some conditions if the teacher as a coach is to be successful.

He maintains that instruction needs to be restructured to focus on student learning activities, using fewer topics, but going into more depth. Goals of instruction will need to change from coverage of material to mastery of selected material.

This cumulative impact of this related research has serious implications for the implementation of a new curriculum. To begin with, research indicates that teacher training workshops alone are not effective in implementing a new curriculum (Smith & Blakeslee et al, 1993). Materials that take into account the constructivist theory of learning, design for conceptual change, and incorporate metacognitive skills are essential components in bringing meaningful learning into a classroom (Smith, Blakeslee, and Anderson, 1993; Lee & Eichinger, 1993).

ROLE OF TEACHER BELIEFS IN IMPLEMENTING A NEW CURRICULUM

Researchers substantiate that limited research has been completed on teacher beliefs and the relationship these beliefs have to teaching and curriculum implementation (Yager & Pinick, 1983; Cronin-Jones, 1991). Clark & Peterson (1986) note that the *Second Handbook of Research and Teaching* (Travers, 1973) did not include "a chapter or even a reference to teachers' thought processes . . . research is so new ... (the absence is) conspicuous" (p. 292).

However, the importance of teacher beliefs in relationship to implementation of new curriculum is recognized. Clark & Peterson (1986) assert that "if the teacher's implicit theory about learners or their mental image of an effective teacher were contrary to that embodied in the new curriculum, they would be unlikely to bring the innovation alive (p. 292). Wright (1993) claims that these beliefs have even more impact on teachers' classroom actions than research and training by saying that "teachers work from personal experience and intuition. Beliefs and practices drive the teaching enterprise, not research-based findings" (p.1).

Surveying existing research, Clark & Peterson (1986) note that teachers' beliefs are marked by a wide range and great individual variety. Cronin-Jones (1991) designed her research to identify the major categories of teacher beliefs influencing curriculum implementation as follows:

1. Beliefs about the ability of students
2. Beliefs about the role of the teacher in the classroom
3. Beliefs about how children learn
4. Beliefs about the relative importance of topics

The conclusion naturally follows that much more research is needed in the area of teachers' beliefs and the relationship of these beliefs to implementation.

Consequently, this paper is in part based on the work of Cronin-Jones, but goes farther in testing a model to change these teacher beliefs and increase potential of curriculum implementation.

Teacher Beliefs About Low-Achieving Students

A study on teacher beliefs by Gallagher (1985a) presents two groups of students, target students who learn and a remaining group of students who memorize but do not really understand. Teachers view these students as having limited potential – with few having the "natural intellect" and high motivation to be successful, most can't read and can't follow directions. This results in limited expectations on the part of the teacher, where few are expected to succeed. Consequently, goals are limited to short term outcomes – pass the test, pass the course, get the credit (Dweck & Elliot, 1983). Finally the teachers see these students as poorly motivated, having failed so often that their self-esteem is damaged to the point of a decision to "not work", simply to save themselves from another failure. The consequence of these beliefs, together with the position that these students require a lot of direction (Cronin-Jones, 1991), impacts the classroom by giving a higher priority to classroom management than

instruction, by choosing activities where behavior can be controlled rather than where learning is maximized. The resultant mode of instruction is primarily whole-class presentation by the teacher (Cronin-Jones, 1991).

Teacher Beliefs About the Role of the Teacher

According to Gallagher (1985b), teachers see themselves as presenters of information and organizers of instruction with factual content considered most important (Cronin-Jones, 1989). The purpose of teaching reinforces short term goals, such as getting students ready for standardized tests and completing the proscribed curriculum (Ignatovich & Cusick, 1979).

Teacher Beliefs Regarding Learning and Teaching

Teacher beliefs about learning not only influence the choice of classroom activities, but in turn impact implementation if at variance with the view of learning promulgated by a new curriculum.

Prawat (1989) notes that:

another major obstacle to promoting understanding is the commonsense notion that learning progresses hierarchically. According to this view, the mastery of "certain prerequisite" lower order skills is a necessary if not sufficient condition for the development of more complex understanding and application-oriented learning (p. 317)

This view of learning in part then determines the teacher's view of teaching.

Drill, repetition, and practice are necessary to establish this base-line level (Cronin-Jones, 1991). Some activities are viewed as unworkable with the low-achieving students (Doyle, 1979). Group work is considered "not worthwhile" (Cronin-Jones, 1991) as students waste too much time and fool around. Lab work is considered unworkable as students have difficulty following directions.

Above all, good discipline is considered primary in teaching these students (Cronin-Jones, 1991). This belief of teachers is further reinforced by administrators

who will judge teachers by classroom control and orderliness as much or more than by student understanding and learning (Cusick, 1983)

Even when involvement type activities were used, in many cases students failed to develop conceptual understanding as teachers believed students would infer correct conclusions from their observations (Smith & Anderson, 1984).

Teacher Beliefs About Relative Importance of Topics

In most cases topics are determined by teachers who decide which topics are appropriate for students (Brophy & Good, 1974). This judgment considers various factors including the teacher's view of the students ability, their future potential (most will not go to college, but will still need to be trained for a technological society), and to a large degree the textbook. Yore (1991) found that teachers primarily select topics by the textbook, even though they reject the textbook model of content selection and sequencing. This was attributed to lack of viable alternatives.

Conclusions & Implications

In summation, it is evident that teacher beliefs have a great impact on implementation. Teachers will alter (Cronin-Jones, 1991), transform, distort (Olsen, 1981), and adapt the curriculum to more closely fit their own beliefs and theories of teaching (Cronin-Jones, 1991; Olsen, 1981; Smith & Anderson, 1984). It becomes obvious that research is needed to identify the teacher beliefs that directly impact curriculum implementation, and devise strategies to bring the beliefs of teachers and the underlying philosophy of the intended curriculum more into alignment. Both classroom observation and case studies are suggested as means of determining the beliefs of teachers (Cronin-Jones, 1991)

CHAPTER THREE – RESEARCH DESIGN

General Research Topic

What happens in classrooms during the attempt to implement a new science/technology curriculum for poorly motivated, low achieving high school science students? More specifically, why do teachers fail to implement new science materials which were written by teachers for the these students?

The Nature of the Study

Little progress has been made in changing the nature of science classrooms during the past thirty years (Welch, 1979; Gallagher & Tobin, 1987; National Assessment of Educational Progress, 1989; Hurd, 1993). This lack of significant change in the mode of instruction has been attributed to a variety of reasons; a failure to take into account the social and organizational context in which the change was attempted (Little, 1982), problems with the materials themselves (Smith and Anderson, 1983), a disregard for the beliefs of teachers (Clark & Peterson, 1986), and a failure to consider the prior knowledge and deal with the misconceptions students hold (Nussbaum & Novak, 1979; Posner et al, 1982).

For this reason, a number of researchers have suggested that more research needs to be completed in classroom practices (Lanier, 1981), student and teacher beliefs (Orpwood, 1985), and attempted implementation in actual classrooms (Cronin–Jones, 1991). This is in accord with a current project, entitled Project 2061, Science for All Americans (Rutherford and Alghren, 1989), which recognizes the need to develop standards for science education.

The complexity of classrooms, which involves a large number of factors linked together in reciprocal relationships, strongly indicates a qualitative study where classroom practices, events, relationships, and beliefs can be observed and analyzed

in their natural setting (Bogdan and Biklen, 1982). This approach allows a grounded theory to emerge from collected data (Glaser & Strauss, 1967). Continual observations, detailed descriptions, analytical reviews, generation and revisions of questions help produce patterns and assertions in the attempt to understand choices made by teachers in choosing the activities which in turn determine the nature of classroom learning.

The Format of the Study

This study will take the form of a two-classroom comparative case study, documenting the attempts to implement the new curriculum in two different classrooms. The descriptive narrative will include a change of role for the researcher from strictly observer in one classroom to participant/observer in the second classroom where the researcher modeled class activities for both teacher and students and worked with the teacher and students in assisting them get started with the activities. Evidence will be presented to demonstrate how this "scaffolding" technique has the potential to change the attitudes of both teacher and students toward acceptance of student involvement type science education, which in turn impact the implementation of a new curriculum.

Focus of the Study and Unit of Analysis

This descriptive study will focus on the nature of activities chosen by the teacher and used during classroom instruction. In the effort to understand the meaning and logic behind the choice of activities, an attempt will be made to document and analyze the interactions between the teacher and students and probe the underlying beliefs and attitudes that contribute to the choice of activities used.

In order to generate the data needed to understand the above linkage, observations will focus on some of the following parameters:

- 1) Change over time in teacher attitudes, mode of operation, and teaching strategies.
 - a) Teacher mode and activities upon entry
 - Description of teaching
 - Justification for mode of teaching

Experiences

Attitudes
 - b) Indications of change in teacher attitude toward poorly motivated, low achieving students
 - c) Indications of change in teaching strategies and mode of operation during the course of the unit.
- 2) Change over time in student attitude toward science, behavior displayed during science activities, and involvement of students in learning activities.
- 3) Evidence of teacher beliefs that may affect implementation of a new curriculum such as:
 - a) Beliefs about how students learn
 - b) Beliefs about students' potential.
 - c) Beliefs about the role of the teacher in the classroom.
 - d) Beliefs about the ability level and capabilities of students
 - d) Beliefs about the relative importance of topics

(adapted from Cronin–Jones, 1991).

Nature of Intervention

Implementation in two schools are compared, with supporting data from a third school. At both Western High and South Central High, the researcher assumed the

role of observer only. At Cranston High, the researcher assumed the role of observer/participant, actively working with the teacher in demonstrating the new activities to the students and helping the teacher coach the students in using the new materials.

Research Questions:

The following research questions were developed during the course of data collection and preliminary data analysis. They are organized under four main research questions and subsidiary questions.

Main Research Question One – What classroom routines and modes of teaching are in the previously established repertoire of these teachers that will affect the implementation of a new program?

Main Research Question Two – How is the new science\technology curriculum viewed and used by teachers and students in the implementation phase of development.

Subsidiary Question One – How is the curriculum viewed by students?

Subsidiary Question Two – How is the curriculum viewed by teachers?

Subsidiary Question Three – How is the curriculum used by teachers?

Subsidiary Question Four – How does the teacher adapt the new curriculum to his/her own teaching style and integrate it into established classroom routines?

Main Research Question Three – What factors influence teachers' and students' views and uses (or non-use) of the curriculum?

Subsidiary Question One – How does classroom structure (established method of classroom management, discipline, modes of instruction, and teaching routines) affect the implementation of a new curriculum?

Subsidiary Question Two – How does the teacher's beliefs about students

(how they best learn), the teacher's role in the classroom, and the relative importance of topics affect the implementation of a new curriculum for these students?

Subsidiary Question Three – Why are teachers so reluctant to give up traditional classroom structure?

Main Research Question Four – What strategies can be used to change teacher behavior from the traditional teaching approaches (read textbook, answer questions, lecture) to student-centered activities as suggested in the new curriculum?

Subsidiary Question One – What can we learn about the role of program consultants working with teachers implementing a new science program?

Subsidiary Question Two – Will the scaffolding model (Jones, Palincsar, Ogle, and Carr, 1987) contribute to change in teaching strategies when applied to the implementation of new science materials?

Data Collected:

The following listing gives an overview of the data collected that formed the basis for analysis and conclusions.

1. Meeting notes and minutes taken during early and later stages of the curriculum writing project development, including development, teacher training, field testing, and dissemination.
2. Position papers outlining the original philosophy of instruction used as guiding principles in development of the new technology curriculum.
3. Project Observations (Field notes) from:
 - a) Western High School
 - b) South Central High School
 - c) Cranston High School

4. Pretests and posttests on student attitudes and motivation

St. Paul Christian = 4

Cranston = 23

5. Pretests and posttests on weather unit.

St Paul Christian = 4

Cranston Pretests = 13; posttests = 24

6. Notebooks (South Central and Cranston High Schools)

7. Concept maps (Cranston High School) – weather forecasting and wind

8. Pre-interviews (Cranston) post-interviews at Western & Cranston)

– on attitudes, science, learning, and weather

Data Analysis

Data analysis consisted of two phases, preliminary continuous analysis and summative analysis. In that a qualitative approach was used in this research, preliminary data analysis, using a computer data base, proceeded simultaneously with the data collection. After each day's observations, handwritten field notes were transcribed onto a computer data base and reviewed as to significant occurrences. These were summarized on reflective and analytic memos where assertions were developed, further questions generated, and interpretive commentary noted. As patterns, trends, and routines emerged, each record was characterized by "descriptors" that reflected these ideas and provided a basis for later retrieval and sorting of specific instances to support developing assertions. Descriptors were also generated to record counter-instances to balance an observer's bias and to bring multiple possible interpretations into consideration.

A data record, as recorded from the study at Western High School is used to illustrate the phenomena described as "adaptation":

RECORD NO: 82 FLD STUDY: Ethno PLACE: Western High
 TITLE: The Big Introduction DATE: 87\3\02
 ACTOR: Krause TYPE: ON
 DESCRIPTORS: Adaptation, Role, Participation,
 NOTES:

After today we will not be using our books for a while. We will be using packets starting on Monday. You will be graded on the questions. I will probably make up some extra sheets.

AM – It looks like the teacher is already planning on adapting these materials to her own use. This is especially interesting as she has not opened either the pupil edition or the teacher's edition, as all materials still had the shrinkwrap around them at the beginning of the period.

Following are comments on the above data record to explain some of the sub-headings. The TITLE, "The Big Introduction" was used to characterize the significance of the day.

Under "TYPE", three kinds of data records were used; actual observations, interpretive comments, and planning notes.

Actual observations were further classified as:

ON = Observed Notes – written field notes on actual observations

II = Informal Interview – notes recorded later on casual conversations

FI = Formal Interview – notes on scheduled interviews, supported by transcripts of audio tapes.

PS = Participant Summary was used in instances where the researcher took an active part in instruction and later recorded a summary of the activity.

Interpretive comments formed the basis for on-going analysis and included:

VN = Vignettes used to generate descriptions of episodes

SM = Summary statements used to capture development of events

AM = Analytic memos used to develop possible explanations and connections

AS = Assertions developed for further investigation

Planning notes included:

QR = Questions raised for further investigation

SP = Strategy planning, which includes collaborative planning with the teacher, reminders to prepare materials, schedule interviews, check out certain possibilities, etc.

Note the descriptor "adaptation" attached to record #82. The teacher statement, "I will probably make up some extra sheets" is an early indication that she will not use the material as written and recommended in the Teacher Guide Book.

The last part of the data record is keyed as AM, an analytic memo, recording the reflections of the researcher on the events of the day.

Preliminary Assertions

In this research, assertions were statements used to summarize data, identify trends, and characterize situations and circumstances. From the beginning of data collection and preliminary data analysis, tentative assertions were developed to help structure further data collection, looking for more evidence to substantiate the assertions or counterinstances to discredit the assertions. These preliminary assertions are included here for the reader to give focus and meaning to the data collected in the next three chapters. The assertions will be developed and supported throughout the remainder of the dissertation.

Assertions – For Main Research Question One: Classroom Routines

1. Teachers adopt a transmission model of teaching and an absorptionist model of learning, in which the teacher supplies knowledge and gives it to the students, and the students receive this knowledge, mostly orally.
2. The poorly motivated, low achieving students have difficulty following instructions for extended activities given by textual materials.

3. For the poorly motivated, low achieving science students, classroom teaching is highly teacher directed and not student oriented, including the following routines and components:
 - a) Reading textbook and answering questions
 - b) Teacher lecture to emphasize the main points
 - c) Notebook required
 - d) Review with teacher asking questions and students answering
 - e) Almost no lab work, investigative activities, or group work
 - f) Frequent quizzes & tests, which are intended to motivate students to be attentive and study
4. In order to help these students find success, teachers clearly indicate exactly what they are to learn, drill the material in review sessions, and test for the same content.
5. Regular and advanced science classes have a greater variety of activities (more labs, long-range research, cooperative learning, etc.)
6. Expectations for lower level students are different than for average and upper level students. The type of activities are different and homework almost never assigned.
7. Material is covered in breadth rather than in depth. Material is "mentioned" rather than explained. Lack of involvement and real understanding consequently contributes to low student interest.
8. Most of the tested outcomes reside in the area of content – factual recall.
9. Goals regarding the present education and expectations regarding the future potential of these students differ. Furthermore, teachers' expectations regarding the maturity and behavior of these students are vastly different.
10. A structured classroom with established routines is used as a management and

control procedure as well as an instructional device. This mode of instruction is often a teacher's response to dealing with poorly motivated, low achieving science students.

11. A mode of teaching that is "successful" in the management of these students may be counterproductive in developing the skills they most need to function in society and on a job.

Assertions – For Main Research Question Two: How the Curriculum Is Viewed & Used by Students and Teachers.

1. Students view a new curriculum with trepidation. The uncertainty of not having "correct" answers readily available generates hesitancy and adds to an established fear of failure.
2. Students view science as having little relevance to their personal lives, scant practical application to their immediate future, and detached from the real world.
3. New science curriculum developed out-of-house, is viewed by science teachers as unworkable for the real classroom – a temporary inconvenience in the educational bureaucracy. The attitude among teachers may include one of "Wait and it will go away" or even "This year's new thing" (TYNT)?
4. Teachers hesitate using the new curriculum activities, especially those that require small group activities, student movement from place to place, or working with materials and equipment.
5. Teachers will use new activities and strategies if the researcher is present and works directly with the teacher and the students.
6. Teachers return to the familiar routines when the observer (and help) is not present.
7. Teachers adapt a new curriculum to their own teaching style by using the topics and

content of the new curriculum but retain the same instructional and management strategies.

Assertions – For Main Research Question Three: Factors Affecting Views & Use

1. Teachers' beliefs about and experiences with these students impact their methods of dealing with these students.
2. Teachers view these students as having limited potential.
3. The students rely on the teacher to organize and furnish them with information to be covered in the next test. Thus one of the major student and teacher goals of education is to pass the next test.
4. Teachers are not confident that students can be trusted to act properly and learn independently.
5. Teachers are unwilling to put in extra time and effort needed to make the new curriculum a success.
6. Teachers' failure to implement new science curricula for the poorly motivated, low achieving science students can be attributed primarily to concerns about management and control.

Assertions – For Main Research Question Four: Strategies to Change Teachers

1. Just because good, new science curriculum materials are developed for poorly motivated, low achieving science students, the present potential of them actually being integrated into the classrooms in the intended manner is very small as indicated by:
 - a) Experience with former curricula such as IIS, BSSC Patterns & Processes, and ISCS, AGS (Earth Science).
 - b) Present experience.
2. The scaffolding model (using modeling, coaching, and fading) may be successful in

demonstrating to teachers the potential of a new science curriculum.

3. The scaffolding model may be successful in helping students use new learning strategies.

Interpretations and Significance

As one again considers the tremendous effort that has been invested in educational reform, curriculum development, and curriculum implementation, and corresponding with this a disappointing lack of significant change on the classroom level, especially for the poorly motivated, low achieving science student, it seems that a much closer look at the actual activities in the classroom during the implementation phase may be instructive. More specifically, insights into the classroom structure, established teaching methodologies, attitudes and beliefs of students and teachers that may impact the implementation of a new curriculum would form a basis for designing strategy for change.

The failure to create significant change in these classrooms by the implementation of new curriculum suggests that many factors are linked together in a reciprocal relationship (Clark & Peterson, 1986). The attitudes and beliefs of the students are framed by former experiences in classrooms, especially those that have resulted in repeated failure. For example, the inability to follow directions has resulted in reduced involvement in meaningful activities and contributed to a lowered self-esteem.

Teachers' perceptions and beliefs about students, in turn, have been developed and reinforced by their experiences and frustrations in the attempt to help these students. For instance, the teacher response to student difficulty in following directions has been to structure activities that demand a lower level of student engagement, cognitively, socially, and creatively. This highly structured classroom has

in part been a response of teachers to the attitudes and abilities of students and an effort to achieve success in these classrooms. These structured routines have resulted in a lower level of student engagement, reduced student interest in the material taught, and a lower self-confidence on the part of the students.

The limited view of student potential creates lower expectations on the part of the teachers and reduces long range goals to short term survival goals. Consequently, the very skills that students need to develop in preparation for long term success in life have been minimized. These include reading, written expression, oral communication, and genuine investigation using concrete materials. This results in a whole segment of our school population not being adequately prepared to make a positive contribution of future society.

As documented in the literature review, teachers will adapt new curriculum materials to be consistent with their own established beliefs and teaching routines. For effective curriculum change to occur in classrooms, a thorough documentation of teaching routines, teacher's beliefs about their own roles in the classroom, and their beliefs about students may be needed. Secondly, if these beliefs and attitudes on the part of teachers are creating reluctance to accept new teaching methodology, the question must be raised, How can these beliefs and attitudes, so resistant to change, be modified? Even more significantly, what strategies can be used to change the nature of a teacher dominated classroom to a student-involved classroom?

It would seem that change will occur only when a new curriculum can be demonstrated as successful with students. In most instances, this will require dealing with the underlying established beliefs of teachers. If meaningful understanding can be created in students, while still maintaining a measure of order and control in the classroom, teachers may modify existing attitudes and beliefs.

SETTING OF THIS STUDY

While the scope of this curriculum development project included six school districts, five professors, fifteen teachers, and four graduate students, the primary focus of this dissertation takes a look at the attempt to implement the technology unit *Weather* in two classrooms.

Western High School

The first classroom, which for convenience I will call Western High, is located in an older section of a medium sized Michigan city. In spite of being near the downtown area and a large industrial plant, the neighborhood around the school is well-kept with older brick and frame houses that once represented an upper socioeconomic level, but now are occupied by a racially mixed working class population. In addition, the school draws from a subsidized housing project farther to the East and inner city housing to the North. Present enrollment of this school has stabilized at about 2600 students.

Western High School does offer students the atmosphere and opportunity to succeed in school. The school grounds are well kept and clean, free from litter and graffiti. Security guards are visible in the hallways, at the entrances, and in the parking lots. During the three months I visited in this high school, no fights or serious disturbances were observed. The element of fear, intimidation, negotiation of standards, and student rebellion that characterize many modern inner city high schools seemed to be absent here. The administration and teachers did attempt to communicate an impression of support, as exemplified by the "I Care" buttons they wore (Liske, 1989).

Cranston High School

The second major classroom observation took place in a small Midwestern town

approximately thirty minutes from the larger urban center in which the first classroom was located. This school district consists of one elementary school (Grades K–5), one middle school (Grades 6–8), and one high school (Grades 9–12). This high school draws from a rural area of approximately 120 square miles and a town of about 400 people. The high school has 400 students, with about two-thirds of these students coming from a rural setting.

The people who live in this school district, according to the recently retired superintendent, consist of two groups: 1) the longtime residents, largely conservative in outlook, and 2) the liberal element, consisting of the more "academic type" from the local university and the "executive type" professionals moving out of the urban area to take advantage of the recent suburban development on the outskirts of this rural town.

The high school building in which this second portion of the study was completed was of recent construction, relatively modern, kept in a neat and clean condition. Rarely was paper found in the hallway between classes and graffiti were absent from the walls and external portions of the building. Being in a rural area on the edge of town, the grounds include a large lawn and tree area in addition to the athletic fields and outbuildings. A woods and meadow area next to the school is available for outdoor biology and farmland to the north of the school provides a peaceful, serene setting.

Class and School Comparison

These two schools are similar in several areas. First of all, both schools are traditional in their curriculum, offering the "smorgasbord curriculum" as described in Art Powell's *Shopping Mall High School* (Powell, 1985). The Curriculum Guide for Western High School includes course offerings running all the way from special education, vocational courses, bilingual, to honors and advanced placement. Cranston High School offers courses in approximately the same areas.

In both schools the courses are tracked into various levels. For instance, biological science consists of Basic Bio in the lower remedial track, Regular Biology in the middle track, and Advanced Biology in the upper honors track (Teacher Interview, 1/22/1990). Courses are not identified as such in curriculum listings, but placement by counselors and teachers effectively channel students into courses designed to challenge the better students and give remedial help to those struggling to succeed. Observations in both schools were conducted in classrooms allocated to General Science, designed for the poorly motivated, low achieving science students.

Furthermore, in both schools much of the community life centers around the schools and a high percentage of students are involved in extracurricular activities such as sports, band, and academic clubs (Interview 7/15/91). Casual conversation by students often centers on sports events, deer hunting, and upcoming social events (Field notes, 11/20/89).

Another area of similarity involved the training and experience of teachers. Mrs. Strauss at Western High completed a Bachelor of Science in Chemistry, finished certification requirements for teaching, and completed a Master of Education degree. Her experience involves twenty years of teaching on the Junior High, Senior High, and Community College. Mr. Lindeman at Cranston High completed a Doctoral degree in education and taught for over twenty years at this high school in the area of chemistry and physics. Both now teach a course for the poorly motivated, low achieving science students and were well accepted and liked by these students.

These two high schools differ in several respects. The first major difference between the two classrooms involved the ethnic composition. The classroom at Western High included 43% black students, 50% white students, 5% latino students, and 2% Asian. The class at Cranston High School was comprised of all white

students. While this difference in classroom composition weakens the class to class comparison, the contrast in settings and population does strengthen the generalizability of the study. Supplemental observations in a third urban high school, South Central, added to the data base. A second difference in the two schools is the absence of metal security dividers and security personnel at Cranston, but readily visible at Western High School. Overall, the comparison of the two classes did match quite well as to experience and training of teachers, academic level of students, class composition, and type of curriculum used.

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CHAPTER FOUR – DATA ON STUDENTS

Data Overview

The data presented represents extended observation in two different high schools (Western High and Cranston High), and limited observation in a third high school (South Central High School). All observations were made in classes normally designated as "General Science" or "Basic Science" and fit the profile presented in the literature review and in the teacher perception profile as outlined later in this chapter.

In that the data collection and the data analysis developed concurrently in a chronological manner (finding out what happened and an attempt to understand what happened), the data will be presented in a story form, often using the first person to reflect the events of the moment, the reactions of the participants, and the perceptions and questions of the researcher.

The presentation of the data will be divided into three sections: Chapter Four will present the data on students, their perceptions and reactions. Chapter Five will present the data from Western High School in 1987 when the technology unit "Wheels" was trial tested. Chapter Six will present the data gathered from Cranston High School during the fall of 1989 and winter of 1990 when the unit "Weather" was taught. Chapter Seven will give an analysis of the data, giving comparisons by showing similarities and differences between sites and drawing upon the supplementary data, especially planned and casual interviews, to further substantiate the assertions or disqualify assertions based on counter-evidence.

The data for each collection site in Chapters Five and Six will be divided into three parts; classroom structure, implementation, teacher beliefs, and impact of structure on implementation. In that the classroom routines, pedagogical approach, and beliefs varied somewhat for each collection site, the analysis will first establish the

classroom management routines (structure), and then detail what happened at the attempt to implement a new curriculum.

Next, an overview of teacher beliefs will be presented, and an attempt made to show how the classroom structure and pedagogical methodology are rooted in the teacher's beliefs, and finally how this established structure and the related teacher beliefs impacted the implementation of a new curriculum.

The data format will vary with different data collection sites due to the nature of the discourse involved in these classrooms. Most of the communicative interaction in Mrs. Strauss' classroom could be characterized "one-way", the teacher giving directions, lecturing, or asking questions. The only student communication involved students answering questions posed by the teacher. For this reason the classroom events are presented more in paragraph form using quotations embedded in the paragraphs. In contrast, the communication in Mr. Lindeman's room is more characterized as "two-way" communication, including questions posed by the students and answered by the teacher, more student to student communication, and a freer atmosphere where students call out answers spontaneously without raising their hands. For this reason, classroom events are presented more in dialog or script form with intervening reflective and interpretive commentary.

The examination of the data will progress from a more globalistic view to a more detailed treatment of specific assertions and questions. The data from Cranston High School will begin with more classroom interaction in the form of extended vignettes. Later as the classroom routines, teaching methodology, and forms of student-teacher interaction are identified, descriptions will be limited to new routines, new methodology, and verifying additional instances or counter-instances in support or refutation of assertions.

Who Are These Students?

Almost every American high school with which I have been associated, either through past teaching positions, friends, or professional acquaintances offers a course for the poorly motivated, low achieving students. Most often these courses are called Basic Science or General Science. As we began this study, one of the first questions that came to mind involved the composition of students in these classes, the criteria and procedures actually used in assigning students to these classes. The data presented in this paper is not a comprehensive survey, but reflects contacts with five high schools in a 30 miles radius of the city in which this research was conducted. The study takes two perspectives, 1) Who are these students – as the teachers see them, and, 2) Who are these students – as they see themselves?

In the 1987 ASCD Yearbook, Anderson (1987b) characterized the poorly motivated, low achieving science students by saying,

We suspect that we are not reaching:

- a) passive learners
- b) students who are frequently absent
- c) students who are learning disabled or handicapped
- d) students who are severely deficient in reading or writing skills (p.89)

What do the Teachers Say about These Students?

Jim Grider, at South Central High School describes the composition of his classes as follows: (Interview on 4/21/89)

Overall, (these students) have little interest in science. They are not motivated (about half turn in assignments) ... Students don't really care ... they're just not interested ... attendance is a major problem (on May 17th, a day I visited this classroom, 11 out of 26 were present).

Continuing, Mr. Grider divides the students in his classes into three basic groups:

- 1) A few very good students, maybe 5 out of 80, who get placed in these classes due to schedule problems or other courses being filled.
- 2) Students of average ability, but poorly motivated.

- 3) Poor students, who are not interested, usually from Special Education or with a low reading level.
- 4) A few who use these classes as a stepping stone to other classes.

Ann Cash, one of the program developers who taught at the same school as

Mrs. Strauss, groups her students into three main groups: (Interview on 4/11/89)

- 1) Low ability students who subdivide into two groups.
 - a) Cooperative variety
 - b) Hostile variety
- 2) Those with average ability and poor motivation.
- 3) Those with average to above average ability and a metacognitive deficit.

A more detailed presentation of the perceptions and beliefs of Mrs. Strauss will be added later in this same chapter. However, for the present overview, Mrs. Strauss indicated that seven special education students had been placed in her 7th hour class.

In an interview with Sam Angelo, at Jamison High School, another dimension was added, "The problem is ... the kids themselves ... some on probation ... girls pregnant ... in and out all the time due to attendance (Interview, 10/3/89).

An interview with Dr. Taft, the principal at Sorenson Suburban High School, indicated that goofing off or laziness by students results in the misplacement of students by teachers saying:

Over half of the students in General Science should not have been there (misplaced) ... We now have half the sections we used to have ... three instead of six sections. Many of the students in general science were there by teacher misplacement. They go in because:

- 1) they heard it was easy
- 2) goofing off and failing previously
- 3) emotional and/or family problems
- 4) absenteeism

Dr. Taft noted that according to the new policy students who fail due to absenteeism or goofing off must repeat the same course. With a 20% absence level, students automatically lose credit. The idea of social promotion was no longer to be accepted.

These perspectives by five teachers indicate that the "General Science" student may have been placed there for a variety of reasons which include mental abilities, disabilities, behavioral problems, family and/or social problems, or even character qualities like laziness.

Who are These Students, as They See Themselves?

Many characteristics and attitudes of these students can be gleaned from their own statements, especially considering the context in which statements are made. Most of the following text is taken from pre and post interviews conducted with the students during the fall and spring of 1987. We will look at how the students view themselves, their school, learning, and their futures. In some cases, answers for the same question are grouped from various students to give a wider support for an assertion. Note however, that all interviews were conducted alone, one student at a time.

As you will note, the data confirms some of the teacher's perceptions of these students, but also suggests deeper historical and experiential scars that, in the preservation of a fragile self-esteem, brought many to project an outward image of "I don't care", but who in reality do care, have dreams of their own, often unrealistic, but nevertheless real.

Many of the students in these classes do not understand why they are placed or retained in a certain level of classes. This can be demonstrated by an interview on 11/15/89:

Deanna: Okay, what math are you now taking?

Brent: Right now, Consumer.

Deanna: Consumer math. Is that easy?

Brent: Yeah.

Deanna: Is it too easy for you?

Brent: Well yeah. I mean I started out in it and I like...switched to Intro to Algebra.

Deanna: Oh, you in that now?

Brent: No, she gave me a hundred assignments and then said after I was done with that a test, and I just went back to Consumer.

Deanna: Because, like you'd already been in here too long?

Brent: Yeah, I had to make up too much. So I just had to stick with that. I decided to.

Deanna: Why were you in Consumer Math in the first place?

Brent: I don't know! I signed up for Intro to Algebra, and they put me into Consumer. Not 'cus of the last teacher or anything ... but ...(trails off).

Some of these students still carry a deep stigma from being associated with Special Education. An incident on 5/9/90, though puzzling at first, ended up giving an insight into the depth of the emotional impact. We were preparing to complete post interviews with Katie and Tom. Both hung back, not physically moving to come with us. We first went to the office to find empty rooms. The secretary indicated that the Special Education room and the cafeteria are available. Deanna takes Tom to the cafeteria. Katie hangs back at the office talking to some students. I set up the tape recorder in the Special Education room and then go back to get Katie, who says, "Do we have to go to THAT room?"

I ask, "Why?"

Katie replies, "I just don't like this room" (later I found out that she was sent to this "Special Education" room for released time). It is very difficult to convey the impact of this incident in written form, but the facial expressions, the tone of words, and even the unwillingness to talk about the real reasons do indicate a deep feeling regarding the former experiences.

Many of these students are living with a history of repeated failure, some in the form of low and failing grades and some in the form of repeating certain grade

levels or classes. Two areas of difficulty most commonly expressed were reading and understanding.

Liske: What is the hardest part of school for you?

Tom: Reading (Interview 11/10/89)

Deanna: ... did you work on reading while in the resource room?

Tom: I have sort of a problem. Dyslexia.

Liske: What part of school is most difficult for you?

Scott: Most difficult in school? Reading. I had trouble in English all my life. My father wouldn't let me be in Special Education classes. (Interview 11/14/89)

Laura: Reading material (Interview 11/14/89)

The second area of difficulty most often mentioned by students is gaining a real understanding of the material. Although hard to transmit in the written text, this lack of understanding seemed to be a major contributor to the pervading discouragement that settles on this group of students, as illustrated in the interview on 11/13/89:

Liske: Why do students do poorly in school?

Ross: Because they don't understand ... they don't pay attention ... don't like school ... goof off ... rather do other things ... learn slower

Liske: Why do other students do so well in school?

Ross: They understand ... learn faster.

Liske: What kind of effort do you put in?

Ross: Average ... don't try as hard if you don't understand.

Liske: What makes a good teacher?

Ross: One who makes sure you understand?

Liske: What is the hardest part of school for you?

Ross: Understanding!

Liske: What part of school gives you the most difficulty?

Ross: Understanding how things happen. Didn't understand most of the stuff. The teacher just lectured... didn't use the overhead, like Chief (Ross was in Biology at the beginning of the year).

Other similar answers for these questions:

Liske: Why do students do well in school?

Scott: They understand the stuff.

Liske: Why do students do poorly in school?

Katie: Slacken off .. or .. don't understand the material.

Liske: Who would you consider the best teacher in this school?

Scott: Chief ... the way he teachers ... explains (things).

Liske: What is the hardest part of school for you?

Laura: Don't understand some things.

Katie: Don't understand.. It makes me so upset.

Deanna: Think of the things that Chief does in the classroom ... What does he do that helps you the most?

Brent: He goes over things really well.

Liske: What makes him (Chief) a good teacher?

Sarah: He explains if you don't understand.

An examination of the preceding answers reveals that the areas of difficulty (reading and understanding) are expressed by a variety of students as an answer to a variety of different questions. Of the eight students scheduled for post interviews at Cranston High School, seven students are represented in the above answers.

Initial data from these two schools show that the students in low achieving classes have the following characteristics:

- 1) They seem to lack motivation, as indicated by their frequent absences, low interest in academic subjects, and passive response to instruction. Most have difficulty in reading and written expression and have experienced repeated failure in school.
- 2) They represent a wide range of abilities from handicapped to emotionally disturbed. Often family and social problems compound the difficulties experienced by these students.
- 3) While they often give the appearance to teachers that they do not care about success, in reality they do care and often use a passive approach to studies as a protective device to their self-esteem.

Interviews with teachers and administrators in other schools suggest this pattern of behavior is generalized beyond the two schools studied.

CHAPTER FIVE – DATA FROM WESTERN HIGH SCHOOL

The research at Western High School, completed in a five month period between January and May, 1987, consisted of observations on the attempted implementation of the unit Wheels. In that no planned intervention was attempted at this site during this time, I took the role of strictly observer. In contrast, the later study at Cranston High School, during the fall and spring of 1989–1990, involved intervention on the part of the researchers, who then took the role of participant/observers.

Overall Guiding Questions

The first portion of this chapter will deal with research question number one and document the currently used teaching style and classroom procedures existing at entry in the classroom of Mrs. Strauss, a ninth grade science teacher. The second section will deal with research question number two, how the teachers viewed and used the new materials during the attempt to implement the unit Wheels, the accompanying modifications, adaptations, and the eventual termination. The third section will overview the perceptions, beliefs, and philosophy of the teacher and show how these influence the way teachers treat new curricula that differ from their usual mode of operation.

The Structured Classroom

During the first six weeks of observation at Western High, Mrs. Strauss taught from the officially adopted textbook, and used the style of teaching that represented her accumulated training and experience over the last twenty–one years. I will attempt to show what characteristics give a distinctive structure to her teaching style.

These can be conveniently grouped into three general areas as follows: 1) The role textbook, 2) Established instructional routines and procedures, and 3) The system of classroom management and discipline.

The Role of Textbooks

Two textbooks are used for this class, each representing one half year of study in life science and one half year in physical science. Both are authored by Dolmatz and Wong and are entitled *Investigations in Science – Life Science* and *Investigations in Science – Physical Science (IIS)* respectively. These texts, published by Globe Book Company were written specifically for the poorly motivated and/or low achieving student. Their particular design incorporates topics of high interest and personal relevance. The format involves hands-on activity of some sort for almost every period. A certain amount of background information is given in the text with every lesson, but is minimal.

Each textbook provides the topical outline and content for one semester of study. An interschool science committee decided which chapters from each of the above texts would be "covered" during the course of this school year. The chapters are studied one after another in the same order as set forth in the textbook. No additional sources of information were noted during the course of the first six weeks, except one film. Toward the end of each chapter the teacher would summarize the information in the text, and add some additional examples to illustrate the material. In some instances, additional worksheets were created to give extra practice as demonstrated in the lesson on data charts and graphs on February 19th and 20th.

In spite of the fact that this book was designed for a student involvement type of learning, it was being used in a text-centered approach. During the course of the first six weeks, only two lab activities were completed, the Metric Lab on Feb. 6th, and the Density Lab on Feb. 12th. The lesson progression of read the text, outline the chapter, define vocabulary, complete questions, lecture, review, and quiz will be developed in the next section.

In summary, the textbook determines what is taught, to a large degree the order that it is taught, but not how it is taught.

Established Instructional Routines – Lesson Progression:

First of all, the teacher uses a repertoire of instructional sequences for each chapter that include the following components in approximate and reoccurring order:

1. Read the chapter (in class).
2. Outline the chapter in the notebook.
3. Do the vocabulary words in the notebook.
4. Do the questions on a separate sheet of paper (to be handed in).
5. Teacher gives a lecture with notes on the chalkboard.
6. Students complete review sheets or worksheets (done in class)
7. Review sheets are orally corrected in class.
8. Chapter test or quiz is given, graded, and returned to the students in the same period.

The above lesson progression constitutes about three to four days of work per chapter (See note below). The quiz on the completed chapter, the reading, outlining, vocabulary, and questions of the new chapter are usually done on the first day. The teacher lecture and review sheets are normally completed on the second day, while the test and a new chapter may be started on the third day.

The above lesson progression was partly revealed as I walked into the classroom for the first time on January 22. Before class the teacher gave an overview of activities for the day which included a quiz, reading the chapter, outlining the chapter, writing definitions for vocabulary words, and doing the questions in the textbook. Note that each chapter in this text is actually more of a lesson than a chapter, consisting of two to three pages of written text and two to three pages of

questions with blanks in the text to fill in.

On my second visit, the above sequence was somewhat modified to accommodate a movie. Again the period started with a quiz, during which time Mrs. Strauss attempted to thread the projector, had difficulty, and then went to look for help from the teacher next door. As this teacher was not available, I offered to thread the projector for her. At the beginning of the movie the students were instructed to take notes during the movie. Topically the movie did fit in well with the subject "energy", which was presently being treated by the textbook. This does suggest advance planning and forethought. However, the inability of the teacher to operate the projector (not a new one) also suggests that projection film using this projector is not included in the usual sequence of events.

On the third visit, February 6th, the lesson progression reverted to the original sequence. The period started with a quiz (during which the teacher corrected notebooks), then the students outlined the new chapter and did the vocabulary (while the teacher corrected the quizzes), and finally, the students were asked to complete questions 1-9 in the textbook (while the teacher completed grading the quizzes). The period ended with the teacher calling out the grades for the tests and returning the quizzes to the students.

The last part of the lesson progression did not become evident until the observation pattern was changed. On February 19th, the first teacher led presentation was observed. During this period the students first completed worksheets on the bar-graph, then the teacher lectured and wrote notes on the board (which the students copied into their notebooks). On the next day, the students did a review sheet, which was corrected orally in class. On the third day, the students wrote a quiz and started the next chapter.

During the course of the following weeks the same sequence of events was repeated over and over, with instances on March 16th, March 27th, and April 16th. As will be shown later, the new curriculum materials were also adapted to fit into this particular lesson progression.

A continuing component of the lesson progression is the science notebook. The teacher feels that students need to be organized to be able to learn and notebooks are a way to help teach organization to the students. The requirements for notebooks are clearly given. Notebooks must be in a folder with the pages bound. Loose pages in a folder are not acceptable. Worksheets, vocabulary, and chapter outlines are to be included in the notebooks. These expectations are firmly enforced. For instance, on February 6th, Mrs. Strauss announced, "Hand in your spiral notebooks or three-ring binders. Do NOT hand them in if they are not in a bound folder."

The notebooks are given one grade for the whole quarter and are worth 35 points. They are turned in half way through the grading period for a progress check, and are due one week before the end of the quarter. Oral reminders are given as to the coming due date. The notebooks are quickly graded as the teacher simply pages through them, notes organization, completeness, and neatness, and then assigns a grade between 1 and 35 points. Mrs. Strauss feels that this is one of the easiest ways for the students to improve their grade.

Established Management Procedures – Classroom Routines

Other structuring influences in the classroom are the systematic routines that are part of almost every class period. These will be referred to as period routines and vary little from day to day. The sequence follows this pattern:

1. Teacher stands just outside the south door during passing period and monitors the hallway and the classroom (The north door is locked so the students can enter only by the south door). During this time the teacher checks to see that students have their books for class as they enter.
2. The students are required to be in their seat when the bell rings or else they are considered tardy.
3. At the ring of the bell, the teacher locks the south door and walks behind the demonstration desk at the front of the room. The teacher pauses for a minute without talking, to wait for quiet. Announcements are given over the PA system.
4. The students review their notes quietly for five minutes while the teacher takes roll and returns any papers.
5. The students write the quiz. When finished, they turn it upside down on the desk. While students write the quiz the teacher stands in the front of the room and monitors the test.
6. After a student has completed a quiz, the teacher walks over to the desk and picks up the quiz. When most of the students have completed the quiz, the teacher gives the assignment for the day.
7. While the students complete the lesson (reading, outlining, vocabulary, worksheets, or review sheets) the teacher corrects the quizzes.
8. The teacher announces grades on the quiz.
9. Students hand in questions on the left hand corner of the demonstration desk.
10. The students may talk the last five minutes.

To illustrate the above period procedures an overview of the first day in the classroom (January 22nd, 1987) will be used. As I arrived at 12:55 the teacher was standing at the door in the hallway as the students entered the room. At 1:00 PM the bell rang and the teacher walked to the front demonstration desk. The students ceased talking as the teacher surveyed the room. The announcements tell about the "Right To Know" meeting right after school. Mrs. Strauss next reminded the students about the quiz and asked them to review while she takes roll. She checked off the students present and placed the slip in the crack in the door. The students looked over their notes quietly with no talking. During this time the teacher passed out blank sheets of paper.

At 1:05 PM the teacher gave instructions for the quiz: "It is to be absolutely quiet! Everything off your desks. If you need to sharpen your pencils, do it now! This is how to use your cover sheets. (She demonstrated how to slide the blank sheet of paper down the quiz to cover answers completed) Absolutely no talking, not even 'May I use your pencil?'"

The teacher now passed out the quizzes and then stood in front of the class watching the students. She leaned back against the demonstration table, arms folded, eyes moving from side to side. The room is quiet, no discernable talking. After five minutes she began walking around and picking up papers that the students had completed and turned over.

At 1:11 PM the teacher stated, "We will begin a new chapter today. Turn to page 15. Read the chapter." While the students read the chapter, the teacher sorted papers at the demonstration desk. After ten minutes the teacher announced, "When you're done, I would like you to outline the chapter and do the vocabulary words. (Slight talking) All right now, settle down please! Get busy!"

The teacher now walked over to a student and asked, "Where's your book?"

The student replied, "In my locker. Didn't have time to go to my locker."

To which the teacher responded, "Look on with the girl next to you."

At 1:25 PM the teacher walked around to check how much work was completed, and then explained, "The outline and vocabulary will go into your notebook . . . to be handed in at the end of the period." She walked over to a student, picked up her notebook and said, "This is great! An A notebook! Spiral notebooks are fine." Walking over to another student, she picked up her notebook and announced, "Here is another type that is OK – also an A notebook! When you are done with your outline and the vocabulary words, do the following questions (teacher wrote the numbers on the chalkboard). These are to be handed in and graded. Never do the questions on the same paper as the outline."

At 1:44 PM the teacher walked to the storeroom and brought out a new ream of paper and placed it on the left hand corner of the demonstration desk. Students came to the front of the room to get a sheet of paper when needed.

After a phone call, the teacher walked to the front and picked up the stack of quizzes and announced, "Here are the grades for the tests. Three people got A's, (named the students). Here are the B's (reads six student names), these people got C's (reads nine names), here are the D's (reads 8 names). There is one E (reads name). You will notice that everything I went over on the blackboard yesterday was on the test. You may talk the last five minutes, but stay in your seats."

At the bell the students left quietly and orderly.

Established Procedures – Quiz Subroutine

As we examine the previous sequence of events, it is evident that many of the components of the period are in themselves subroutines each with an individual

function. For instance, the quiz subroutine illustrates the concern the teacher has for students doing their own work. Instructions for quizzes are repeated in subsequent periods. In addition to the verbal directions regarding "absolute quiet" the teacher walks around the room, and reminds the students to "use the cover sheet" when failing to do so. When a slight murmur is heard, the response of the teacher is, "I said there is to be no talking." In the next period (third observation), the oral instructions and requirements are repeated, including a reminder to take "Books off your desks". At the beginning of the next period (seventh period) on the same day, instructions are repeated again, including the comment, "The rules are always the same." The concern for students doing their own work extends to other activities in addition to quiz time. During the time allotted for completing outlines, vocabulary, and questions, the rule of no talking was also strictly enforced on all three days observed.

Another possible supporting evidence in regard to concern for students doing their own work is the procedures with papers at the completion of assignments. Tests are to be turned over. Questions are brought up to the teacher immediately upon completion and stacked on the edge of the demonstration table. In spite of all the routines that have developed around testing, the possibility exists that cheating has not been a problem at all and the precautions that exist are simply wise, normal, preventative measures, established as normal procedures over long years of teaching. It is also noteworthy that even with close observation (actually looking for students attempting to cheat), no specific instance could be found, either by myself as observer, or by the teacher (as might be indicated by a response in dealing with a specific situation).

Established Procedures – Oral Correcting Subroutine

Another example of a subroutine that is part of the lesson progression is the oral correcting of review sheets. The following pattern was developed from class notes taken on February 20th and February 26th:

1. Teacher asks the first student a question from the worksheet or review sheet.
2. The student called upon gives the answer.
3. The teacher responds according to one of the following conditions:
 - a) If the answer is correct, the teacher repeats the answer loudly so all can hear, and then calls on the next student in order of seating.
 - b) If the answer is incorrect, the teacher goes on to the next student with the same question, and continues until the correct answer is received.
4. If the answer to the original question was correct the teacher directs the next question to the next student. If the answer was incorrect, the next question will be directed to the student who gave the wrong answer. This will continue until every student gives at least one correct answer for the assignment.

A verbal interchange on February 26th gives a flavor of this sequence as the teacher begins:

Teacher: Let's look at the worksheets. Hope you are all done?

What is the role of engineers and scientists? Melissa?

Melissa: Could you put "So engineers could produce what scientist found?

Teacher: Close (pause). How has growth and technology changed the way people live? Tony?

Tony: What about (answer not clear)

Teacher: Charisse?

The oral correcting routine achieves two functions: 1) It cuts down on the time needed by the teacher to correct papers, and 2) it gives immediate feedback to the students on their work, providing the right answers, and enabling students to use the review sheets to study for the coming quiz. This was indicated by the teacher's comment on February 20th, "OK, let's go over these. Those who get the wrong answer, jot down the correct answer on your sheets."

Procedures, Routines, & Subroutines

Each of the above routines has a function in the operation of this ninth grade classroom, and represents part of a system of classroom management. On one hand, this system of classroom management is the teacher's way of bringing enough order and discipline into a classroom to allow learning to take place. Furthermore, the amount of time needed to give directions is reduced, and the actual time-on-task increased. The students benefit from the clear expectations, both by knowing exactly what will be on the tests, and also in being clear on what is proper classroom behavior. Over time, the system benefits the teacher in allowing her to prepare a store of reusable worksheets and quizzes. Finally, it allows the teacher to cope with a large amount of students simultaneously and has the function of making the task of the teacher more efficient.

On the other hand, each of these procedures and routines imposes a certain structure on this classroom that in turn embeds a specific amount of inflexibility. Thus, as one considers implementing a new curriculum, two considerations need to be addressed: 1) Is the new curriculum more effective in helping the student's learn, and 2) Does the new curriculum make life difficult for the teacher by not allowing the teacher to function in the structured systematic way that has proven "workable" from

past experience? This question will become the focus of the next section.

Classroom Management and Professional Priorities

Teachers structure their teaching profession and classroom in such a way to make the life of teaching somewhat acceptable. A strong emphasis on classroom management, super organization, and discipline is Mrs. Strauss' way of coping with a traditionally difficult group of students, and permitting her to complete a burden of correcting and class preparation in the allotted time.

First of all, the preparation time given for this teacher is not sufficient to allow the teacher to complete three preparations for five classes, and correct all the written material generated by the quizzes, outlines, questions, vocabulary exercises, worksheets, and tests. Mrs. Strauss has one preparation period, and often uses a portion of her lunch hour in preparing worksheets. Even with using this extra time for planning, new preparation seems minimal as indicated on January 29th. I stopped in after class to find out when lab would be held, as these were the kind of observations in which I was initially interested. As we were discussing possible dates for coming labs, the teacher was looking in her plan book and I was standing beside her. As I was trying to make sense of her plan book, I became confused as the dates written in the plan book did not coincide with the dates for the coming weeks in 1987. The teacher noticed my confusion and explained that this was last year's plan book. Apparently she was using the same sequence of lessons and assignments as the previous year, only changing the dates to the new calendar.

Mrs. Strauss has developed practical routines and organizes classroom activity in such a way that most correcting and preparation can be completed during the class period, leaving little work to take home. The ability of the teacher to both supervise students and complete her own work of correcting papers at the same time became

apparent during the first visit to the classroom on February 6th, 1987. During the passing period from 12:55 to 1:00 PM, the teacher stood just outside the door, thus able to monitor both the students inside the classroom and also in the hallway. The students entered the room quietly and sat in assigned seats. When the bell rang all students were in their seats except one student who came in late. After the bell rang, the teacher stood in front of the room, and surveyed the room without saying a word. The room was absolutely quiet! Next the teacher announced, "Use the first five minutes to review for the quiz! "The following was already written on the chalkboard:

Test today – Chapter Six
Notebook check today

While the students reviewed quietly for the quiz, the teacher took roll by comparing the students present with her printed list. When this task was completed, she placed the slip in between the door and the door jam for the student aide to pick up. During the remainder of this quick review period, the teacher stood at the front demonstration desk, sorted and stapled papers.

At 1:05 PM the teacher announced. "Hand in your spiral notebooks or three-ring binders. Do not hand them in if they are not in a bound folder. ... Place your notebooks on the edge of your desks so I can collect them." The teacher paused while the students placed their notebooks on the edge of the tables next to the aisle.

The instructions for the quiz were now given by the teacher, "Clear everything off your desks except the notebooks to be corrected. Keep your paper covered. Put your name on (your paper). Absolutely no talking!"

The teacher passed out the cover sheets while giving the above instructions. Next the quizzes were passed out. As the students wrote the quiz, the room was absolutely quiet. There was no perceivable indication of any talking, whispering, or

student attention elsewhere. All students were reading and writing. After the students had started the quiz and were settled, the teacher went to the first two desks, picked up three notebooks, took them to the demonstration desk at the front, paged through them, assigned a grade, noted the grade in her record book, returned the three notebooks, picked up the next three or four, and repeated the process so that by the end of the quiz she had already checked, graded, and recorded grades for all notebooks available. As the students finished their quizzes, they turned them over on their desks, and waited quietly.

The teacher now continued with the following instructions: "We are going to outline the chapter today and do the vocabulary. I will try to get the tests corrected so you will know before you leave."

While the students worked quietly at outlining the chapter and completing the vocabulary, the teacher sat at the teacher's desk and corrected the quizzes. Twenty-five students worked steadily. Two sat staring out into space. Two students exchanged a note.

At 1:24 PM the teacher went over to the metal cabinet, unlocked the door, took out her handbag, reached in for a calculator, and calculated the grades on quizzes. Then she went to the chalkboard and wrote: Questions 1 – 9. The students continued to work quietly at their desks and the teacher continued to correct papers while standing at the front demonstration desk.

At 1:46 PM the students began to bring their questions up to the front and placed them on the corner of the demonstration desk. A slight murmur was heard among the students, and the teacher responded with, "No talking until the last five minutes."

The teacher now called out the grades for the quizzes as follows: "Three A's (and then names three students), six B's (and then names six students), fourteen C's (names fourteen students). The rest not mentioned have E's. Now talk to your hearts content."

The time is 1:51 PM, the students talk quietly. Two students stand up, and the teacher reminds, "Be seated, ladies and gentlemen!" At 1:55 the bell rings and the students exit the room; all walking, no running or pushing.

A close description of the previous vignette indicates that the teacher keeps the students busy at all times, except for the last five minutes of the period. While she is taking roll, the students are reviewing for the test. While she is checking the notebooks, the students are writing the quiz. While she is correcting the quiz, the students are outlining the chapter. The second overriding impression is that the teacher keeps herself constantly busy, except while the students are writing the quiz. As noted above, she corrects the previous assignment while the students complete the next assignment. During the quiz however, her attention is focused on monitoring the class. While correcting the notebooks, she was in front facing the students, and continually looking up from her work to check on the students.

The third component of this class that allows the teacher to be highly productive in completing her own work of correcting papers is the almost complete quietness, and the lack of disorder. The high level of engagement and the absence of talking was almost uncanny for a classroom of 29 students (four absent today).

During the first visit to the classroom, I wondered how the teacher was able to correct the volume of written work generated in this classroom. It became more evident during this period. As explained on January 22nd, "The outline and the vocabulary go into your notebook." These two types of assignments are corrected very

quickly by scanning. The quizzes are mostly multiple choice with an occasional fill in the blank, and so are very quickly scored. The questions are collected and graded by the teacher.

Does Mrs. Strauss use time after school to complete correcting and class preparation? The taped interview of 3/18/87 indicates that Mrs. Strauss spends little time after school on school work.

Interviewer: How often do you have to stay after school?

Mrs. Strauss: After three? Ah, I usually stay until about ten after three. Which is (pause) – I'm supposed to stay until twenty after, but I usually don't. I think once in six weeks (pause) I stay after until I get done. I had to do it the last semester because I was behind a little bit, but I usually get everything done in my planning period or lunch. You gotta remember that we have a whole hour for lunch and a whole hour for planning, so that's two extra hours."

Thus Mrs. Strauss has structured her profession in such a way that most planning and correcting can be completed during the time spent at school, leaving little work to take home or to finish at school after 3:00 P.M. Her desire to finish all work at school and not allow teaching to infringe on family time was verbally indicated during a taped interview on March 18th, 1987 as follows:

Interviewer: What proportion of time do you have to spend at home compared to what you spend at school?

Teacher: Very small percentage. . . . I am very organized. I do all my work, or I try to do all my work here at school, and that is correcting, and sometimes I do get behind, not very much behind. ...Ah, I don't like to take work home as I feel home is home and this place is this place. So I try to do all of my stuff here, and it has worked out very well. If I need to stay after school for a little while, I will, but I don't like to do that either. But like this week, I had some work at home. I made up a ditto. And when grades come due, then I have to take some things home, and average the grades. But other than that, I am a believer in 'home is home.' And I like to separate the two. When I leave here, I want to forget about it.

First of all, the above quotation speaks to the amount of work done at home in comparison to the preparation done at school. She indicated that a "very small

percentage" of class preparation is done at home. This is further substantiated by the observation of this teacher leaving the building shortly after dismissal with only a purse and thermos bottle in hand. School books and papers simply do not go home on a regular basis.

The above quotation also indicates the intent and the underlying reasons for completing work at school. "I try to do all my work here at school" and "I am a firm believer in home is home, and I like to separate the two. The family here is taking a higher priority than the profession. The question needs to be asked if these two priorities are mutually exclusive, or has the task of teaching become so unpleasant, that the teacher wants to erase the distasteful experiences from her mind, and dwell on the more pleasant interactions of family life? The task of teaching does not seem to have a compelling professional priority to this teacher. She indicated that "when I leave here, I want to forget about it." The ability to separate work and home life is a commendable ability that contributes to sound mental health, but realistically does it allow the teacher to prepare adequately for class?

Classroom Discipline and Classroom Structure

Classroom discipline has a great impact on learning. To a large degree it influences classroom climate, determines what activities are used, and what modes of learning will be utilized. Furthermore, classroom discipline is interwoven with classroom management and often the two are inseparable. While the form and effectiveness of discipline often determines what is possible in a classroom, the opposite is also somewhat true. The teaching style and professional priorities of a teacher will often dictate different forms of class management and discipline.

The discipline used by Mrs. Strauss helps her complete her work during school hours, is compatible with her teaching style and professional priorities, and is

consistent with her beliefs about students. As she stated in an interview on March 16th:

I've gotta run a tight ship for me. I mean that is the way I teach best. I can't teach in a real loose situation where everybody is going off in their own direction. I guess a lot of people claim they can, but I can't, and it would make me nervous and would make me feel discontent. ... I would go home at night feeling I hadn't really done anything. I just can't work that way.

The preceding quotation ties a system of discipline directly into a teaching style that again is related to personal preferences. As Mrs. Strauss continues:

You see, it (classroom discipline) is very difficult, because it all depends on your personality. Now if you are the kind of person that is really comfortable ... when kids bring in pop, and sit around, talking, and you like that kind of ambience, then my way will not work for that type of person. A lot of people do not like my way, because it requires a lot of work (backbone). You really have to put in a lot of time at the beginning of the year. You have to tell them what your rules are and then not deviate from them. ...At the end of the semester (I still) get some kids that come up to me and say, 'Can I go to the bathroom?' and I say 'No, that's one of the rules. You have time between classes to go, and you can't go.' So at that time of the year, they are still trying or still testing you out. So right at the beginning you have to be very strict, and you might get kids who come up to you and say, 'I can't stand you, you're too strict. Why can't you be more like so and so.?' But you can't let that bother you because you have to know that you are doing it for them because they've got to have that kind of classroom where they can work in, nice and quiet, where they can work and concentrate, and you've got to have an area, an atmosphere where YOU can work, where you can do your best. If you can't do your best, then they're not going to get this from you.

Mrs. Strauss has been successful in establishing a classroom that is orderly, quiet, and organized. Rarely did she spend more than five minutes at the beginning of the period taking care of housekeeping details and giving instructions for assignments. On various occasions, I would specifically look for instances of misbehavior and talking while the students were to be working on their individual assignments. During the quiz on March 6th, I could not find one instance of students talking. While quiz time may have its own consequences for talking and thus be naturally quiet, this same level of quiet carried over to the graphing exercise on March 19th, and to the review sheets on

March 20th. During a 15 minute period, the only discernible noise was one student cracking his gum, to which the teacher immediately responded, "Please, no bubble gum cracking!"

Not only is the room extremely quiet, but the level of on-task behavior is high. A count on 2/6/87 revealed 25 students who appeared to be working steadily. Two were just sitting or sleeping. Even when the teacher was not watching this level of engagement continued as during the graphing exercise on 2/20/87 when the teacher sat at the front desk intently correcting papers. The one part of the period with a relatively lower level of engagement was during the five minute review for the quiz. On February 6th only 67% and on February 12th only 74% were actively preparing for the quiz. During the course of these first six weeks, individual instances could be pointed to where students were passing notes, secretly whispering, or involved in nonlearning activities. But overall, Mrs. Strauss has established the type of classroom environment that she believes is most effective in helping students learn.

What philosophy and action allows Mrs. Strauss to achieve this level of class control? First of all, as noted in the previous quotation, she believes that good discipline is established at the beginning of the year, requires a lot of work, and will pay off in the long run. A special emphasis is given to training the students in classroom procedures. For instance, the use of the "cover sheet" was explained on 1/22/87 and reminders given on 1/29, 2/6, 2/12, 2/26, and 2/27.

Secondly, Mrs. Strauss believes that rules must be clearly stated and followed up consistently. Again from the interview on 3/13/87, Mrs. Strauss states:

"You do have emergencies ... but I noticed that once you start allowing something, than the kids will pick up on it just like that (snaps fingers). They say, 'You let so and so' and once you let somebody, then if you are fair, you've got to let everybody . . . You've got to be firm. . . It does require a lot of work . . . a lot of stress at the beginning, but it makes it easier for the rest of the year.

Our reputation gets around. They know you won't put up with a lot of crap, and that makes it better all around.

An area that illustrates clearly established rules and consistent follow up is in the matter of being tardy. Not only has the rule been established but clear consequences have been laid out. As explained by Mrs. Strauss:

A student can't be repeatedly tardy. I stand outside because I am on hall duty, and my rule is that they have to be in their seats by the time the bell rings. Otherwise they are tardy and they have to make up a half hour during their lunch hour. I'm very strict about it . . . a half an hour for every time they are tardy, and I do follow up. I get into a lot of bookwork, but if they know you are going to do it, and if they don't want to waste half of their lunch hour sitting in some room, then they are going to be in their seats by the time the bell rings. And the reason I do it is because when I walk in, I am ready to teach and I want them to be ready to learn. So if I don't want to wait around and say, 'Joe, would you please get into your seat? Johnny, in your seat please?' You know it takes too long, and I don't have the patience for that every day.

Specific instances of enforcement were observed on various occasions. On 2/6/87 a girl came to the door with the wrong book and asked, "Can I get my book?"

To which Mrs. Strauss replied, "Yes, but that is the chance you will have to take. Either marked for a tardy or marked down for coming to class with the wrong book."

Instances of students coming to class tardy without excuse slips were rare. On 3/6/87 the bell rang when the teacher was still out in the hallway. Two students who were out of their seats made a quick scramble to sit down before the teacher appeared. Evidence indicates that Mrs. Strauss did follow up on application of the consequences. Reminders to students to make up tardies were given on March 18th, March 23rd, and March 25th. Additional consequences were added in the event that students did not make up tardies, "If you don't make up these tardies, you will be getting an E on the report card."

Thirdly, Mrs. Strauss monitors the class after instructions are given to insure that directions are followed. For instance, at the beginning of a quiz the teacher would give the direction for no talking and then would stand at the front observing the class for the entire testing period. In all of the six weeks, I was not able to find one student talking during the quiz. Settling the students down for the five minute review, reading, questions, or worksheets sometimes took a few reminders, but Mrs. Strauss would stand and monitor until all were settled, working, and quiet. For example, on March 10th some soft talking started after Mrs. Strauss had given directions for the activity. Her response was, "OK, let's settle down! (Pause) Get busy! (Pause) Shhh...shhh (hands up with palms down, gradually dropping).

Again on March 18th Mrs. Strauss gave the assignment at the beginning of the period. She started out with:

We are still on chapter 26. I'm going to put the questions on the blackboard.
You have until the end of the period to finish. I will check them then.
Questions are to be handed in. Put them on a separate sheet of paper.

She then wrote the following on the chalkboard:

Outline chapter 26, p.160
Vocabulary
Questions 1-6 and 10-22

Mrs. Strauss then continued, "There are a lot of questions. Each question is worth one point. No more talking! I want to see those pencils moving." She watched and waited. When one student begins to whisper she responded, "Mouths shut! Books open!" One girl turned around and Mrs. Strauss responded, "Mary, I don't want to see the back of your head again!" She then continued to watch the class for two more minutes, took roll, and then sat down at her desk correcting chemistry labs. I watched the students and counted 26 students actively working, one spent a few minutes day dreaming before starting, and one pair of girls sneaked a whisper

periodically.

This example is a bit nonrepresentative as normally it would take no more than one statement and one reminder from the teacher for the students to completely settle down. However, this example is used to demonstrate the persistent follow through this teacher uses to make sure that directions are followed and she means what she says. It is also noteworthy that in the eleven weeks that I observed in this classroom, not once did Mrs. Strauss raise her voice. The quiet firm manner of the teacher seemed to set the tone for the whole classroom. The classroom next door, in which the same science class is being taught by one of the coaches, provided a sharp contrast. On March 25th, I worked in the prep room between the two classrooms and had opportunity to view this classroom. Students would walk around during the middle of the period, sit on desks, lounge back in chairs, and gather in small groups for social conversation. This occurred after the teacher had given them an assignment. The teacher shouted continually so loudly that I finally had to close the door to concentrate on the work in which I was involved. In spite of the loud global commands of "Sit down ... get to work....be quiet", the students simply ignored the teacher and continued to relax and do what they pleased.

Mrs. Strauss has the amazing ability to monitor the class and get her work done at the same time. A high sense of organization, combined with a unique "with-it-ness" allows her to continue her own work and supervise the class at the same time. Nothing seems to get past her. She responds to every infraction immediately, no matter how small, whether it is talking, a crack of bubble gum, a watch alarm, or a missing book. The teacher response is specific, directed at the individual involved, rather than globally announced to the class as on 2/20/87. "All quiet! (looking directly at two girls still whispering). Let's act like ladies."

From the beginning I wondered what kind of consequences this quiet lady would use to bring an active high school freshmen class of thirty-three students into such order. Over the period of time the follow-up consequences grouped themselves into two categories, the "regular things" and the "last resort" measures. The "regular things" could again be subdivided into positive and negative reinforcement. On the positive side, Mrs. Strauss gives the students the last five minutes of class to talk and visit, provided they are quiet and work during the period. Her strategy was explained as follows:

I let them have five minutes to talk, their reward for being good little boys and girls. . . You lose that time anyway because they are looking at the clock and say, 'Five minutes to the end of the period. Better start cleaning up.' But I kill that by saying, 'I want you to work and then you can have the last five minutes to talk' and that works real well. They think they are really getting something.

Another positive approach used by Mrs. Strauss would be personal conversation:

I talk to them, kinda on a one-to-one . . . 'You know this stuff, (science) I've been through this. . . if you want to repeat this next semester, or next summer, then you are going about it in the right way.' So I kinda try to have a talk with them personally and try to show them that they should be doing this, otherwise they are going to be doing it again in summer school. (With others) I try to kid around with them and start saying, 'Summer school, Oh, summer school' or 'You don't have anything to do this summer, do you?' (To which they answer) 'Oh yes, I do!' (And to which I reply), 'Oh, you can't have! I mean you are going to summer school.'

As an example of negative reinforcement, Mrs. Strauss uses seating arrangement as a tool for classroom management. On 3/4/87 Jack came over to Ann and commented in passing, "I don't know why she moved me. We didn't talk that much."

Another example of "the regular things" would be writing sentences. As Mrs. Strauss explained:

There have been kids in the first semester that talked an awful lot. I made them write sentences – I will not talk in Mrs. Strauss' class (or) I will not give so and so the finger – . . . and that worked very well. But you have a lot of management then. You have got to remember the next day, 'Do you have the sentences? No you don't! OK, fifty more on top of that!' And then finally kick em out and say, 'You can't come back into class until those things are written!' That takes a lot of follow-up.

Still another "regular" consequence used by Mrs. Strauss is deducting points from cumulative grade total. This is used for students coming to class without their book. Mrs. Strauss likes to deal with discipline herself instead of relying on the administration. But "last resort" measures involve the administration and the parents. In answer to my question, "Do you feel you get administrative support?" Mrs. Strauss replied, "Ya, I do. You see, I don't call for administrative support often. Oh, I think that if they know that, then when I do, they back you. So if I go downstairs and say to Swan, 'This parent really needs to be called in,' they're not going to let him back into the classroom until such and such a parent comes in to talk to me. And he follows up on that." Two instances were noted that Mrs. Strauss had parent conferences at times other than the regularly scheduled times.

Considering all the consequences used by Mrs. Strauss, a varied arsenal is at her disposal, with different consequences for different infractions. Not only do the consequences vary in form, but also in degree of punishment. It appears Mrs. Strauss has set up a system with increasing "teeth" for repeated or continued misbehavior as noted in the sentences, additional sentences, kicked out of class, and parent meeting. .

One response almost completely absent in her repertoire of action is the use of threats. The only recorded instance observed is the reference to students having to take summer school, if they didn't settle down and get their work done.

At the close of this first phase of observation, various questions come to mind. "Is there a relationship between the classroom structure (including teaching style, type

of classroom management, and interactions with students), as rooted in the teaching beliefs of the teacher and the level of new curriculum implementation. For future observations, this question could be broken down into the following subsidiary questions:

1. How does a structured classroom (as in Mrs. Strauss' room) differ from the new activity-based curriculum?
2. Will an activity based program be incompatible with the teaching style of a very structured teacher, and thus make implementation of the new program difficult?

Finally, it must be noted that the system of management and discipline that Mrs. Strauss has refined over her teaching career is consistent with her professional priorities and contributes to the type of learning she believes is most beneficial to this type of student. As previously noted, a high level of on-task pupil engagement is evident. In addition, daily work and test results indicate that her system of work, repetition, and review does teach students what she feels is valuable for them to know. The quiet orderly atmosphere with almost no distractions does allow students to concentrate and finish an amount of work that would not be otherwise possible. The amount of teacher control also provide a safe, secure environment where students do not feel physically threatened. In spite of the strictness of discipline, a warm relationship exists between the teacher and the students. In addition, students have good relationships between one another. Only once during the eleven weeks, did I note a student being unkind to another student. Lastly, and perhaps most important of all, this system of management and discipline allows the teacher to complete her work at school, prepare a store of materials that are reusable, and does not necessitate taking work home. Mrs. Strauss has combined an organized system of class

management and discipline to bring a high degree of order to her classroom and feels that for her, "This is a system that works."

BRING IN THE NEW PROGRAM?

The last section gave a detailed description of existing circumstances in Mrs. Strauss' classroom at the time of my entry into this setting. An additional attempt was made to analyze the components that contributed to the structure, organization, and order in this classroom. In this section, an attempt will first be made to show how the existing system of classroom operation differs from the design of the new activity based unit *Wheels*, and then describe what happened when the new unit was introduced into Mrs. Strauss' classroom.

Contrasting a Textbook Based Program and an Activity Program

An analysis of the textbook approach to teaching as observed in this room and an activity approach to teaching as planned in the technology course results in the following point to point comparison given on the next page in Figure 5-1.

New Wine in Old Wineskins

The time finally arrived. On Thursday, February 26th, Mrs. Strauss indicated that tomorrow she will introduce me and the curriculum materials to the students and on Monday will be starting the new unit *Wheels*.

The First Day with Wheels (2/27/87)

As I arrived at 12:50 P.M. on Friday, I noticed that the teacher had stacked the packages of project materials on the front student table beside the demonstration desk. I counted 56 sets of materials and then asked the teacher how many students she had in the two sections. She informed me she had 32 students in 6th hour and 31 students in 7th hour, making a total of 63 sets needed. Examining the materials, I

Table 5-1: CONTRASTING A TEXTBOOK-BASED PROGRAM WITH AN ACTIVITY PROGRAM

Text-book Approach (existing program)	Activity Approach (new program)
Students do not need to talk The room can be very quiet	Students need to talk, but may also talk about other things.
Students need to read well enough to understand the text	Students need to be able to read directions to do the activity.
The only materials needed are the text, paper, and pencil	Students have materials and may fool around and misuse them.
Few materials are needed except for an occasional demonstration	The teacher needs to prepare materials ahead of time and will most likely have to put in extra time
Easy for the teacher to monitor All students remain in seats and can be working quietly	More difficult for the teacher to monitor. More noise and movement makes it harder for the teacher to spot irregularities
The class usually remains quiet throughout the period	Noise tends to build during the course of the period
Teacher can complete her own work during the period while students are quietly working	Teacher has difficulty completing her own work as additional monitoring is needed and students need help with equipment and procedures.
Low level of preparation allowing the teacher to complete all work during regular school hours	Higher level of preparation requiring time after school and at home.
Lessons can be reduced to a progression of routines that allow a standardized and repeating set of procedures	Since student involvement activities are not easily reduced to routines, standardized procedures are difficult to establish

noticed that one set was the student materials and one packet was the Teachers Guide Book for *Muscles and Bones*. My concern increased as I quickly calculated that we must be short nine sets of student materials.

After roll and announcements, the teacher turned to the class to say, "We are going off the beaten path for a while. Mr. Liske will tell you about some special materials developed at the university. Mr. Liske!"

I explained to the class that the new materials were written by teachers from three school districts in this state and would fit right in with the material they are now learning. These materials were trial editions and we needed their help to find the good and bad parts before we wrote the final edition next summer. I read and explained the letter to parents, emphasizing the confidentiality and the freedom to withdraw at any time. Special note was given to the form that they were to have their parents sign so I could use their work and interview them on tape.

Mrs. Strauss then interjected, "If you want your opinion to count, get these letters back by Monday."

As one of the girls sitting at the student desk was sorting through the sets of new materials, she suddenly held up one packet and said, "Look, this one is smaller!" I took the packet and noticed it was the Teacher's Guide Book for *Wheels*, unopened, still in the shrink-wrap plastic. I handed it to the teacher. Obviously, she hadn't looked at the material up to this point. I wonder, "Will she be ready to teach this new material by Monday?" During the remainder of this period, the teacher passed out the new packets to the students and had them write a quiz.

Lack of preparation and advance thought created another difficulty. The teacher passed out the student materials, which were bound in shrink-wrap plastic. Each student had a stack of loose typed pages approximately 1/2 inch thick. The

teacher noticed the problem and left the room to get some fasteners to hold the pages together. Upon her return the fasteners were placed into the materials, only to discover that about half of the materials did not have holes punched in them.

Seventh hour was basically the same except for Mrs. Strauss' introduction, "After today, we will not be using our books for a while. We will be using these packets starting on Monday. You will be graded on the questions. I will probably be making up some extra sheets."

The first day with the new materials already raised some questions. Will Mrs. Strauss be willing to put in extra time (probably beyond the school day) that will be needed to make the new materials a success? More specifically, extra preparation will most likely be required in:

- 1) Studying the new activities ahead of time to be able to give clear directions to students.
- 2) Finding and organizing the lab materials ahead of time.
- 3) Actually doing some of the activities ahead of time (to work out the bugs as the activities are adapted to local available equipment.

A second possibility existed. Perhaps Mrs. Strauss can again reorganize the school day and structure the class to accomplish the above without staying after school or taking work home? So we wait for Monday to find out!

Second Day with Wheels (3/2/87)

As I arrived at 12:50 P.M. on Monday, Mrs. Strauss was standing at the teacher's desk, leaning over the Teacher's Guide Book with paper clips and a tongue depressor in hand, and a quizzical look on her face. She indicated difficulty in putting the rubber band scale together, especially determining where the knot on the string was supposed to go. I took the parts and demonstrated them to her. The bell rang

and students began to enter as we finished up the scale.

After the usual roll, announcements, and returning of papers, the teacher began, "Take out your booklets. Some of us are short. Look on with your neighbor. This lesson starts with page S-1. Please read S-1, and then we will have the pre-assessment test." Students read quietly and then worked on the pre-assessment test.

After ten minutes, Mrs. Strauss continued, "How many people are done? Turn to S-3. Outline this reading in your notebook, then answer the questions below it. Entitle your notebook Unit 1." Students got paper from the front and worked quietly. While the students are completing the outline and questions, the teacher cut the string into measured lengths, and passed out string, tongue depressors, paper clips, rubber bands, masking tape, and an empty envelope.

A level of previous preparation on the part of the teacher is noted. She did have the necessary materials gathered. However, it was also obvious that she did not try to make the rubber band scale ahead of time, depending on lunch break to quickly try to put one together.

The familiar sequence of read, outline, questions, and notebook is beginning to appear. Will the cycle of lesson progression be carried into the new materials? Will the new materials be adapted to fit the established routines and mode of operation. The comment, "I will probably be making up some extra worksheets", almost suggests so.

A continuing concern of mine as a writer was whether the directions in the material are clear enough for the students to work by themselves. I question Rose, "Are the directions clear enough to figure out what you're doing if you work from the reading alone?"

Rose answers, "Yea!"

As writers we had also placed a concept map into the introductory pages to interrelate various concepts. The intention was for it to be used in an introductory discussion. I was curious if students realized the purpose for this diagram and asked Rose and Lynn, "Do you know what this is about?" (pointing to the diagram).

Both answered, "No."

The teacher announced the next set of directions,

"If you're done, sit nice and quiet please (pause). I want you to turn in your booklets to S-9, Doing an Experiment Measuring Forces. You will make and calibrate a scale. Put your names on the envelopes. You will use these to keep your materials in."

I picked up a set of weights and gave them to Rose and Lynn and asked them to continue to see if they could calibrate the scale from the printed directions. They continued to work and accomplished the task.

A restlessness generated in the class as a few students had difficulty putting the scale together. Three hands went up, and students called for help. The teacher responded, "Try using the diagram in the book!"

The teacher went into the storeroom to get the weight sets. While the teacher was in the storeroom, Morris scooted to the front, picked up the teacher's demonstration scale and slipped back to his seat. The teacher returned, looked for her scale, spotted Morris with it and said, "You're supposed to use the diagram in the book!"

Morris answered (pointing to me), "That man helped you make it. You didn't make it by yourself."

The teacher walked around the room and showed students the demonstration scale. While the teacher was in back of the room, one table beckoned to me for help.

I motioned them over to my desk, gave them a hint and they finished the scale. Noise was on normal conversational level. The teacher continued, "All right now, step No. 2. You are going to calibrate them. First, you are going to make a zero N. Take a pencil and mark zero at the knot. A student called out, "Zero N what?" (The question is misunderstood, ignored, or not heard by the teacher. Other students are also talking simultaneously)

Teacher: Knock it off! (firmly) Going to do 50 grams. Where it stretches, put 50. Then put a 100 and where the knot meets the tongue depressor, put 100. Then put the 200 on the scale and repeat the above.

Student: Can't do it, Mrs. Strauss. (With the 200 gram weight the knot went below the bottom of the tongue depressor.

Teacher: If the 200 doesn't work, hook up a 100 and a 50 to make 150.

At 1:45 P.M. the teacher begins to gather the weights. The noise level is rising. The teacher responds, "Heh, folks!" and the room quietens down again. One student is surreptitiously eating potato chips and one points a rubber band at another student and stretches it back.

The teacher concluded with, "Now listen, I want you to put these in your envelopes, and I will come and get them. Put the hour (class period) on the envelopes also."

A number of developments can be noted during this period. The noise level of the class has risen above previous levels and increased more as the class continued on into the construction activity. Secondly, the teacher did show creativity, organizational skill, and forethought in using the envelopes to collect and redistribute the materials. Thirdly, the fact that the teacher did not do the activity ahead of time caused a problem with the 200 gram weight going off the bottom of the scale. However, the teacher fielded this quirk gallantly with a creative suggestion. It is also noteworthy to see how the students immediately begin to take advantage of a situation as soon as the operating rules relax (eating the potato chips). It is also interesting how quickly the students realize inadequate preparation on the part of the teacher, and will

immediately capitalize on any insecurity or hesitancy.

The Third & Fourth Day with Wheels (3/4/87)

It is now Wednesday. As I arrived at 12:55 P.M., I wondered what happened yesterday with the new unit, so I casually ask Rose and Lynn, "Well, what happened yesterday?"

Lynn answered, "Well, I babysat."

To which I countered, "I mean, what happened here yesterday?"

Lynn answered, " We worked out of our books. We made an outline and did the questions."

At 1:04 Mrs. Strauss handed out the envelopes and the following interchange took place:

Mrs. S: Turn your books to S-4 (pause). Sorry, wrong page. Turn to S-10 (murmur among students). Shh .. Answer questions (pause) you will measure something at your table (pause) Anything you can use - watch, keys. (Mrs. Strauss goes to the desk, sits down, and begins correcting papers. Students begin working quietly.

Mrs. S: Answer all the questions - quietly!

George: How many objects?

Mrs. S: (without looking up, holds up two fingers). (Lynn and Rose measure a watch, and a notebook. The notebook stretches the rubber band off the scale).

Mrs. S: Do your objects twice to see if you get the same.
(She passes out the rulers and then the 200 gram weights. Robert pulls back the scale, shoots himself in the finger, and grimaces).

Mrs. S: OK, your attention! (Keica tosses purse across to Holly) You hopefully have finished A through E. Please turn to page 11. The purpose is . . . (reads from the pupil text) . . . You will need this equipment - a length of string tied in a loop (pause) Oops! (Students begin to talk). I think you can use the string on the scale (with a note of hesitancy - then as student talking increases) Pl.e.e.ease!! Mr. Trellis, where did I say the pencil should be?

Mr. T: Right where you said (Students laugh).

Mrs. S: (Sharply) Do you want to put this all away and go back to reading your text? (teacher holds up the scale and shows where to place the string) You are going to estimate (pause) going to do this twice (pause) obviously.

The only thing that is very obvious in this situation is that the directions are not clear in the mind of the teacher. The question that needs to be answered is whether the source of confusion is a lack of clarity in the materials or a lack of preparation on the part of the teacher? I again turn to the two students sitting on the same table as I have been sitting and note that they too are having difficulty knowing what to write on the chart on page S-11. I ask the two girls where the fulcrum, resistance, and the effort are on the setup. They both shrug their shoulders and give a bewildered look. The directions that seemed so clear to the writers are not clear to either the teacher or the students. Identification of missing concepts and sequencing of instruction will need to be clearer in the teacher's manual.

The teacher is now standing in front of the room reading the student materials trying to figure out what to do. I begin to walk around the room. Larry comments, "I had to show her how to do it! Seriously."

Mrs. Strauss retorts:

You should have been able to figure this out from your reading yesterday. (She now explains fulcrum, force, and resistance, and then finishes with) You should have deduced this from your reading yesterday.

It became very obvious that the directions were not clear in the mind of the teacher. The time spent pouring over the teacher's guide book, the grim smile (with pursed lips), the pauses, and completely changed the tone of the classroom.

Whereas the classroom formerly had been almost absolutely quiet, with a security of complete teacher control, the students immediately took advantage of the confusion and inattention on the part of the teacher, and used this time to make quiet remarks to

one another.

Now for a fast extraction! Mrs. Strauss directed the students, "Turn to page 5. You will be reading about the wheel. Outline and answer the questions as you go. Do the questions right in your booklets."

I walked around the room and looked at the student booklets. Four groups did not have the blanks filled in. About five tables had the material partly filled in. Only two tables (of the ones I observed) were on track. On page S-6, about one half of the books were almost completely blank, and the others had nonlogical answers. No more than one fourth are correct. As I examined the teacher's guide book, I noted that it called for one weight. The student materials called for three weights.

These examples indicate that the teacher was not familiar with the materials and had not read either the teacher's manual or the student materials before beginning to teach the unit. (Both the student materials and the teacher materials were unopened in the shrink-wrap plastic on the first day of the unit). The hesitancy and mistakes in giving directions was completely out of character when compared to previous lessons from the IIS text with which the teacher was familiar. Here directions were clear, concise, and well thought out ahead of time. The final affirmation of this assertion is given in the admission by the teacher that "I haven't really looked over this stuff yet."

A level of preparation is also indicated by how well the teacher prepared materials ahead of time. To begin with 63 copies of student materials were needed, but only 54 were on hand at the time the unit was introduced, February 27th. These materials had been made available to the schools in October and agreement to observe in this particular classroom was reached on January 13th. Both of these dates would have allowed adequate time to duplicate more copies if a simple count had been

made. The feelings of the teacher toward the additional time needed to prepare materials was expressed in an offhand comment the teacher made to another teacher who had dropped in for a few minutes after school, "Setting up these experiments is really the pits. It took me all of my prep period yesterday to get all of this stuff together, and then my hands were filthy."

This point marks the beginning of the end for the new innovative program. From this point on the teacher began to use more and more material from the regular textbook so that by March 18th the new materials have been completely abandoned and instruction was totally from the regular textbook (IIS materials) used at the time of entry. The period ended and I stayed to see how things will go with the seventh hour just coming in.

Mrs. Strauss began, "I want you to listen. First thing you are going to do is turn to page 10, please. The teacher now demonstrated the ruler setup on the demonstration table, explaining where the force, fulcrum, and resistance is. Directions are now clear, sequential, and logical. The students worked with much less frustration.

I left the room at 2:25 P.M. On the way out I ran into Mike Evans, the departmental chairman and asked if we should expect the written materials to stand on their own, with the students being able to follow all procedures from the written instructions.

Mike nodded, "That is what we have to shoot for!"

I explained how Mrs. Strauss had some trouble with the directions as she had not done the experiment ahead of time and ask, "Can we expect the teachers to do all the experiments ahead of time?"

Mike's answer, "Realistically no."

During the course of this study, it becomes evident that project writers had a certain set of routines and assumptions which were unknown to the teachers involved in the trial testing of these materials. Routines the writer teachers do naturally and take for granted were not adequately explained in the new material and the trial teacher got bogged down in little details. The next day will provide an excellent example of how these little details can be very frustrating and cause a teacher to abort a program before it has a chance to get off the ground.

Day Five – A Tiny Hole Kills a Class (3/5/87)

I arrived at 1:55, just before the beginning of the 7th period class. The teacher was at the door, and immediately took me over to the pulley system she had set up and showed me how she had trouble with it (the string would slip), and consequently the experiment was not done during 6th period.

I examined the pulley system (actually a wheel and axle) and found small holes into which the string could be knotted to prevent slipping.

Mrs. Strauss began class and gave notes on the six simple machines, talking while writing on the chalkboard. The class atmosphere is very quiet again today. No talking, all working. After the lecture, the teacher passed out two prepared review sheets. While the students were working, the teacher came over to my desk to chat, "I am really glad to have a day in between. The students really needed a day to settle down. Answering questions at their desk really helps to keep them quiet."

The preceding provides an interesting example of the teacher returning to the style that is most comfortable and to a situation providing for the easiest class control. Mrs. Strauss indicated that it was good to be able to have a study session again as it "really helps to quieten the students down." Additionally, she did have notes prepared

summarizing the material for the lecture. Were these already prepared from previous instruction with the IIS program and indicate that she planned to revert to the previously used adopted textbook?

Day Six – Try it Again! (3/6/87)

The period begins with a printed, duplicated test on machines from Prentice–Hall, publisher of IPS. After the quiz, a review sheet is distributed and then directions are given for the pulley experiment. The directions are much clearer today, but the students still had great difficulty doing the exercise correctly. Should there have been a discussion of the parts of the setup, identifying the effort, the resistance, where the force scale should be, and how this machine really changes force for distance? Mrs. Strauss comments on the incapability of these students to handle experimental work profitably, "They just don't follow directions. It seems like it just goes in one ear and out the other."

Day Seven – Interim (3/7/87)

We as researchers were on present at school on this day. The students completed the selfassessment quiz and the generalizing experience on page S–19 of the project materials.

Day Eight – The Usual Routine (3/10/87)

The students read and outlined pages 1–3 and 8–10 in the project materials.

Day Nine – Time Out, A Movie (3/11/87)

Day Ten – The Last Lab (3/12/87)

Another measure of adequate planning for the new program is the necessity for the teacher to actually do some of the activities ahead of time to allow a precise understanding and make sure that the directions given will permit the equipment to work. In this classroom, few to almost none of the activities were done ahead of time.

The calibration of the rubber band scale illustrated two points. First of all, because a variety of materials, like rubber bands in this case, need to be individually adapted to the situation, each experiment should be done ahead of time by the teacher.

Secondly, it indicated that the teacher had not tried to make the scale ahead of time, or she would have known that the 200 gram weight would stretch the rubber band below the end of the tongue depressor.

The consequence of not trying out experiments ahead of time was again demonstrated on March 12th. The teacher had decided to give a demonstration with the materials instead of having the students do the activity. The lesson proceeded as follows:

Teacher: (firmly) Ladies and gentlemen! (pause) We are on S-4. I am going to read this introduction to you. (Teacher reads the page and points to the parts of the pulley system that had been set up for the demonstration). You will be watching this wheel (points to wheel) and counting as I turn this wheel (points to wheel A). On wheel A, I have the string on the outer ring, which is number 1. On wheel B, I have the string on the inner ring, which is wheel number 4.

As the teacher was trying to demonstrate, the entire setup tilted inward, the strings slipped, and the other wheel did not turn at all. The students laughed, and the teacher looked embarrassed.

In the above instance, the teacher had the ring stand facing outward (the wrong way), and so was not braced, and as soon as some force was placed on the system to make the wheels turn, the entire setup collapsed inward. Had the teacher tried this ahead of time, a simple adjustment could have saved the day.

This demonstrated the impact of lack of advance preparation and further affirmed the position taken by the departmental chairman that we cannot assume that teachers will do experiments ahead of time.

The teacher's perspective on doing labs ahead of time was received in a

conversation on March 16th in which the teacher stated, "I really don't do as many labs as the other teachers. I just don't get around to doing them ahead of time. Some of the teachers do an awful amount of labs. A person has to teach them something too" (meaning give them some information).

The lack of materials caused schedule changes and in the long run contributed to reverting completely to the old textbook. For instance on March 23rd, the following conversation was recorded:

Interviewer: What constraints hamper the use of these materials?

Teacher: Well, we don't have all the equipment. Like today, I was going to do the little steam engine, and of course I didn't get all the materials. We don't have scissors, so I have to put that off for another day. Um . . . a lot of it has been the use of the equipment. A lot of stuff the physics department has, but our particular section of this department doesn't have it, so we have to beg, borrow, and steal. That all takes time, and it takes time to set up and going to find it.

Looking Back

During the past weeks we observed the attempt to fit a new curriculum into the routines of a management structure designed to control students and maximize teacher time efficiently. The new wine (new program) did not fit into the old wineskins (structure). Consequently, during a period of two weeks, from March 3rd to March 16th, Mrs. Strauss gradually began to incorporate more and more material from the IIS textbook, so that by March 16th, the class was once again using material exclusively from this textbook and again following the lesson progression of read, outline, questions, lecture, review sheets, and quiz. In reflection it seems clear why this teacher is reluctant to give up the traditional structure. Accumulated data seems to suggest that this system of classroom management and organization is a means of coping with a difficult teaching situation. It provides classroom control and with it a measure of security. It means less work as she makes it work for her.

Moreover, the established management procedures and lesson progressions have, in her perspective, brought a degree of success in the management and control of students, historically considered unruly and difficult to manage. From a pedagogical point of view, the lesson progression previously described has some built-in strengths. The sequence places a heavy stress on repetition and review, which means the students do acquire a chosen set of facts and some basic skills (like organization) the teacher selects for them and wants to stress. On various occasions I tabulated oral answers given by students while worksheets and review sheets were being orally corrected. For instance, on February 20th, twenty students out of twenty seven had correct answers, two had incorrect answers and the rest said, "I don't know!." Again on February 26th, twenty three out of twenty seven students had correct answers, three were partially correct, and one was completely incorrect. Thus, even though these students are the lowest track students in this high school, they are able to decipher the written text, take notes as the teacher directs, and express answers in acceptable form.

On the other hand, the particular lesson progression and style of teaching depends heavily on students working alone in their seats, with almost no class discussion, no student initiated questions, or student to student interaction. During the course of these first six weeks, only two lab activities were completed by the students. Thus while students are acquiring facts and some concepts, are they actually developing the ability to process information, use the information to solve problems, and transfer it to other situations?

TEACHER PERCEPTIONS AND BELIEFS

The style of teaching and structure of the classroom will be influenced by the teacher's views of teaching as a profession, by the teacher's perception of herself as a

teacher, her perception of the students she teaches, and finally what she believes is effective in teaching this group of students.

First of all, Mrs. Strauss sees education as a profession with misplaced priorities and resources. She shared her feelings by saying that:

all our resources from the (Federal) government and from the state are going to the low level student. I feel that is a mistake. They are not our future. Our future is in the middle and the upper (students). They don't seem to realize that and they are pouring all this money into the low level kid and they are not getting very much back for it. You know they think they are saving ... souls.

Mrs. Strauss sees herself as most effective teaching higher level classes. As she explains, "I'm not a low level type teacher. If I had my druthers I would teach all chemistry and advanced classes. I like IPS too. . . This morning I had a class on radioactivity, and I talked almost the whole hour and the kids were loving it because they love to know about radioactivity. They were enjoying it, and then my chemistry class on solutions. So I lectured on that, and if I can lecture and know that kids are learning and understanding and I get feedback, then I'm having a good time. . . that's the fun part of education. But try to drag it out, that's the bad part, and that's what you have with the lower level classes.

Management and control of students is a high priority to Mrs. Strauss. As a teacher, she wants the students to know that she considers time in class as "all business . . . I want them to know that I am the teacher and they are the students . . . even though outside the classroom it is a lot friendlier than that." Mrs. Strauss sees herself as uncomfortable with a looser, more relaxed classroom, saying:

if you are the kind of person .. that is comfortable, ... can work with that kind of ambience in your classroom (kids bring in pop, sit around talking), then my way will not work for that type of person. ... So right at the beginning, you have to be strict.

The teacher's assessment of the present status and future potential of a student will have an impact on both the teacher's attitude toward teaching that student and the mode of teaching used in teaching that student. Thus, we next consider Mrs. Strauss' views on the students in her room. Students are characterized as unwilling participants in the educational process who don't care, won't work, are bored, can't read or follow directions, and are incapable of understanding much of the material. In the words of Mrs. Strauss:

"They don't want to be here, they don't want to learn, not even the fun stuff. . . Even the biology part, they'll do that but they won't understand what they are doing . . . and they don't have the capacity for enjoyment (in learning) like the upper classes do. . . This group wants to be entertained – doesn't want to do any work. You give them something you think is fantastic (like the moonwalk movie we had yesterday) and look at them – half of them are sleeping! It is very difficult to get a reaction out of them that makes teaching worthwhile. It is difficult to get any type of feedback from them. Nothing really excites these kids except TV." Mrs. Strauss does not see any future scientists coming from this group.

As will be demonstrated, these perceptions and beliefs about students are grounded in experience and classroom reality. For instance, the belief that students "don't care" is rooted in a multitude of things from the lack of effort to their level of cheating. In the discussion on the use of the cover sheet, Mrs. Strauss explains:

The low level kids usually don't care enough to cheat. It's really pathetic to have to say something like that, but they will if given a chance ... but cheating is a very big problem, and it is worse in the higher (level) classes, like in chemistry.

The difficulty most often mentioned by Mrs. Strauss and a source of frustration is the inability to follow directions. A series of events occurring during the implementation of the new "Weather" unit again illustrated how a belief is grounded in classroom experience. In the density experiment on 2/12/87, the students had difficulty figuring out how to get the mass of water. Before the class the teacher had predicted they would have trouble, and after class shared her frustration at working

with this group (not able to follow directions). After experiments on 2/19 and 3/6, at which time the students again had difficulty following directions, Mrs. Strauss commented on the incapability of these students to handle the experimental work profitably, "They just don't follow directions. It seems like it goes in one ear and out the other."

When directly asked, "How do students perceive activity or lab time?" Mrs. Strauss answered, "A time to goof off – a nonworking time ... even have that in chemistry."

Not only are the students viewed as incapable of following written directions, but are also viewed as unable to focus long enough to conduct a profitable discussion. In answer to the interview question, "What happens when you have a discussion with this group?" Mrs. Strauss replied, "They get carried away, or a few people will get involved and the rest are just dead. One person will have all the answers and the rest just don't know a diddle.. Thinking is not their forte."

A series of statements and classroom observations can be linked together to demonstrate how a foundational belief of the teacher carries over into classroom management and into teaching methodology. In a casual classroom conversation on 2/6/87, Mrs. Strauss (who has been collecting notebooks) makes the following comment, "The key (to learning) is being organized." Mrs. Strauss not only demonstrates this in the management of her own personal time (as illustrated in the chronological record), but also believes this for the students. She requires them to outline almost every chapter as part of a reoccurring teaching routine (assignments from March 2nd, 3rd, 4th, 10th, 12th, 16th, 18th, 23rd). Moreover, she requires a notebook as a means to help students select important ideas and review them for quizzes. To emphasize the importance of notebooks, she collects and grades them

and sometimes allows the students to use notes on a practice quiz (See 3/6/87). Mrs.

Strauss views these students as incapable in many respects:

There is much about this group that is very irritating. There is such a large range of intelligence – from the kid who should be in biology, to some who can't read, to the ones who won't read. I wonder if it is too late already for (learning) reading. There seems to be a certain time span, and if they don't get it in then, it seems they never get it.

I asked if it is realistic to try to write materials for this group to operate from written instructions alone?

Mrs. Strauss answered, "No, I don't think so. . . usually I prelab the lab, demonstrating how to do it. Even then the problems are numerous. . . Even with me going through the lab, they just get tuned out."

When asked about the choice of topics that may interest these students, Mrs. Strauss replied, "Everything, as you know . . . is boring.. . . How can we peak their interest, because you can't."

A sense of resignation permeates the attitude of teachers who feel that additional factors out of the control of teachers impact these students. As stated by Mrs. Strauss:

The hardest thing I found, in my teaching career, has been the administration. ... Sometimes you need backup. And getting that backup is sometimes difficult. That's about it! I think that is the hardest problem in education. Of course there are other things, minor things, like the kids don't want to do their work, and it all leads back to home life ... and I don't have control over that. ...Nothing really excites these kids except TV. This group does not want to be here... they are required. The kid in the back with the Western jacket, Alan Stamm, really a bright kid. At parent interviews, the father told me that all he does is watch TV. Guess what he watches? Not sports. Just cartoons.

Considering the difficulties in teaching this group of students, I was interested in what approaches Mrs. Strauss felt were most effective in working with this type of student. In answer to my question of "What do you think is most effective with this type of class?" Mrs. Strauss answered, "Bookwork, worksheets, writing assignments . .

. For this group the hands-on approach should be the best, but I don't see it for this group."

One of the assumptions of the writers of this program, also supported by research (Anderson ,1987 and Tyson-Bernstein, 1988) is that science textbooks do not present enough depth of material and the material is presented in segmented short units. This is substantiated as a belief of Mrs. Strauss with her comments on the textbook, *Investigations in Science*:

The Wong book. It's OK. The tests are bad. The multiple choice sometimes has more than one answer that they can choose from ... I'm not really satisfied with it. But it is very difficult to find something at this level for these kids. Ah ... some of the chapters are too short ... the labs are not very interesting ... What I think they (students) liked about this book was that the physical science is separate from the biological science ... and as it supposed to be. I do, you know, ... like the way the chapters are set up. I do like the vocabulary at the ends. They can work on that. Ah ... but you have to have a lot of extra stuff with it. There is not enough material to go with it for you to run a classroom ... and I mean, for every chapter I have review sheets, and dittos that I have made up. So it takes a lot of time, you know, an effort to get all that stuff made up, because on some of those things the kids need repetition.

Although some of the dissatisfaction refers to the lack of content and the segmentation of content, Mrs. Strauss also looks for more supplementary teaching materials to make her job easier, especially in providing for the kind of repetition she builds into the teaching regimen to bring a degree of success to these students.

Referring to the "Wheels" unit, she continues:

I'd say it needs a lot, a lot of work! Mainly because it doesn't gave enough things to do for the kids. You've got a lot of experiments in there, but we've already talked about what I think of so many experiments for this age group, or for this level. I think there are too many (experiments) in that unit. What I think they need is repetition. I should say, Um, I think there is one problem in there on work and they need a whole slough of them ... let's see ... they need more writing work, more problems, more questions, review sheets, um ... It's too loose a program. I am very much into discipline.

This section gives verification of the assertion that the pedagogical approach used by a teacher is to a great degree impacted by the class management system the

teacher has found to be workable for their own individual teaching situation. Her last statement about the program being "too loose" is directly connected with her approach to discipline. Moreover, Mrs. Strauss does not see lab time or activity time as profitable for these students. As she explains, "I really don't do as many labs as the other teachers. I just don't get around to doing them ahead of time. Some of the teachers do an awful lot of labs. A person has to teach them something too."

An informal comment during class by Mrs. Strauss supported the assertion that seatwork can be used to control the students:

Really glad to have a day in between (experiments). The students really needed a day to settle down. Answering questions at their desks really helps them to keep quiet. Those kids don't really understand what is going on in these experiments. They just go through them.

Casual conversation after school between Mrs. Strauss, Louise Adams (a fellow teacher who walked into the room), and myself indicates that setting up labs is considered to be an additional burden and created difficulty in proper implementation of the unit. Speaking to both of us, Mrs. Strauss commented: "Setting up these experiments is really the pits. It took me all of my prep period yesterday to get all this stuff together, and then my hands were filthy."

Evidence also supports a proposition that the content of what is taught is somewhat determined by a combination of what the teacher believes these student need and the work requirements of her own and the school testing program. In reply to the question, "In designing a curriculum, what do these students really need to be successful in life? Mrs. Strauss answered:

I think the angle that it should be approached from is not from how we can peak their interest, because you can't. You know, I'm not saying for everybody, but I'm saying for a group ... um ... the things that they really need to know ... some discussion on matter ... energy. I think work and simple machines are important, and I think geography, and a little bit of weather, some that really pertains to their daily life.

The impact of testing and extra school time needed for quarterly grades can be illustrated. As I arrived on the afternoon of March 16th, Mrs. Strauss explained, "Didn't tell you we are going to work from the textbook today. . . it covers pretty well the same stuff as in your units. Besides I have to get them ready for the final test."

Curious I asked, "Is that the MEAP test?"

The answer, "No, it's the test I wrote. I just don't want to rewrite the test."

Serious consideration of the beliefs and perceptions of Mrs. Strauss reveal that they are very consistent with her teaching style and method of classroom management. When a teacher does not believe that experimental work is profitable in the education of a student, the likelihood of student involvement in this type of activity is not too great. When a teacher believes that class discussion only involves a few students and the rest "check out", little meaningful discussion will take place in the classroom. When a teacher believes that these students are mentally incapable, little time will be spent on individual research, project planning, data analysis, data interpretation, and validity of conclusions. I believe the evidence strongly suggests that teacher perceptions of students (most of which is based on past experience) determines the classroom management system (a structure), which in turn determines the teaching methodology, which in turn will be one of the greatest factors in the implementation or abandonment of a new curriculum. It was only a matter of time until the type of instruction in Mrs. Strauss' classroom would adjust itself to again fit with her perceptions and beliefs.

The story of this chapter gives some insight into the problems facing implementation. In attempting to bring about significant educational change, modern researchers are beginning to realize that simply devising new curriculum, various teacher training programs, and increasing teachers' salaries alone will not be

sufficient. The structure of teaching as a profession needs to be changed to allow the teacher to develop as a professional. Faced with inadequate preparation time, isolation from colleagues during the day, and lack of control over many aspects of their professional lives, teachers respond in ways that allow them to cope with existing circumstances.

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CHAPTER SIX – DATA FROM CRANSTON HIGH SCHOOL

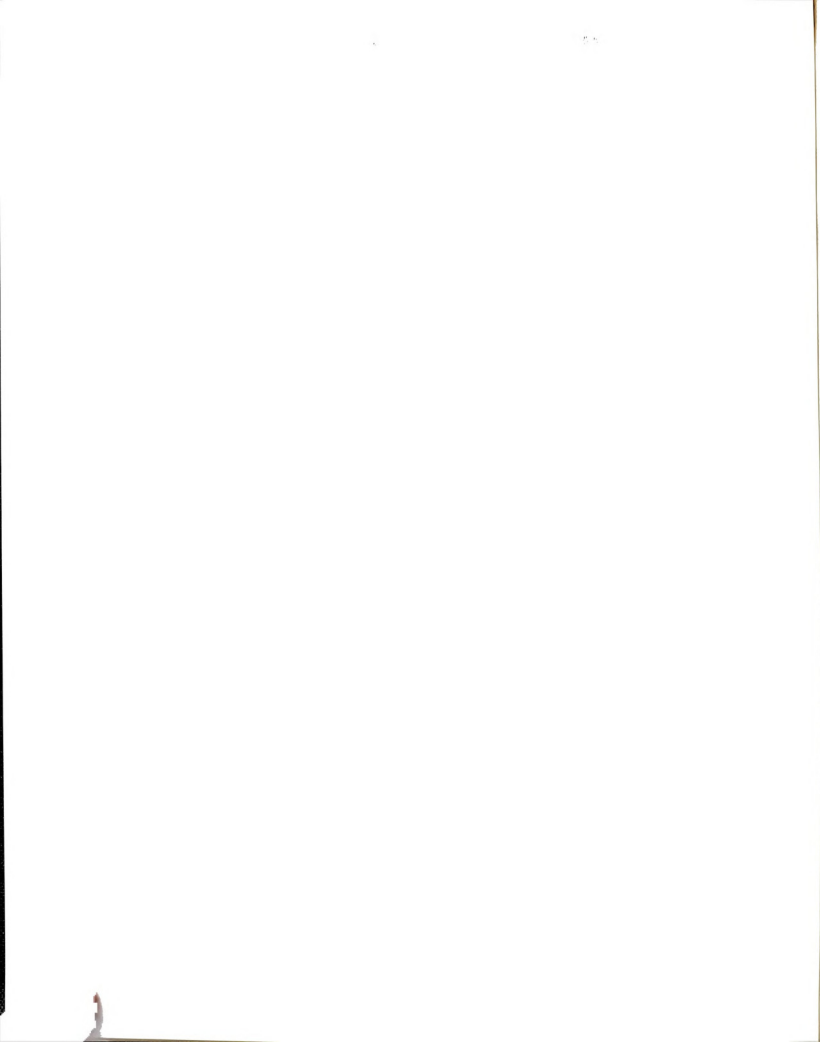
AN UNPLANNED INSIGHT

This chapter comprises the data section on Cranston High School and will first detail classroom circumstances present upon entry into the classroom in October of 1989, including classroom atmosphere, student population, teacher characteristics and various routines such as classroom management and instructional procedures. The first section will deal with Main Research Question Number One: What classroom routines and modes of teaching are in the established repertoire of the teacher at Cranston High School that will affect the implementation of a new curriculum?

The second part of this chapter will describe the response of the teacher and the students to the introduction of the new technology unit, "Weather". This section will address the Second Main Research Question: How is the new science\technology curriculum viewed and used by teachers and students in the implementation phase of development?

The third part will record some of the changes in teaching methodology that were used to bring about constructive changes in both the teacher's perspective and the students' attitudes. This section will describe material pertinent to Research Question Four: What strategies can be used to change teacher behavior from traditional teaching approaches to student-centered activities as suggested in the new curriculum?

The last part of this chapter will contrast the beliefs and attitudes of the teacher and students at the beginning of the study with those toward the end of the study, dealing with Research Question Number Three: What factors influence teachers' and students' views and uses (or non-use) of a new curriculum?

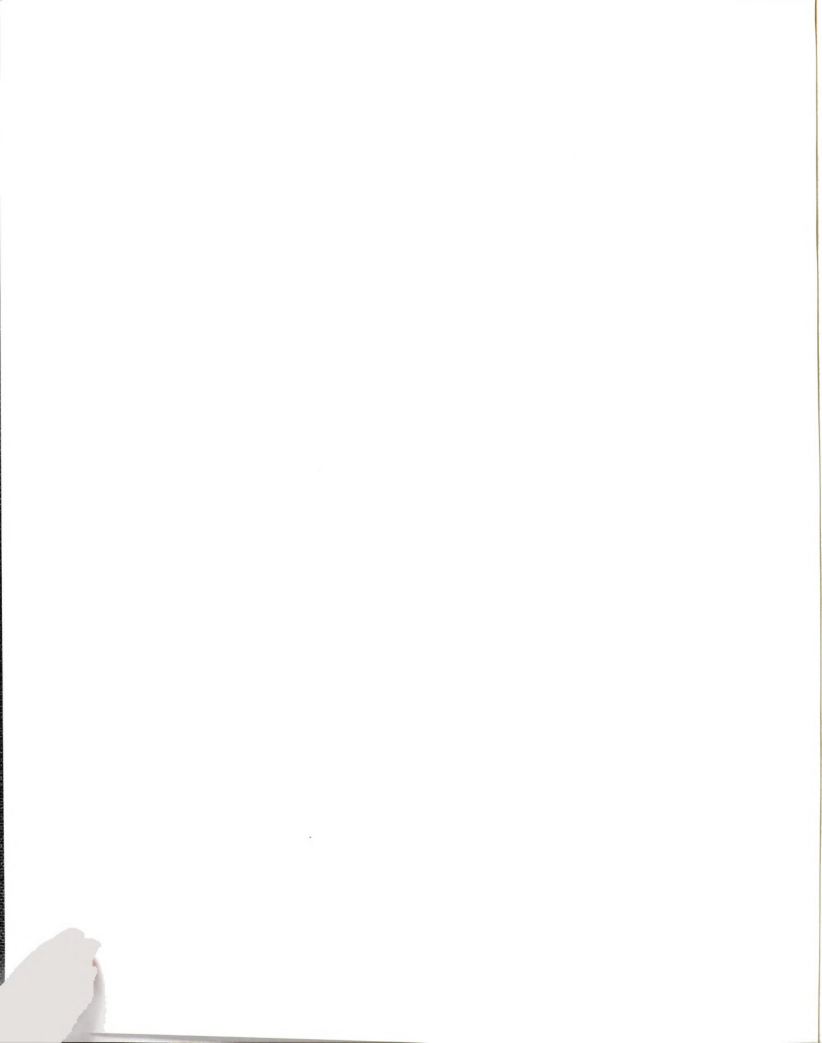


Another Study

Since the trial run of technology materials at Western High School in the spring of 1987, the materials were revised and implementation plans devised. Part of the implementation plan included researchers working with teachers to assist in incorporation of these materials into the curriculum and to assess the acceptance of the materials by teachers. Moreover, a second study was needed to determine if the substantial modification and abandonment of materials observed in the first trial runs were related to design deficiency of the materials or due to the beliefs of teachers and the established classroom structures tied to these beliefs.

After the marginal usage and radical adaptation of the "Weather" Unit at Western High School and a partial trial run at South Central High School, I was looking for a site that would give this unit a fair chance to test its worthiness. As one of the writers, I was anxious to see what would happen in a classroom if the materials were taught as initially intended. Would the new content capture the interest of these students? Will the group strategies actively involve the students in the process of learning? And so in the spring of 1989, we began a search for schools and teachers to trial test our units and to develop a research basis for some of the assumptions and strategies placed in the new technology units.

Getting Started – It was not as easy as anticipated. The search began in April of 1989 with two brainstorming sessions, one with Ann Cash, a long term teacher from Western High, and one with our writing/development/implementation committee to generate leads as to possible sites and teachers who would be willing to trial test one of the five "Technology" units. From this list we eventually checked out eleven schools and twenty-one teachers as possible testing sites. Many showed initial interest, hesitated to make a commitment, and eventually found various reasons not to



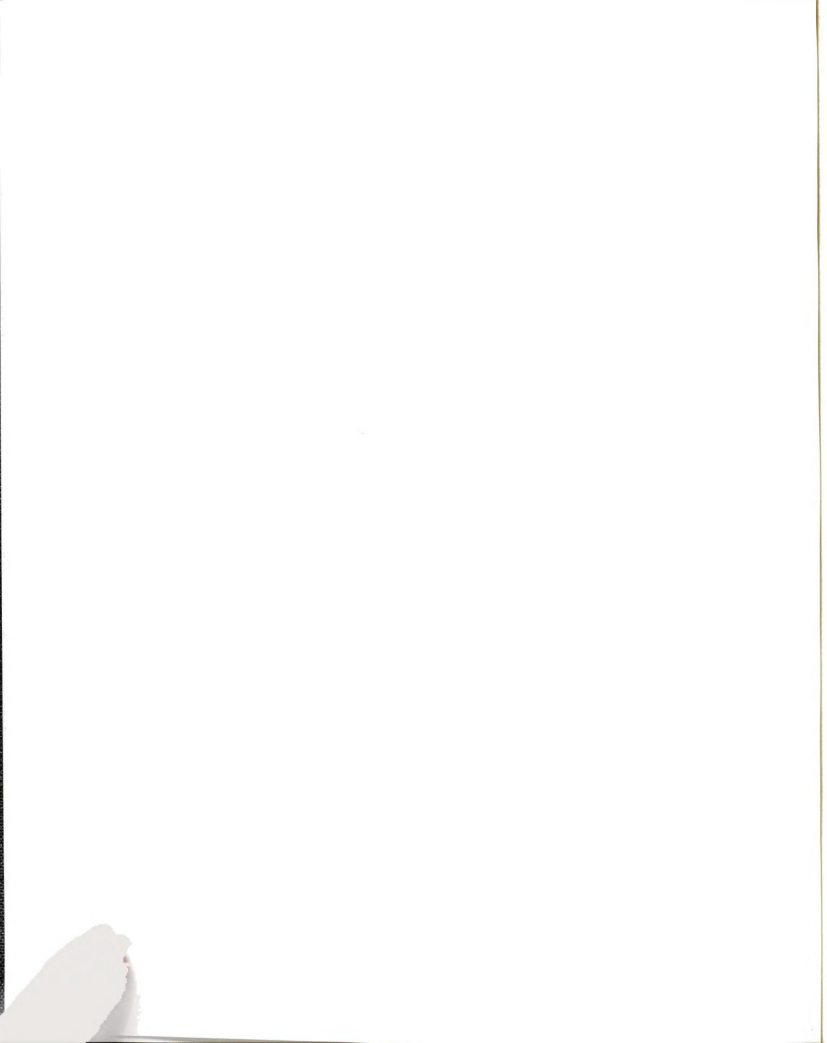
participate. Examples given:

- "revamping the whole science curriculum" (field notes, 6/9/89)
- "agree to look at the materials" (field notes, 6/9/89)
- "will be teaching all upper level biology next year" (field notes, 10/3/89)
- "Do not have word from school as to exactly what I'm teaching next fall" (field notes, 8/23/89)
- "not able to do it this year" (field notes, 9/14/89)
- "I've got a problem with these materials" (field notes, 10/3/89)

Most teachers exhibited an overt hesitation to become involved in a new trial program. A secondary source shared a common expression among teachers as, "What's the new thing this year" – that the central office will come up with to justify their consultative and administrative positions?

However, one teacher, Glen Lindeman, of Cranston High School, seemed promising. A cheery reply, "I'd be glad to cooperate" (phone conversation, 5/26/89) brought encouragement. We immediately mailed out a set of the materials to him to preview. Permission was cleared with the superintendent and the principal. Everything looked good, especially considering that Glen was an experienced teacher, also taught regular chemistry, has an earned doctorate in science education, and was very active in the local science teachers association.

An initial meeting was set up with Glen during the first period on October 23rd, 1989 (a prep period) to give an overview of the project (see "Research Overview", in the Appendix). The purpose of the project was outlined – to trial test the new curriculum and to provide research data to substantiate the assumptions made during writing the technology curriculum. The expectations as far as the role of the teacher were outlined: filling out feedback response forms (see Appendix for samples), keeping a log, consultations with project researcher, and teaching to include contextual and conceptual linkages. The offer of support from the university included free printed materials, \$300.00 for supplies, and additional stipend for additional time spent by the



teacher. I left copies of the "Weather" unit as follows: 27 copies of the Student Activity Guide, 27 copies of the Student Text, and 1 copy of the Teacher's Manual. We agreed to start the new "Weather" unit on 6th of November. However, I would begin observation immediately to familiarize myself with the classroom and identify normal routines in classroom management and instruction.

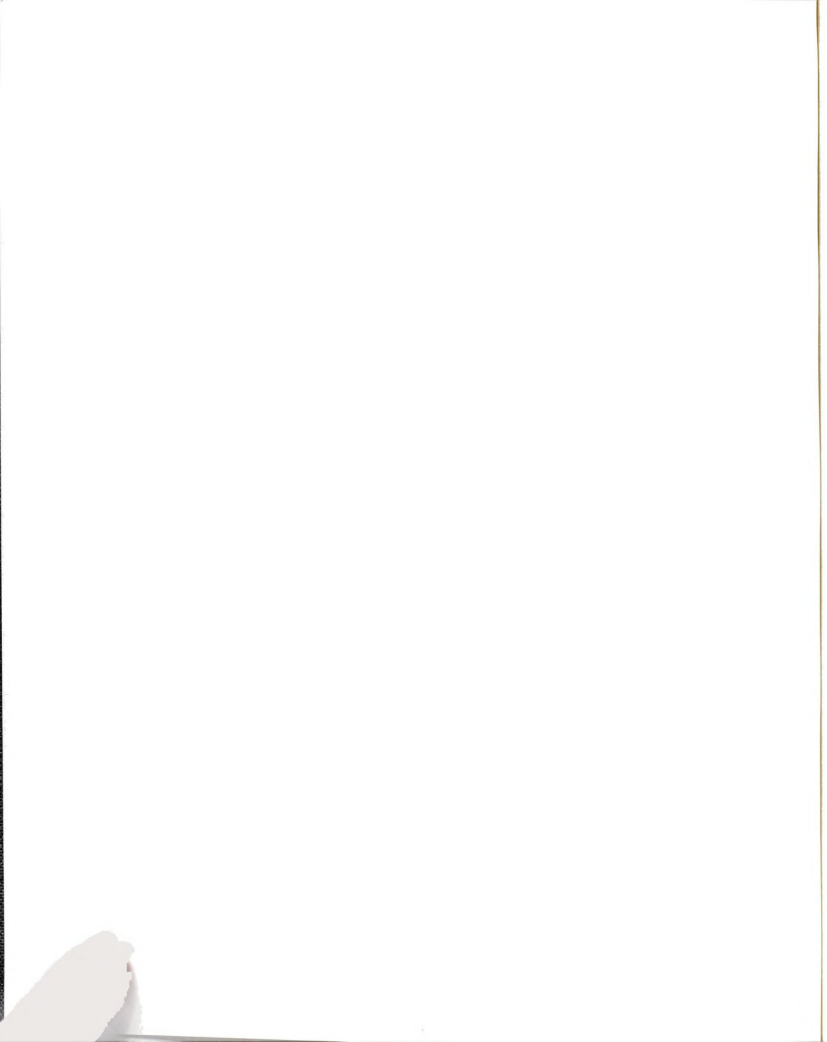
ESTABLISHING EXISTING ROUTINES IN BASIC BIO

Under the first research question, it was asserted that classroom teaching for the poorly motivated, low achieving science students, is highly directed by the teacher in structured routines. This will first be developed by presenting vignettes of two days in the life of this classroom to chronologically describe the distinctive characteristics and verify classroom routines. After the initial introduction to this classroom, a developmental approach will take each assertion and draw substantiating and corroborating instances from the data on a topical rather than a chronological basis.

The First Day – October 26th, 1989

(from field notes for 10/26/89, record no. 2 to 5)

I arrive at 1:55 PM, during passing period, carefully maneuvering my way through the hustle and bustle of students moving from class to class. The chatter consists of quick bits of passing conversation, the mood is remarkably unhurried. The floor is surprisingly clean. Glen and a fellow teacher are out in the hallway. Glen introduces me to Al, who teaches earth science. They apparently have been talking about the new materials as Glen asks about "prep time" for the project. A sense of reluctance may be indicated by the next comment, "Teachers do not dare activity type activities...but we are committed to finished the unit!." This statement reconfirmed in my mind the hesitation shown by other teachers regarding the pedagogical utility of curriculum initiated by outside groups.



The students and the teachers now move into the classroom. The buzzer sounds at 2:05 PM. The teacher hands out sheets and works on setting up the video equipment. At 2:06, the video entitled "Red-Tailed Hawk" begins. Glen augments the audio with his own running commentary, alerting students to questions on the worksheet as the video comes near the answer as illustrated by the following conversation: (field notes, 10/26/89)

Teacher: Pileated woodpecker should be number 10.

Andrea: What's this?

Teacher: Watch how he practices flying. Sort of neat – just revs up .

Yes, number 14. Damaged eye is partly closed.

Andrea: Oh, I feel sorry for him.

The students watch and write – little talking observed. The video finishes at 2:30. The classroom lights are turned on and the teacher directs, "Get together and see if you can get some answers. You have a word list we can work on." The teacher works with the students to fill in the rest of the answers as illustrated:

Ross: Numbers one to five?

Teacher: Ya, get number one to five right now! (teacher orally goes through questions and answers with the students).

Number one: Open areas, woodlots, meadow habitats.

Number two: Nest made of sticks.

Number three: When are most baby birds born?

Students: (in unison) In the spring!

Teacher: Number four: Which feathers are missing?

Ross: Quills.

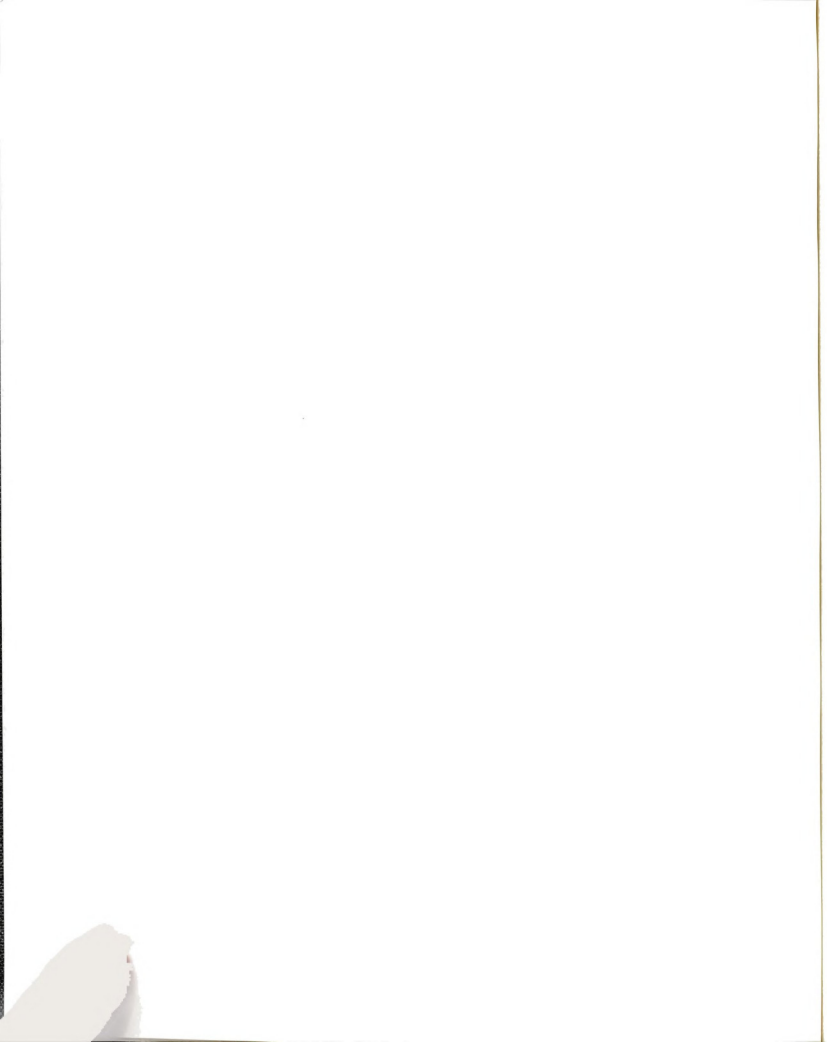
Teacher: In the wings and feathers.

Teacher: Number five ...babies are neat!

Teacher: If you got drawings, get them to me. Get together and work on them.

Teacher at 2:35: Complete your drawings.

By now the classroom was finishing up the assignment. A quick survey indicated 13 students still working, 6 visiting, and 4 walking around. I count and find a total of 21 students present today.



Barbara now asks: Can we get our grades?

Teacher: Not until tomorrow. Have a quiz tomorrow.

The teacher hands out a word list. Tom leaves the room and returns after a few minutes wiping his mouth with his sleeve (indicating he probably went out for a drink). Barbara (in a checkered shirt) has spent the last ten minutes just walking around.

At 2:42 the teacher asks, "OK, everyone all caught up with the hawk sheet?" At 2:46 he announces, "Relax and enjoy yourself." By 2:47 four students are still working, the rest just waiting and quietly talking. A student hollers out loudly! The teacher responds lightly, "Sh...sh. Who is that with the loud voice?"

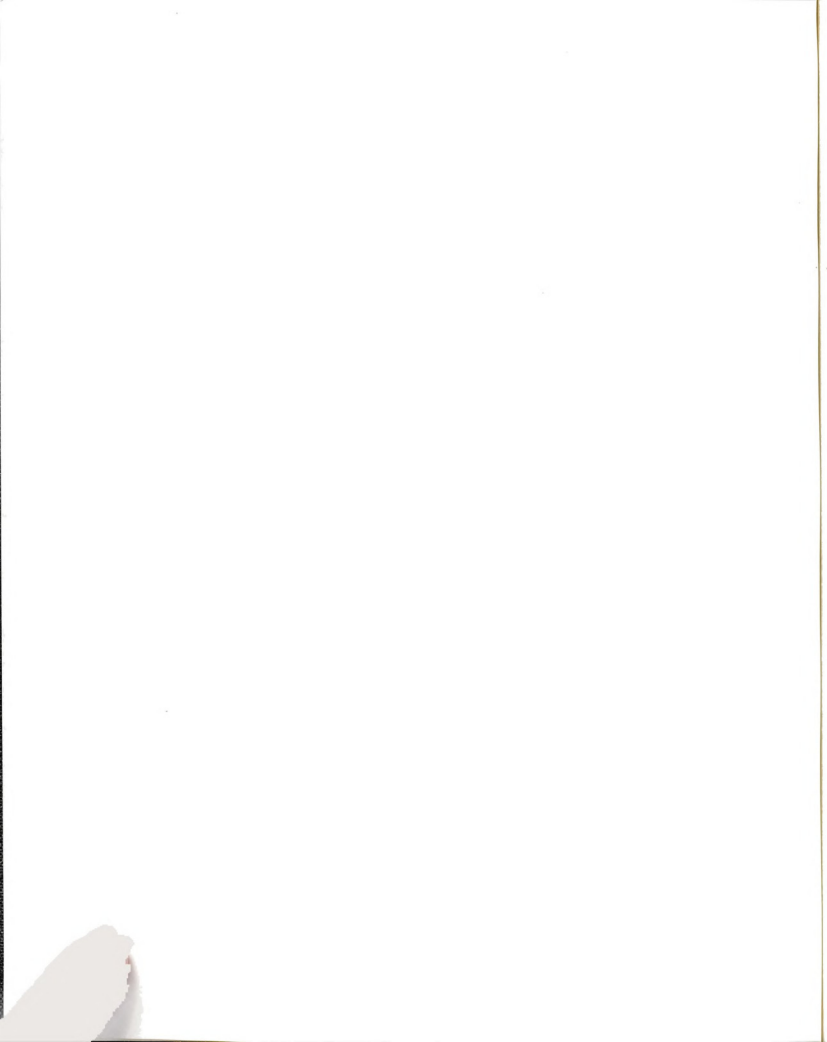
I catch an interesting side conversation. Apparently Carla made a comment to Andrea which Ross overheard and interjected, " Spare me!")

Carla replies with disdain, "You are so immature!"

The teacher comes over to me and explains, "Usually we don't have this much down time. Half the class just came in from PE. Half have been through the course 'Science Essentials'. Half of the class are freshmen and the other half are sophomores."

I notice that the teacher has a cold, is beginning to lose his voice, and I chalk up the relaxed schedule to existing circumstances. At 2:52 the students put up their chairs, at 2:53 announcements come on the intercom, and at 2:54 the buzzer sounds and students leave the room. I leave a copy of the research proposal, the interview forms, pretests, posttests, and consent forms with him. Glen is the track coach and so leaves promptly after class.

While driving on the way home, I reflect on the events of the day, and mentally note some impressions:



1. This teacher extends himself to help the students complete work, almost to the point of giving answers.
2. The classroom has a peaceful sense of order and calm despite the freedom of movement, visiting among students, and calling out answers without raising hands.

The Second Day – October 27th, 1989

(from field notes for 10/27/89, record no. 6 to 9)

I arrive at 1:55 PM as the students are entering the room. The bell rings at 2:00, Scott enters at 2:01 and goes directly to his seat. There seems to be no apparent sanctions for coming late.

At 2:02, the teacher turns on the overhead projector and says, "Two things! The assignment and a quiz on hawks." As the teacher proceeds, he explains various items and summarizes the main points by writing them on the overhead projection table. The agenda for the day is projected on the screen:

- *Journal 11/27/89
- 1 – The digestive system
 - 2 – The respiratory system
 - 3 – Draw egg. p. 494
 - 4 – Quiz on red-tailed hawk
 - 5 – Turn in notebooks ...don't worry about the articles.

The teacher pauses while the students copy the assignment and begins to work with the students in completing the worksheet. At 2:07, Donna enters the room. No response or sanction from the teacher is apparent. I count and find 22 students present. The conversation continues as follows with sections marked with an * both orally given and also written on the overhead projector:



Teacher: * Number 1. Why do birds seem to be hurrying when they eat?

a) They are competing for food.

b) On guard against predators.

Teacher: Anyone here from a big family? Number three. Food is stored here (points to the crop on the diagram). Next week we will finish up on birds. Doris, are you taking this down? Question 5.

Prowntrculus...mixes food with fluid. Number 6. Gizzard....grinds up the mixed food. (the teacher pauses, looks up and says, "How are we doing?" Done?

Students (in unison): No! (talking continues among students).

Teacher: Sh..sh.... What do we find in the gizzard to help grind up the food?

Students (in unison): Rocks!

Teacher: Pyloric valve ... like a trapdoor!

Laura: Why the big white speck? (referring to spot on overhead screen).

Teacher: Don't worry. There is a reason.

Laura: Do I have to leave one too?

Teacher: How are we doing? OK ...on to the respiratory system.

Lesson 2. OK, let's see if we can get some answers!

* Number 1. Why is this system needed?

a) Get rid of CO_2

b) Take in O_2

Donna: What's O_2 ?

Teacher: Oxygen.

* Number 2. Why do birds need so much oxygen?

a) Long migration flights.

b) High altitude flying.

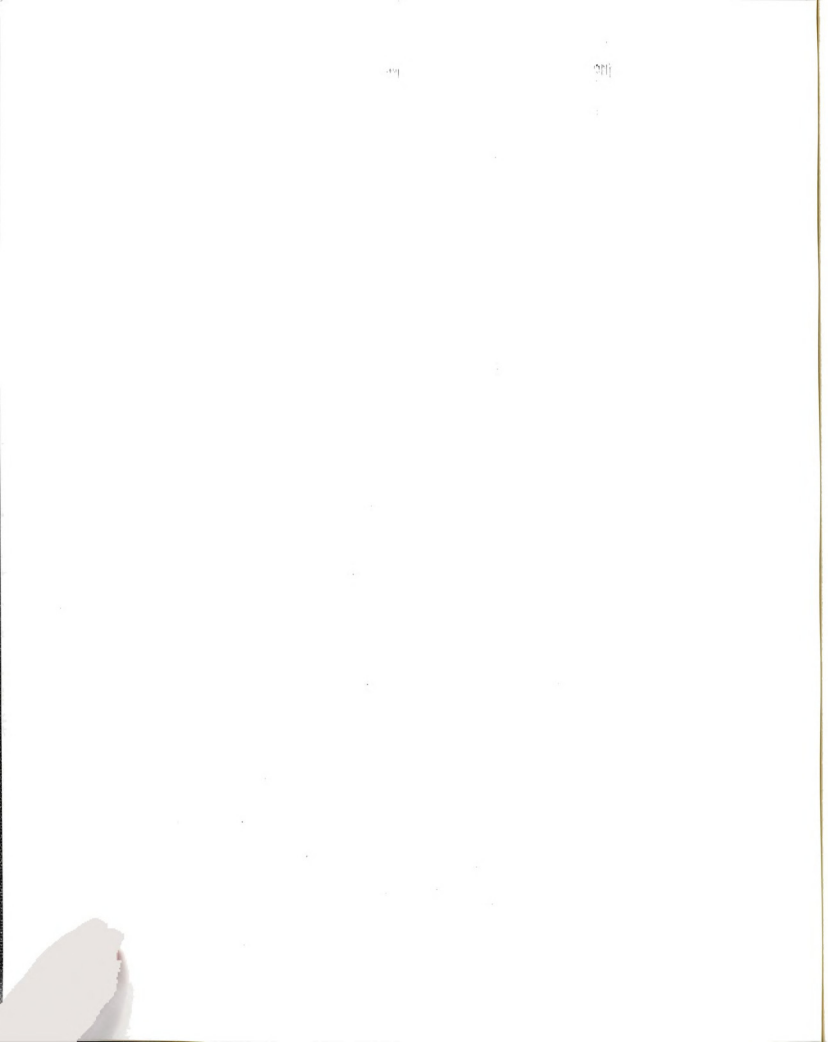
c) Digestion.

The class continued with the same lecture-question procedure until 2:51 when the students put up their chairs. Announcements followed and the students quietly chatted until dismissal. During this time, the teacher asked, "Len, how long was your run last night?" (Len is on the cross-country team and Glen is the coach).

At 2:54 the buzzer sounds and the students leave the room.

THE CLASSROOM - AS I FOUND IT!

Reflecting on the events of these first two days, various impressions seem to characterize this classroom. The vignettes do point to a distinctive feature of this classroom in Cranston High School. The classroom structure consisted more of



routine instructional activities, rather than management techniques (as the "stay in your seats" and "no talking" characteristic of Western High School. At this point the question may be asked, "Are both of these forms of structure, management and instructional, used as control devices for the poorly motivated low achieving science students?

These management and instructional routines will be further developed using evidence and instances from subsequent days.

The Classroom – Orderly, but Relaxed

This classroom provided a relaxed, yet very orderly learning situation. Students usually speak without raising their hands, both to each other and to the teacher. The first two days provided numerous examples of this informal atmosphere, both in students addressing the teacher and speaking to one another. As a result of this relaxed atmosphere, student participation in this classroom is spontaneous and evident. Students ask questions when they do not understand a point, call out answers without raising their hands, and freely discuss material with one another.

This relaxed atmosphere was even found during quiz time as illustrated by the following vignette describing students fishing for answers, calling out opinions without raising their hands, digging through their notes, and conversing with each other during the quiz:

Teacher: Anything you don't understand? (pause) Write down the question if you don't know the answer

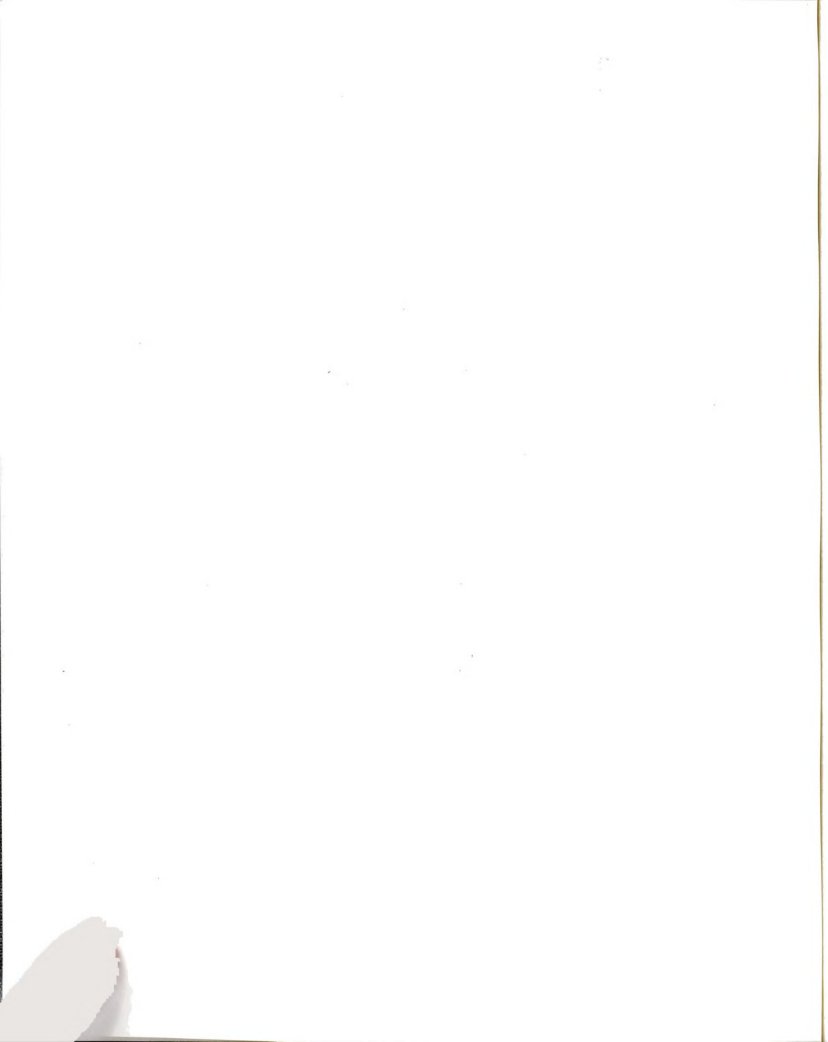
Scott: It's a shape? (student probes for a hint out loud).

Teacher: It's a smooth shape?

Scott: Ha! I know the answer! (Students talk without raising their hands. Two girls in the center are whispering, talking about the quiz. A two-minute interim discussion about football develops among the boys).

Teacher: Get back to work! (Someone is exchanging answers in the back of the room. The football talk continues).

George: Number 12. We didn't do that!



Teacher: Yes, we did! Look back on your first day of notes.

Ross: Look on October 20th.

Teacher: I hear October 20th as the first day of notes.

Teacher: I'll continue.

Tom: Wait a second!

The preceding vignette illustrates the freedom students assume in completing work almost to the point of a running conversation with the teacher and each other.

Additional examples of a loosely structured class management system are evident. Students come in late without sanction, get up for a drink without permission, and move freely about the classroom.

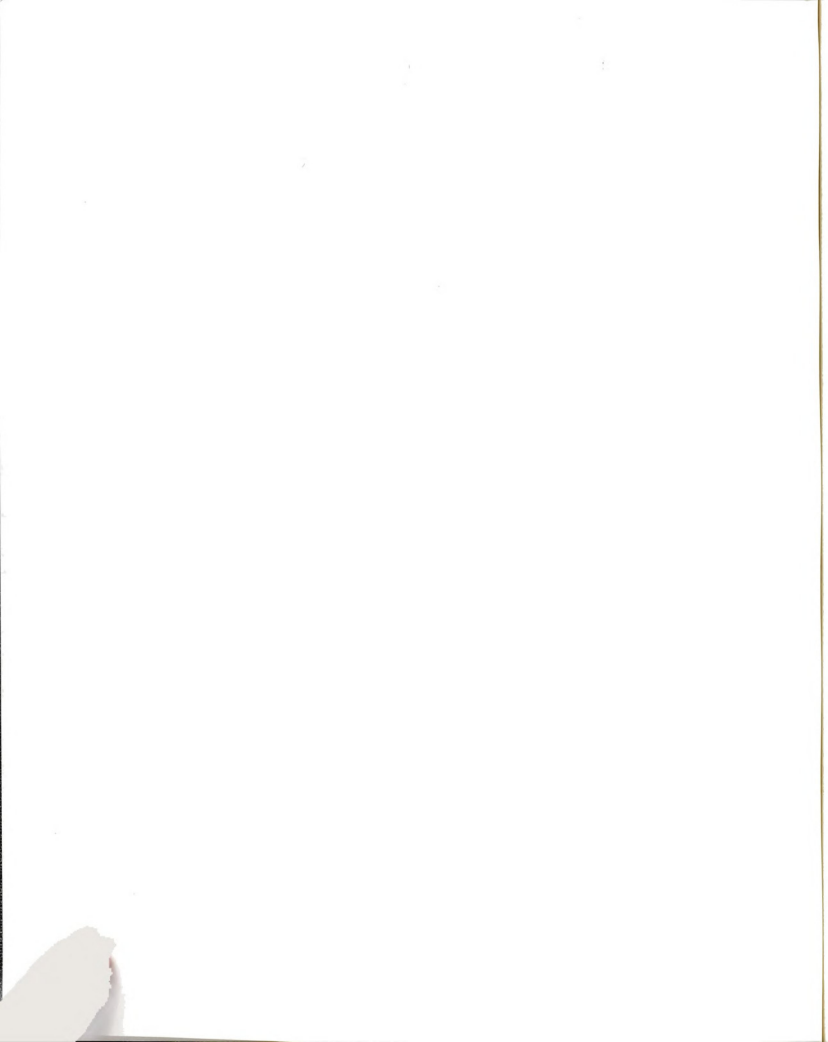
Although there is a lack of strict rules and a relaxed classroom atmosphere, the teacher is still in control. This is substantiated by the fact that no matter what is going on in the room, the teacher can get their attention without raising his voice. Control in this classroom then must relate more to the choice in type of activity than to specific classroom management techniques.

The Classroom – Productive and Challenging, but also Limiting

In some ways this classroom is productive with challenging material presented, but also very limiting in the expectations of the students by the teacher.

In spite of this being the low level science class, it has a high rate of daily attendance. Of 23 total students, the attendance for the two days were 21 and 22. This is in great contrast to the inner city school, South Central, where a two day attendance was only 11 out of 26 for one period and 14 out of 23 for another period (field notes for 5/17/89 and 5/24/89).

Secondly, the ability of the class to settle down quickly and stay on task was remarkable, considering the freedom allowed. While lecturing at the overhead projector on October 30th, a quick count indicated 22 out of 22 students intent on



getting the material into their notebooks. A second count later in the same period again generated 22 out of 22 giving full attention to the teacher. On-task activity during completion of a worksheet was not as good as during a teacher presentation. A count on November 15th revealed only 13 out of 21 actively engaged in productive work and another count on January 11th, 1990 produced 13 out of 19.

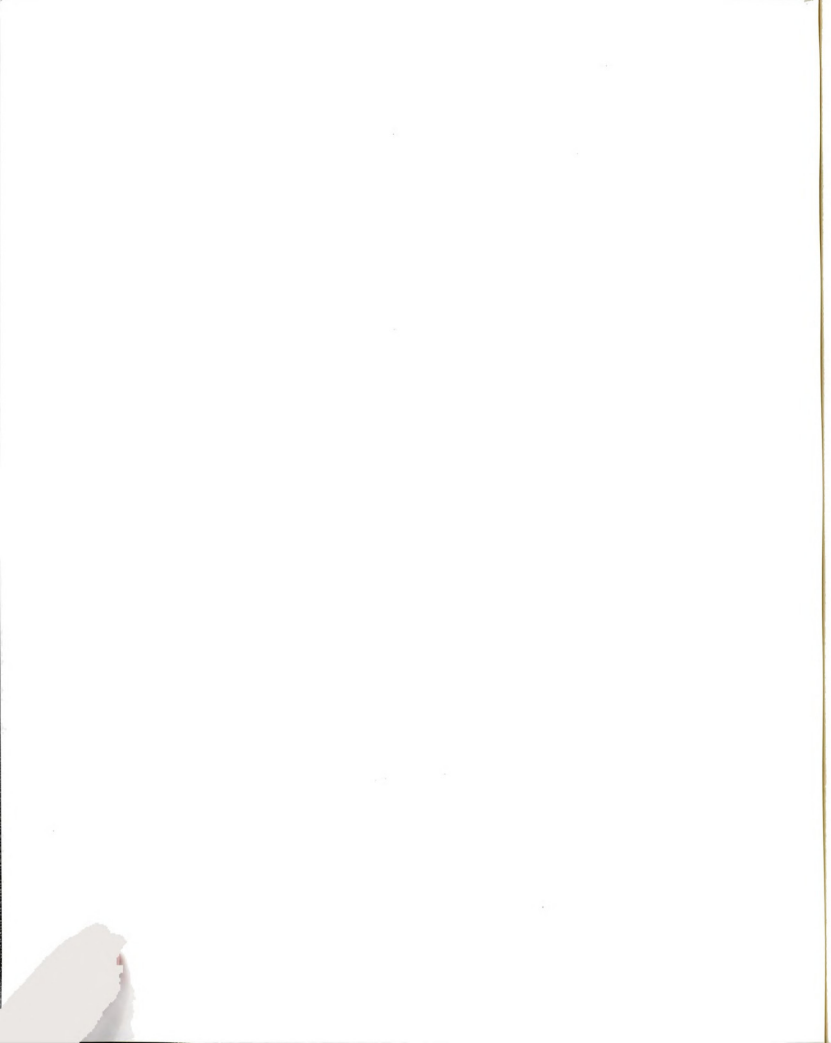
Assertion Number Five (Question One) suggested that material is covered in breadth rather than depth. In this classroom, the lack of depth of material is more represented by the methodology of teaching, rather than the content. The complete lack of lab work, the absence of any activities requiring problem solving, data handling, or mathematical computations does support the assertion that a lack of depth is characteristic of teaching in this classroom. In regard to content, this classroom almost offers a counter- instance of the assertion, but a strong contrast to material presented at Western High School where breadth rather than depth of material characterized instruction.

In spite of this being a class for the poorly achieving science students, the material presented to the students at Cranston High School could be characterized as challenging. In the presentation on the excretory system of birds, the teacher presents the structure, explains the function, and extends content to implications:

Teacher: (writing on overhead projector and speaking simultaneously)

Excretory system – to get rid of wastes.

1. The Kidney – A key part of the system – changes poisonous chemicals to non-poisonous substances and sends them out of the body. Uric acid is a poison from nitrogen compounds the bird has digested.
A Problem – The bird has no bladder – can't get rid of liquid wastes separately.. so.. bird gets rid of solid and liquid wastes all at once through the cloaca. Not having a bladder is an advantage....cuts down on weight.



Another example of challenging material presented and developed occurred on January 8th, as follows:

Teacher: (Writing on overhead projector) The orange pigment is _____ and the yellow pigment is _____ also found in the chloroplasts.

Ross: Xanthophyll

(Later on in the lesson)

Teacher at overhead: The chloroplasts are involved in a very important process. They use light along with the gas____(carbon dioxide) and ____ (water) in a process called ____ (photosynthesis).

Teacher: . . . What does photosynthesis mean?
(various answers, not intelligible)

Teacher: I told you what synthesis means.

Jack: Putting together.

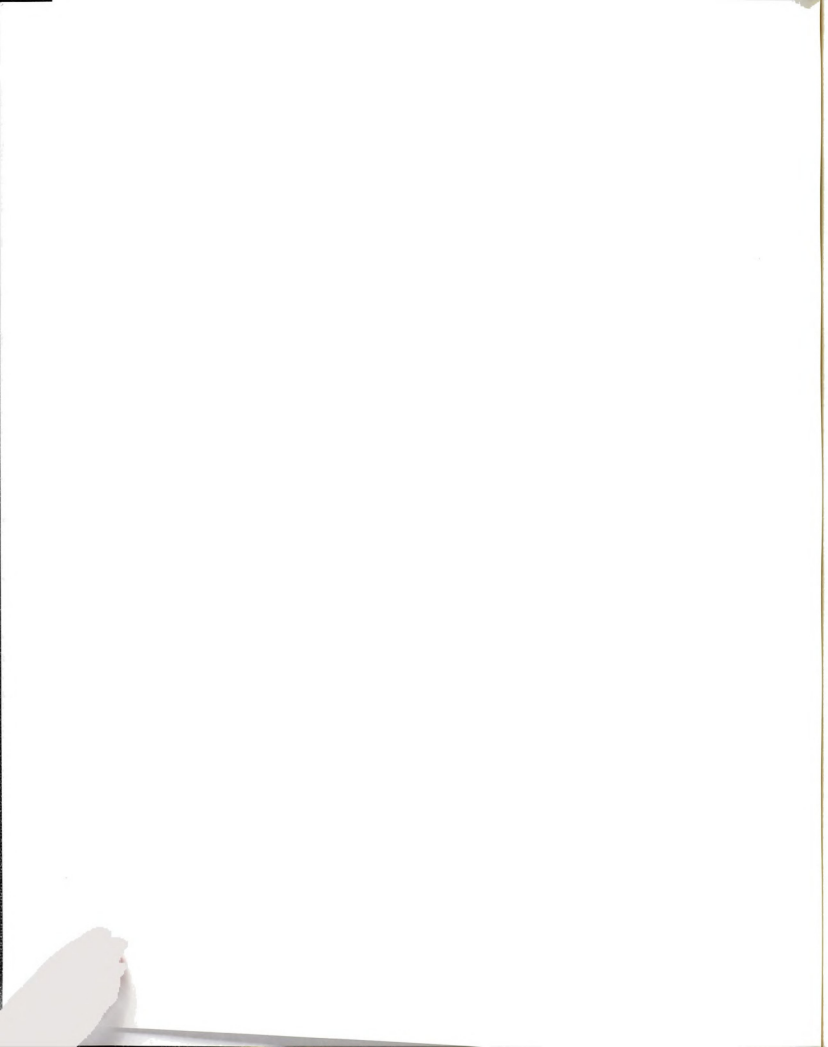
Teacher: Yah, putting together with light.

This second interchange again illustrates the class dealing with material almost comparable to regular biology class, yet using a different methodology that in itself is very limiting and in the long run may be counter-productive for these students. Further analysis indicates that the teacher gives the students the exact material required on quizzes and tests. During discussions, the answers are often given by a select group of target students, or supplied by the teacher himself. The textbook is seldom used and if assigned not read by some students. Overhearing Carla complaining she can't find the answers to the worksheet, "I don't understand this book!" I inquire if she has read the text. Both Carla and Denise admit they have not read the textbook. An interchange two days later further substantiated the disregard of the text book as Ross notices Kathy, with a look of exasperation, flipping pages looking for an answer.

Ross: Read it! Believe me, it would help if you read it.

Kathy: Why? I never read it!

Although the material for completing worksheets required the textbook as a source of information, the first time an assignment to read the textbook was actually



given was on January 25th. The textbook plays a minor role in the education of these students. As will be later demonstrated, most information is supplied by the teacher.

Data from this section does support Assertion Number Nine that expectations for the poorly motivated, low achieving science students are different from the upper level classes. Considering the fact that reading, writing, and following directions are some of the critical skills these students desperately need to develop, it would seem that avoiding reading would limit the development of the very life skills later needed.

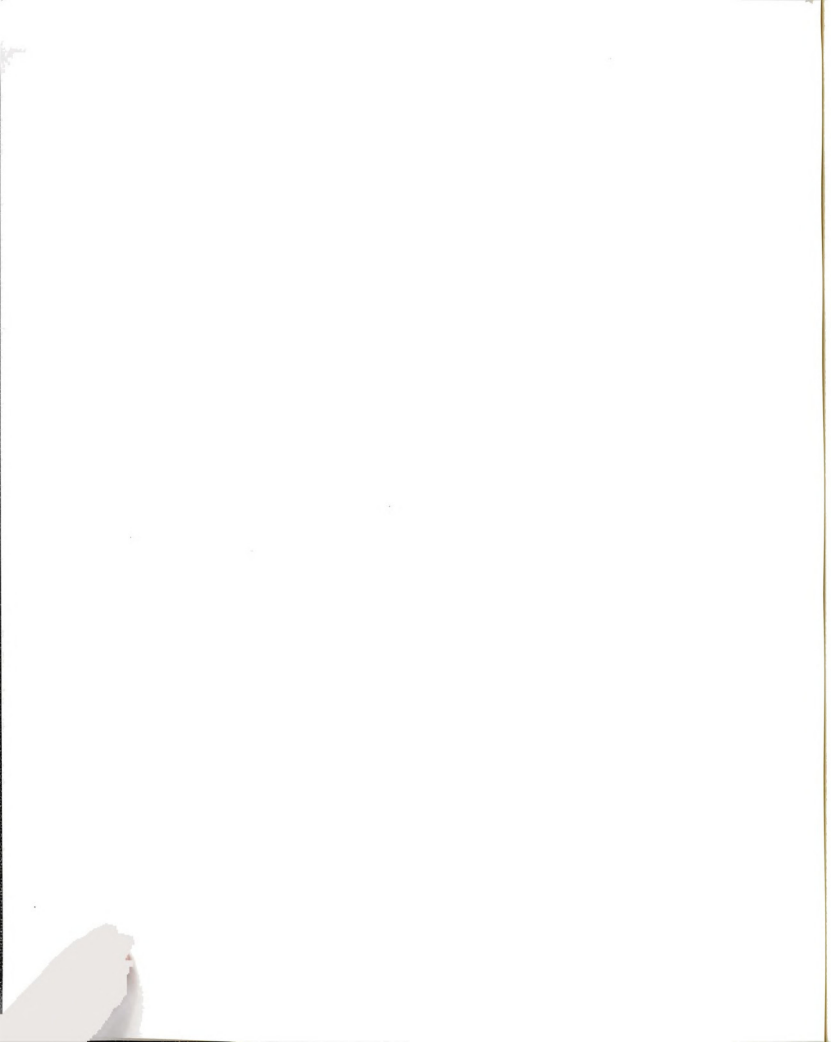
The activities used also support Assertion Two stating that regular and advanced classes have a greater variety of activities. The chemistry class, meeting immediately before this class, includes regular labs, individual research projects, cooperative learning, and data analysis.

The Students – Who Really are They?

Evidence substantiates the position that students are enrolled in this class for a variety of reasons. Two new students (Michael and Tammy) joined the class after the semester break as "they were not doing well in regular biology", according to the teacher. Some were mainstreamed out of special education, having spent time in the resource room (Katie and Tom). Some are average students who were failing due to absenteeism and goofing off (Ross and Brent). Most students admitted to difficulty in reading (student interviews and personal conversation). Some were placed in the class due to behavioral problems and interactions with other teachers (Jack).

In many ways, these students are the normal American high school students with the same interests and concerns as others – going out on dates, football, hunting, friends, and dreams for the future.

In spite of teachers' general perception of low level students expressing a "I don't care" attitude, these students (at both Western and South Central) give evidence



that they do care about succeeding in school work, especially in regard to grades. Various indicators substantiate this assertion: Kelly asking on October 26th, "Can we get our grades?"; Laura asking for further explanation (Oct. 27th), "What's O₂?" (not realizing the symbol refers to oxygen); and Donna (during a quiz on Oct. 30th), "I don't understand...Each on of what?" Katie showing concern about getting notes down (October 30th) asking, "Hold it a second"; Ross in a frantic search through notes looking for an answer during a quiz. There is a constant concern among the students to identify which material will be on a coming test or quiz as noted on October 30th:

Teacher: These are our notes

Denise: This on our final test?

Teacher: Only on birds. How are we doing?

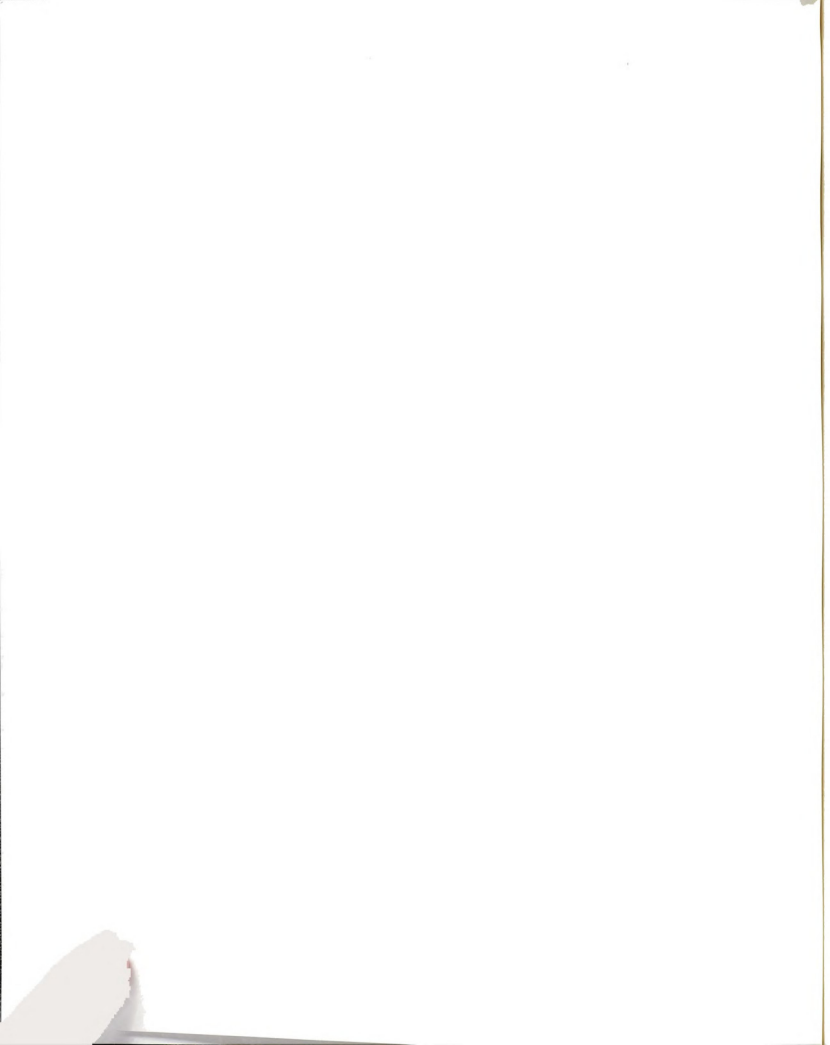
In spite of not completing homework, reading the textbook, or studying for tests, the words and actions of these students suggest that they are concerned about success in school. The question then surfaces as to why a whole group of student behaviors are counter-productive to the very success they desire.

Classroom Management Routines

Assertion Six (under Research Question One) stated that a structured classroom with established routines is used as a management and control procedure as well as an instructional device. As formerly indicated, the structure noted in this classroom is derived more from the type of instructional activities chosen by the teacher and not primarily from the classroom management routines.

In spite of the relaxed style of classroom management and the freedom given to students in their personal conversations, the instructional/management ratio seems fairly high. Chief's statement of "down time" seemed to be indicative of only one day.

Note #1: Students normally address Mr. Lindeman by using the term "Chief".



On all three days, the management routines at the beginning of the period took less than five minutes and by 2:05 instruction was well under way. The class assignments and period agenda were written on the overhead and projected on the screen. The teacher took attendance while students copied these assignments into their journals. During this whole period, the only real down time was the two minute discussion on football. Otherwise, the students were continually working.

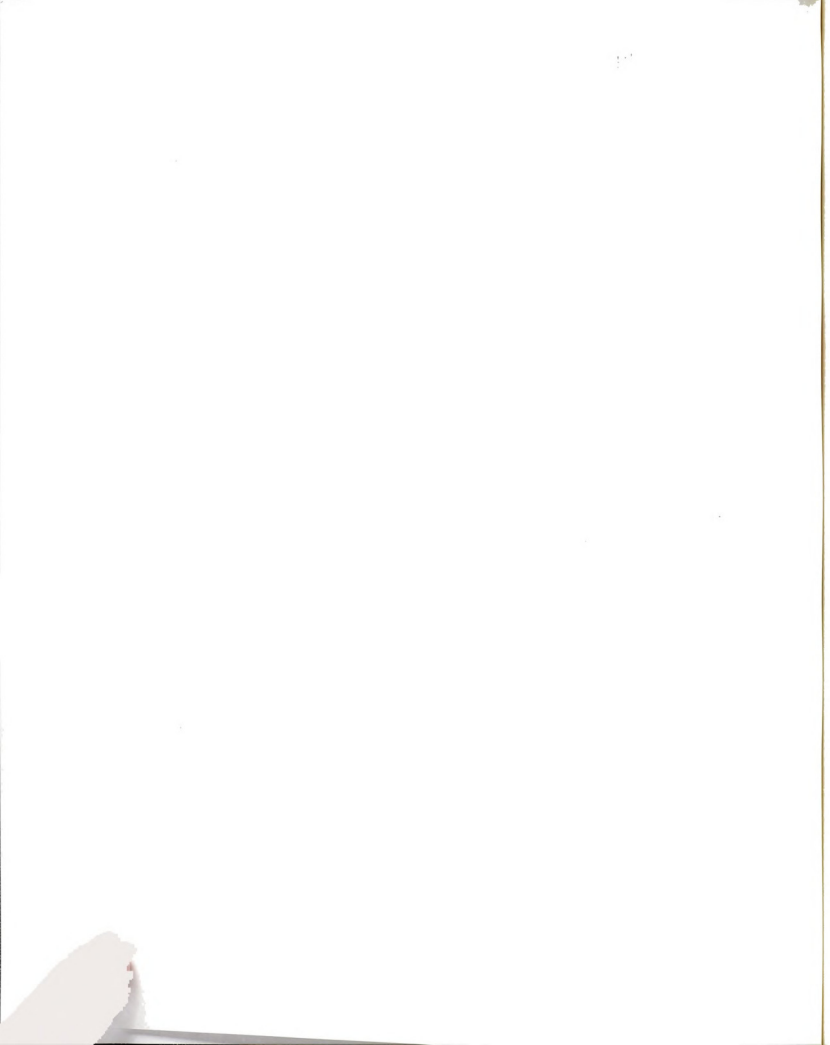
Since students were usually in the classroom at the beginning of the period and ready to go, tardiness was not really a problem, and seemed to be ignored when occasionally encountered. Homework was assigned only once during the 15 weeks present in the classroom, and as such required no special procedures. The teacher would often give the students the last five minutes of the period to talk and visit, as a reward for hard work. During this time, students would put the chairs on the desks, visit and relax. This classroom is orderly, relaxed, and productive in activities chosen by the teacher.

Development of Lesson Routines and Teaching Progression

The preceding lessons furnish enough information to begin developing some lesson routines and a sequence of activities in a teaching progression, which is remarkably similar to the routines and sub-routines proposed in Assertion Number One, under the first main question. An overview of the first three lessons yields the following summary:

Day 1

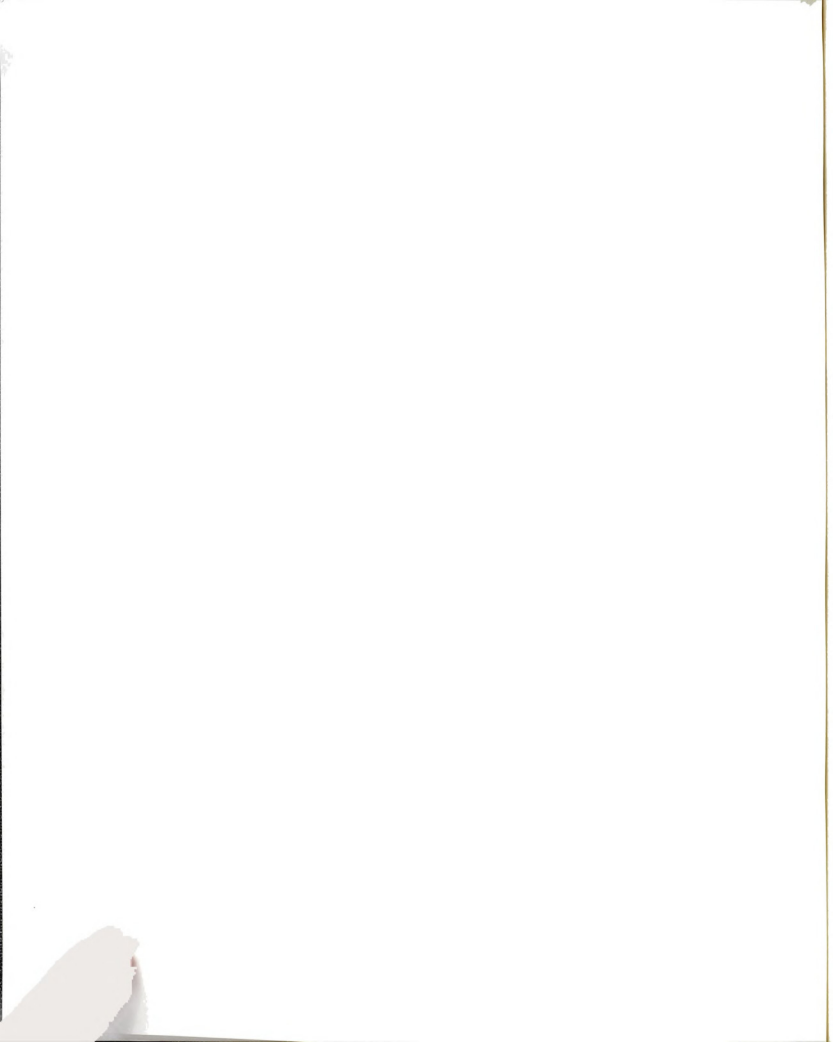
1. Students are given a worksheet and a wordlist.
2. Video sub-routine:
 - a) Students fill in the worksheet while watching a video.



- b) The teacher helps the students find answers with a running commentary.
 - c) Students work together after class to share answers.
 - d) The class corrects the worksheet together. The teacher reads the question, and the students call out the answers. Each student corrects his/her own sheet. The students may fill in missing or incorrect answers.
3. Students turn in drawings from previous day.

Day 2

1. Students get assignment while teacher takes care of class records.
2. Lecture on overhead with students taking notes in journal.
3. Students complete drawing and labeling from text.
4. Quiz Subroutine (Quiz on vocabulary words).
 - a) The teacher directions are as follows:
 - Cut your paper lengthwise
 - Go to the ends of the tables
 - You can use your notes
 - Number 1 to 20
 - I will give you the definition. You write the word
 - Work by yourself
 - This quiz is preparing you for the test on Thursday
 - b) The teacher writes definitions on the overhead projector. Students write answers on their sheets.
5. "Trade and grade"
 - Students exchange papers
 - Teacher reads the question on the overhead
 - Students shout out answers



- Teacher writes answers on the overhead projector
- Papers are returned to owner who brings the final copy up to the teacher's desk.

6. Turn in notebooks

Day 3

1. Students write down the assignment from the overhead projector while the teacher takes roll.
2. Teacher lectures using overhead projector.

Students take lecture notes in their notebooks (journals) and complete an outline worksheet.

3. Quiz sub-routine:

a) Teacher gives the following directions:

- "Cut paper lengthwise."
- "Go to ends of desks"
- "Work by yourself".
- "You can use notes".

b) Teacher reads questions and places questions on overhead projector, while students write answers on their own papers, one at a time.

c) Quizzes are graded together in class:

- Papers are exchanged
- Teacher reads question
- Students shout out answers
- Papers are returned to owner
- Papers are brought up to the teacher's desk

One variation in the quiz sub-routine noted later (Dec. 6th) is that students are sometimes allowed to correct their own papers. Other than that the procedures in the

classroom remained relatively constant from day to day.

Teaching Methodology

Assertion Number Four suggests that for teachers to find success with poorly motivated, low achieving students they clearly indicate exactly what students are to learn, drill the material in review sessions, and prepare them for tests with extensive oral review. The following data summary clearly substantiates this assertion.

As may be evident from the information already presented, the primary teaching method used in this classroom is direct instruction. Research to date has suggested that this is one of the most effective methods of instruction (Rosenshine, 1971; Brophy and Good, 1986). In this classroom, direct instruction is used almost to the exclusion of other pedagogical methods, with the teacher being the primary and almost sole source of information. Mr. Lindeman presents the information to the students and drills them on the content to ensure success on the tests, enabling them to pass this course. As one considers all the following strategies used by the teacher to ensure success, it could almost be characterized by the term "spoon-feeding".

First of all, Mr. Lindeman makes special effort to insure that students copy down the material that will be required on the next quiz or test in their journals. He asks questions during lecture and then fills in the right answer orally and on the overhead transparency. An example of the close correlation between the notes given and the content on the next day's quiz is illustrated on December 14th when Mr. Lindeman showed the video on Kodiak Island. This was again illustrated on February 26th when notes were used to summarize important content of the video "Birds of Prey" in preparation for a quiz next day. Another method of defining content for coming quizzes and tests are through worksheets, spelling lists and wordlists. As noted on the first day, Mr. Lindeman works with the students to fill in the answers on

the worksheets. The students have become quite adept in wheedling answers from him as illustrated during a session on Nov. 20th. :

Teacher: Let me help you with No. 1.

Jack: Is No. 1 protoplasm?

Teacher: Yes (teacher circulates and helps students). Let me help you a little bit. After "organized" write in "protoplasm".

Ross: Are all those living things?

Teacher: No. Number three is "environment". Number five is develop and(pauses)

Ross: Grow? (teacher nods in agreement)

Teacher: Notice that these are all things living things do.

Jack: Chief, where do we find B?

Teacher: When you get down to B, just use the five stages of life?

Sarah: What did you say #6 is?

Teacher: Reproduce.

Donna: What about part C?

Teacher: Nope! No help on C, but I will help you on A and B.

Teacher at 2:43: Take out your deer worksheet (The class reviews the worksheet: The teacher asks the questions, the students shout out the answers, writing in correct answers on their own sheets).

This same "fish and feed" technique was again used by students on October 26th (worksheet on Red-tailed Hawk and wordlist) and again on Dec. 4th while the students were completing the worksheet on the mink. During this period, the students openly asked each other for answers, asked the teacher for answers, and finally the teacher went through the whole worksheet orally, question by question, to verify if each student now had the correct answers. This interaction on October 26th nicely illustrated students cooperatively generating answers.

The "spoon-feeding" preparation is also characterized in test preparation. First of all, the content of the coming tests is a review of the content of accumulated quizzes, as Mr. Lindeman states on October 30th, "This quiz is preparing you for the test on Thursday". Additionally a review session carefully goes over the content of the coming test, almost to the point of giving the test questions ahead of time. The teacher's heart for these students is marked by a desire to do whatever possible to

insure success on the test. The review for the semester final also proved instructive. The content of the test was laid out in detail. With the review before Christmas and the first weeks of January, the class spent a full nine days going over the material for the semester final.

In the administration of tests and quizzes, the teacher granted these students special allowances to help them succeed. Although he gave explicit instructions that were intended to limit cheating during the quiz (Go to the ends of the tables.... Work by yourself), he still allowed the students to use their notes, did not stop talking among students during the quiz, and ignored two girls obviously exchanging answers.

In conclusion, the "spoon-feeding" observed in this classroom did help these students to achieve a measure of success, some for the first time in their lives, did help them receive credit for their science course, and did convince the students that the teacher really wanted to help them learn. However, students did not have the opportunity to develop skills in reading, choosing important and relevant information, or the communication skills of written and oral expression. The methodology of teaching presented does support the "transmission view of teaching and the absorptionist view of learning" (Prawat, 1989) as proposed in Assertion Ten (Question One).

There were however, some instances where Mr. Lindeman took initiative to help students construct meaning out of the material presented. On October 26th, he helped students understand how the large respiratory system of birds is needed for the oxygen demands of flying, and on October 30th explained how the lack of an excretory system resulted in less weight, again providing a design that is consistent with the flight of birds.

Additionally, Mr. Lindeman helps the students develop what I call contextual linkages (tying new material into the known surroundings and life experiences of the

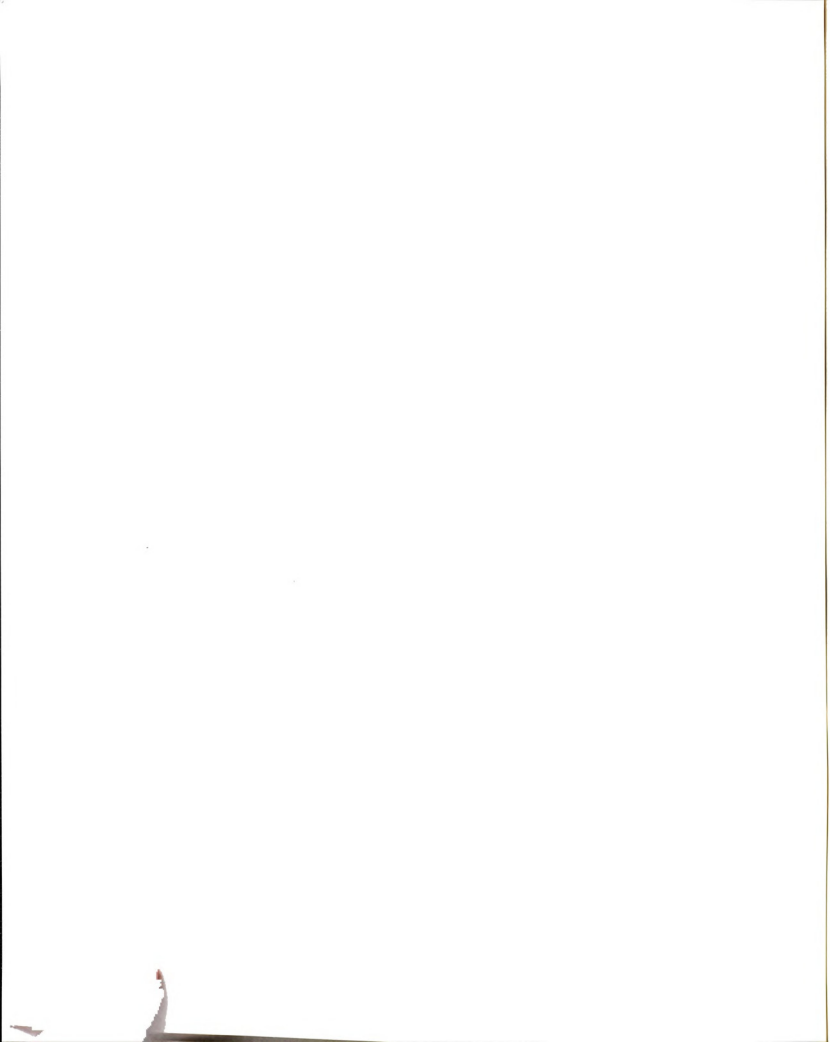
students). The presentation on the deer began with a discussion on which variety of deer is the local "buck", greatly desired by class hunters (11/20/89). The new material on weather was introduced as a fall topic and tied into the study of animals through migration, hibernation, and color change in plants. In the study of fossils, he referred to mastodons locally found in Dansville, Perry, and Owosso. The Petoskey stone was also noted to be ancient fossilized coral.

Another form of constructing meaning used by Mr. Lindeman is what I call "conceptual linking", that is tying one concept to another concept. My own experience is that students learn many "big words" in isolation, but do not tie them together to form coherent explanations (Roth, 1985). Mr. Lindeman helped students understand how the abscission layer is related to the leaves falling and explained the meaning of words (synthesis and photo in photosynthesis). These efforts at constructing meaning were not found at Western High School and provide a counter-instance to Assertion Five in that topics were developed in some depth as well as breadth.

Even though official small groups were NOT formed and sanctioned and not truly representative of "small group work", Mr. Lindeman did occasionally allow the students to work together in smaller groups. For instance, he did allow students to help each other find and share answers while working on the worksheets on "The White-Tailed Deer".

Another noteworthy strategy used by Mr. Lindeman was a roving presence out among the students while working on worksheets. His clarification questions, pointed comments, and suggestions almost reminds one of "coaching" as described in the scaffolding model (Anderson, 1987a; Jones, Palincsar et al, 1987).

Lastly, one of the historic components of instruction effectively used by teachers of low-achieving students is repetition. Mr. Lindemen presents new



information, gives a worksheet to have the students process this information, reviews the material for a quiz, follows up on previous lessons and holds students responsible for material. Quizzes covering material from the previous day are common.

Teaching Methodology Linked to Teaching Philosophy

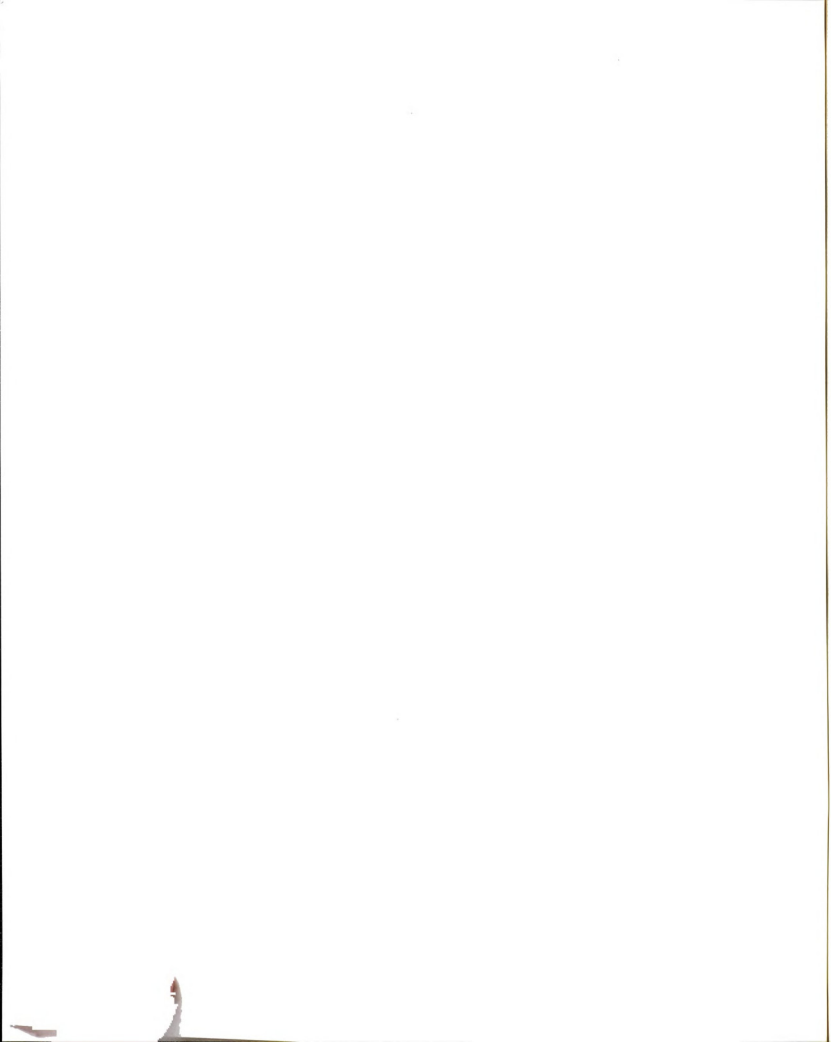
Often teaching methodology emanates from an underlying teaching philosophy. The traditional (textbook/lecture/review/test) methodology reflects a large portion of education today and focuses strategies toward content acquisition (Anderson, 1987b). This mode of learning depends highly on the organizational, analytical, and communicative skills of the teacher, reflecting what Prawat (1989) calls the "transmission" view of teaching and the "absorptionist" view of learning" (p.318). The long standing complaint emanating from this traditional approach to education is the production of students who know a lot of information, but cannot apply the information in an effective and useful manner in their own lives or on entering the job market. It may be argued that substantial content is necessary for functioning efficiently in any analytical, synthetical, or creative manner, and as such needs to be a goal component in any educational philosophy. The data clearly indicates that for all three classrooms examined, this view of teaching and learning predominates.

Although most of these poorly motivated, low achieving science students have high aspirations (biologist, veterinarian, professional football player – according to student interviews in October, 1989 and March, 1990), most of them will not go on to college. However, they will need to acquire more education and training if prepared to constructively function in a modern technological society. Thus, education for these students must also include the acquisition of skills useful to continued learning – such as reading skills, data analysis, organizational skills, communication skills, and even specific skills like following written directions. Units in the technology project were

designed to develop these learning skills in students. This explains the inclusion of textbook reading, instruction to follow directions, written paragraphs, data collection, data analysis, planning and execution of experiments. Gallagher (1990) as director of the Technology Curriculum Project asserts that the failure to require students to use the textbook and respond in written form is counter-productive to the development of the very skills that these students will later need in life (Personal conference, May, 1989).

Considering the rapid changes in our technological society (the automation of industry, the information explosion, rapid communication, and the rise of the service industries), education for these students must also include certain technological skills that will prepare students for gainful employment in future years. Recognizing this development, the project includes such activities as use of instruments, planning and execution of experiments, data collection, data analysis, and interpretation.

In an economic system where most employment requires people to work with one another cooperatively, where communication is an integral part of sales and promotion, where development of personal relationships (contacts) contribute toward success in many fields, and where much research now takes a team approach, the development of social skills must also be a component of education. Moreover, consider the fact that on one hand, whole group instruction (usually textbook/lecture/seatwork method) has to a large extent been a failure with these students (Berkheimer & Maxwell, 1986). On the other hand, independent/individualized instruction was also discarded as not making any significant difference, and in most cases these students did more poorly, hampered by a low reading ability (Howe & Stanbach, 1963). Consequently, the technology project elected to include the use of small groups, which would achieve two goals – a) development of social skills, b) and development of



technological skills like data collection, data analysis, interpretation, and communication.

In contrast to this transmission/absorptionist view of teaching and learning, the design philosophy of the project adheres more to a constructivistic position which includes long-range projects, allowing development of the various components of research. Selected one-shot lessons on different topics develop a compartmentalized view of science and do not reflect the real world of science. Planning, design, experimentation, data collecting, data analysis, interpretation cannot be accomplished on one topic in one period. The collection of the weather record, the analysis of the weather data using the graphical approach, and the final conclusions derived from this interpretation confirms the utility of longer range research projects with this group of students, both in capturing their interest and in providing a concrete platform for them to link concepts together into a coherent understanding of natural phenomena.

More specifically, the experiential philosophy commonly used in teaching the poorly motivated, low achieving science students involves what Dr. Gallagher calls the "TV Model of Instruction – keep it short and change it fast." Justification for the use of this model is often grounded in the following logical progression:

- a) Many of these students have a short attention span, and so..
- b) They lose interest quickly in the topic. Therefore..
- c) Instruction must be broken up into short segments, in which..
- d) Activities and topics are quickly changed.

We find Mr. Lindeman tenaciously holding to this model as evidenced by the teaching methodology observed in this classroom.

Teacher Characteristics

In this section we will consider some of the personal teacher characteristics which obviously impact the classroom milieu and the relationships that underlie instructional interactions.

Mr. Lindeman is an accomplished professional, with an earned doctorate from a major university, who has taught chemistry, physics, and earth science for most of his teaching career. His experience with this level of students is limited, judging from his comment on February 14th, "Although I have taken numerous courses in biology at the State University, this is really the first low-level biology course I have taught."

First of all, Mr. Lindeman takes an interest in the personal lives of the students such as asking Len, "How long was your run last night?" (Len is on the cross-country team) or jokes with Tom, "Will you swear on your Wolverine Bible" (obviously a University of Michigan fan). From casual conversations, it is apparent that students confide in him, as he knows the personal and family circumstances of most of his students.

Secondly, Mr. Lindeman has shown himself to be patient and considerate as demonstrated by his willingness to wait for everyone to finish writing the material down from the overhead screen. This is repeatedly demonstrated in a "pause and check" technique to make sure students are not getting lost or frustrated. In the lecture on October 27, he twice paused, looked up from the overhead and asked, "How are we doing? Done?" and then paused and waited for a student response. While giving notes on October 30th he paused and asked, "Caught up yet?" Often these interchanges take on a lighthearted touch as illustrated on January 8th, "Laura always yells at me! ... Can we roll? Is Laura ready? Don't want her to get mad at me on Monday!"

Thirdly, Mr. Lindeman demonstrates an amazing amount of what researchers have come to call "withitness." He is aware of almost everything going on in the room, lets the students know he is watching, and responds immediately. On October 30 he gently acknowledges a raised voice with, "Sh..Sh..". While teaching and without breaking stride, he notices Peter making faces and warns in a stern voice (January 8th), "Peter, you better behave!" Part of the element of "withitness" includes a preemptive measure like on November 22nd saying, "Simon and Jack! You can turn around and face the screen!"

Fourthly, Mr. Lindeman has a unique way of dealing with student challenges with what I will call a "non-confrontive rebound." This is nicely illustrated when Andrea in essence told the teacher that "Kwiz" (which he had written on the overhead as an assignment) is not spelled correctly and Mr. Lindeman answered, "Oh, Oh! We have an English major here!". Another instance that illustrates his effective combination of praise and humor is the comment, "Listen to that woman!" To a reader of the printed page, this may not seem to indicate a supportive posture, but the tone of voice and the smile certainly did convey an encouraging and friendly message. At the beginning of the class on January 8th, a student corrects the teacher by pointing out the wrong date written on the overhead screen. Chief¹ simply responds, "Am I close?"

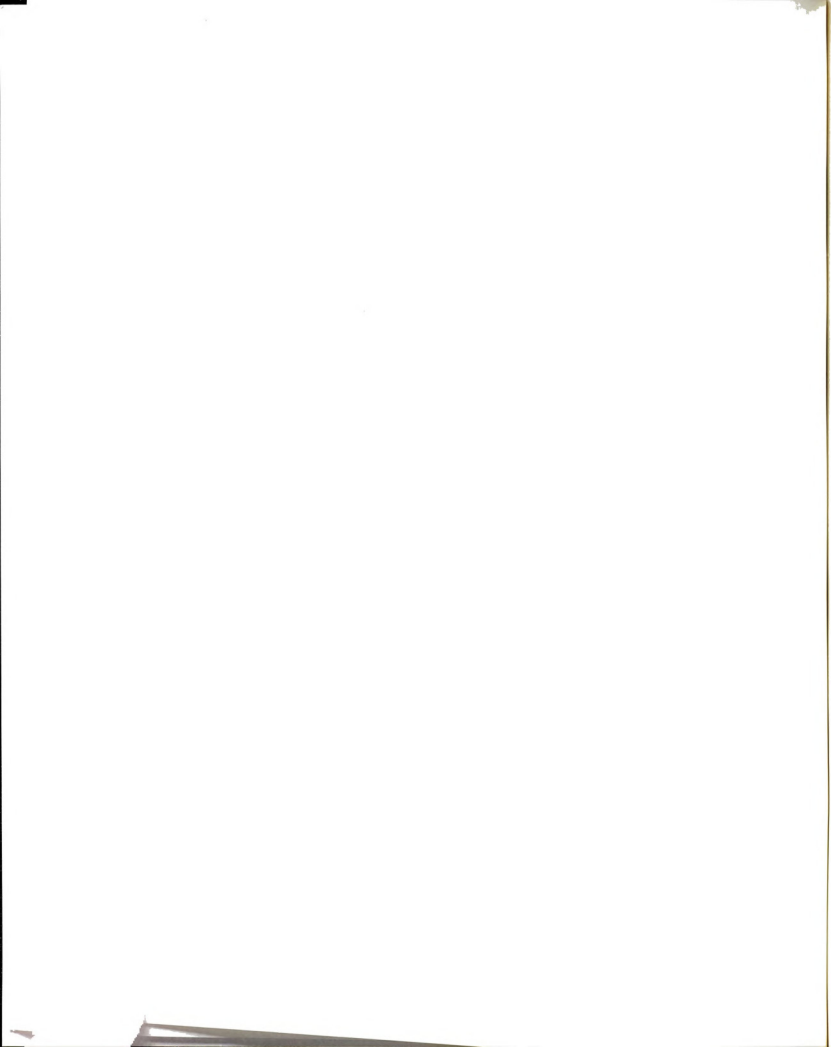
In many classrooms, these types of situations develop into real confrontations and a test of wills between the teacher and student. The combination of a quick come-back and a bit of humor not only diffuses a potential problem, but also can encourage students as illustrated by the following interchange in the same period:

Teacher: *What is the structure in which we find chlorophyll?

Scott: Chloroplasts

Teacher: My! Listen to that guy! A walking encyclopedia.

*The orange pigment is _____ and the yellow pigment is _____? Also found in the chloroplasts.



Ross: Xanthophyll

Teacher: Did you know that or did you look it up.

Ross: Looked it up.

Teacher: At least you know where to find it.

Teacher: One more page. You know I never lie on Monday.

(teacher asks Brent a question)

Brent: I'm still on vacation.

Teacher: I don't blame you.

Last one. I promise that's it for the day.

A student telling the teacher he is on vacation and refusing to answer a question could be intimidating for some teachers, but Chief simply answers, "I don't blame you," noting that this is the first day back after the Christmas break. Chief's ability to deal with these situations in a lighthearted and humorous manner has done much to maintain a good relationship with the students.

A Good Teacher!

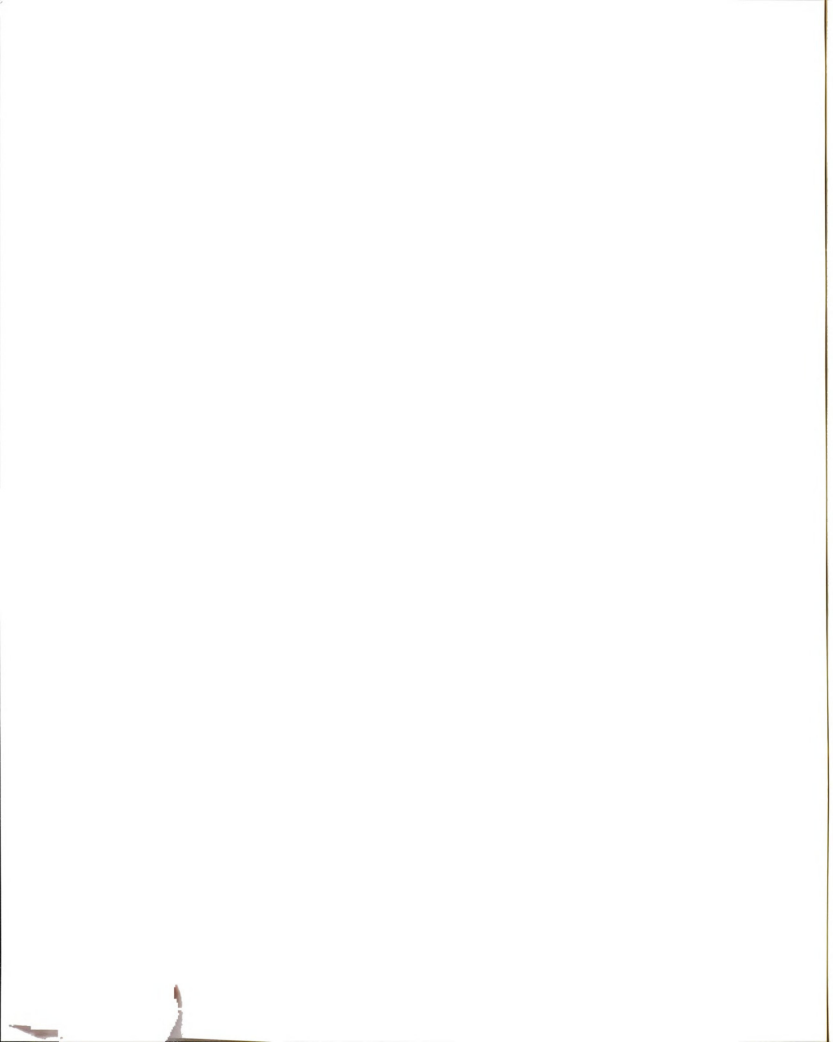
One thing seems to be quite obvious. In his own way, Mr. Lindeman is successful as a teacher with poorly motivated, low achieving students. He has gained their respect. They do complete work for him, pay attention in class, do understand and retain some of the material selected for them to learn. Both the interviews and comments in class verify the appreciation students have for Mr. Lindeman. On October 30th, Jack asked, "Heh Chief, did you ever get the good teacher award?" Mr. Lindeman's answer, "No Jack, you going to give it to me? Again on December 15th, Ross calmly observes, "Chief is always ready!"

First of all, Mr. Lindeman has not "given up" on these students. He does have substantial expectations for them, even though they are classified as "General Science", for the poorly motivated, low achieving students. Many of the terms and concepts are the same ones taught in regular biology – plant pigments (carotene, xanthophyll), cell types (parenchyma, abscission). This is in contrast to student reaction to the *Investigations in Science*, by Harry Wong, which some students feel is

an affront to their dignity, treating them like 6th graders (Teacher interview, 6/27/89. Record #189). However, it appears that his expectations for this group are lower than for his other classes. Analysis of classroom discourse indicates that he often gives answers, not waiting for students to respond.

Furthermore, Chief is a real encourager in a lighthearted sort of way. The comment, "My! Look at that guy! A walking encyclopedia," elicited a smile from Scott and a chuckle from the rest of the class. Even the student who found the answer in his notes was commended, "At least you know where to find it."

A part of the encouragement that is offered in this class is the feedback on work. It may be well to examine the feedback offered by the teacher to determine its role in successful students with this target population. First of all, feedback given by Mr. Lindeman is immediate. Worksheets and quizzes are orally corrected at the end of each period. Written feedback is limited as few written papers are assigned, collected, and graded. Oral feedback is given to answers in an encouraging and supportive way during discussions and while Chief walks around the room during work periods. Furthermore, this feedback is specific to questions, informative in developing understanding, and non-normative in evaluation, thus hypothetically tending to increase intrinsic motivation (Butler & Nisan, 1986; Corno & Rohrkemper, 1985; Ryan, Connell, & Deci, 1985). These authors claim that this type of feedback helps establish learning rather than performance goals. Evidence to date from this classroom does not seem to support this position. The concern for grades and correct answers on tests suggest that performance goals are the higher priority in this classroom. Furthermore, the negative coping strategies used (almost total dependance on the teacher for informational input, non-use of the textbook, lack of written expression, and use of notes on tests and quizzes is geared more to "task completion" and does not



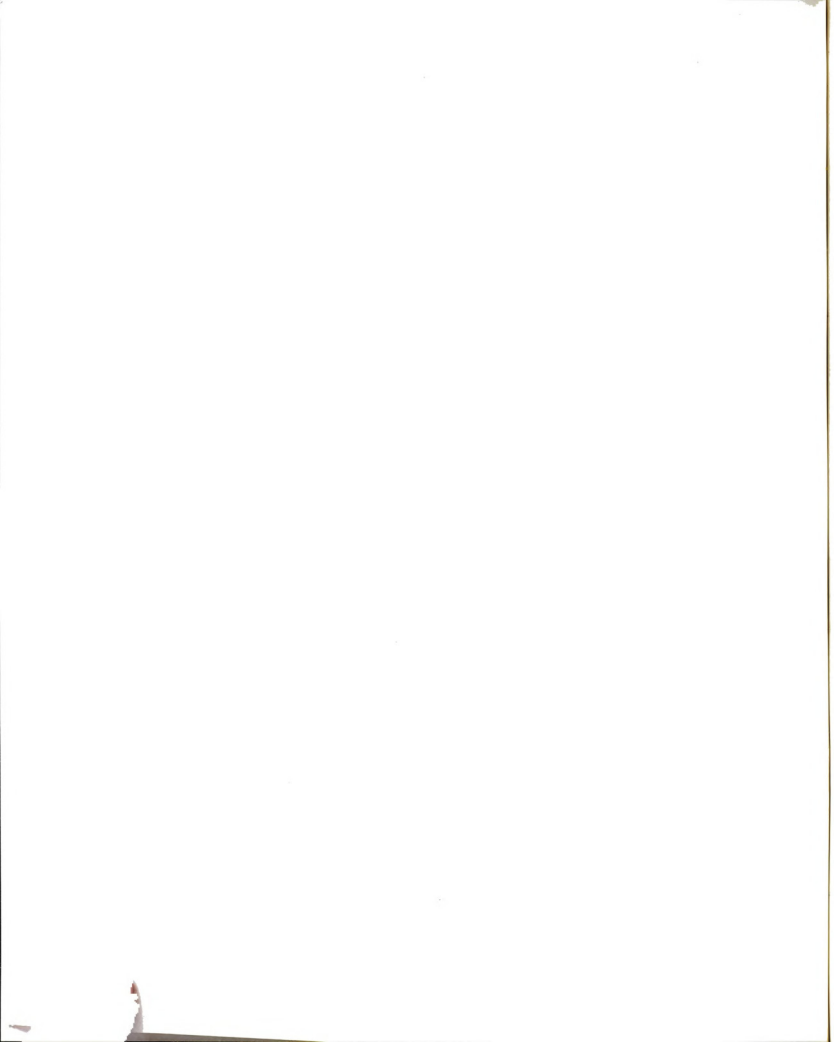
"contribute to mastery of content or maintenance of adaptive learning-to-learn skills" (Cullen, 1985, p. 290). Still, the feedback given by Mr. Lindeman is definitely not judgmental, is non-normative, and is directed toward building up their low self-esteem.

An operational definition of a successful teacher for low achieving, poorly motivated science students based on an emerging profile may include:

1. High average daily attendance
2. Openness of the students to ask questions
3. High on-task level of activity during instruction and learning activities
4. High ratio of instructional vs. management time
5. Achievement of learning goals for a particular program

Accepting the fact that by the above definition, Mr. Lindeman would be considered a successful science teacher for this group, at least relatively, and an analysis of the pedagogical routines and management procedures used by him may provide some insight as to what is workable with this particular population of students.

First of all, we will assume that learning is enhanced when there is a good relationship between the teacher and students. Thus, in an attempt to glean useful information from this setting, we may ask, "What builds a good relationship between the teacher and students? Several factors seem to underlie the relationship Mr. Lindeman has established with the students. First of all, he takes an interest in the personal lives of the students beyond the classroom. The comment to Len, "How long was your run last night, Len?" would suggest this. Further evidence to support this assertion is the ability of the teacher to supply personal and family information about the students (teacher interview, 10/23/89). Secondly, even though many of them have been classified as special education, it is evident that he cares about the students and treats them with respect. During the eight days of classroom observation, not one



instance of sarcasm or "put-down" was observed. Instead, he allows them to voice their opinions and actively listens to them as they speak. Thirdly, the ability to use humor effectively in difficult situations helps dissolve frustration and anger, often common to these students. Comments such as "We have an English major here! (Field notes, 10/30/89) illustrate handling of an episode in an encouraging manner, even though some teachers would respond to the student query as a challenge and use a put-down to deal with it.

Fourthly, he responds to student answers in an accepting manner, even when incorrect. Examples of responses to wrong answers include, "Good guess...you are getting the right idea". In clarification of a test question, his answer was, "Acceptable, let me reread it and discuss it with you."

The analysis of the teacher-student interactions may be broadened by rephrasing the question to, "What are the characteristics of a teacher who is successful with poorly motivated, low achieving science students?" This allows us to consider a broader range of factors, which can be approached on two levels: 1) the underlying qualities that build a good relationship and in turn promote successful learning for the students, and 2) the types of pedagogical approaches that convey these qualities to the students. For instance, the "check and pause technique" used by Mr. Lindeman does two things - it allows the teacher to pace instruction so students have time to record notes accurately and secondly, conveys to the students a message that the teacher is a patient, caring individual, willing to take the time needed to help students understand and be successful.

I believe the analysis needs to be separated on these two levels (individual characteristics and pedagogical strategy). Consider, that some caring, patient, teachers (due to their own frustration, inability to cope, lack of adequate preparation

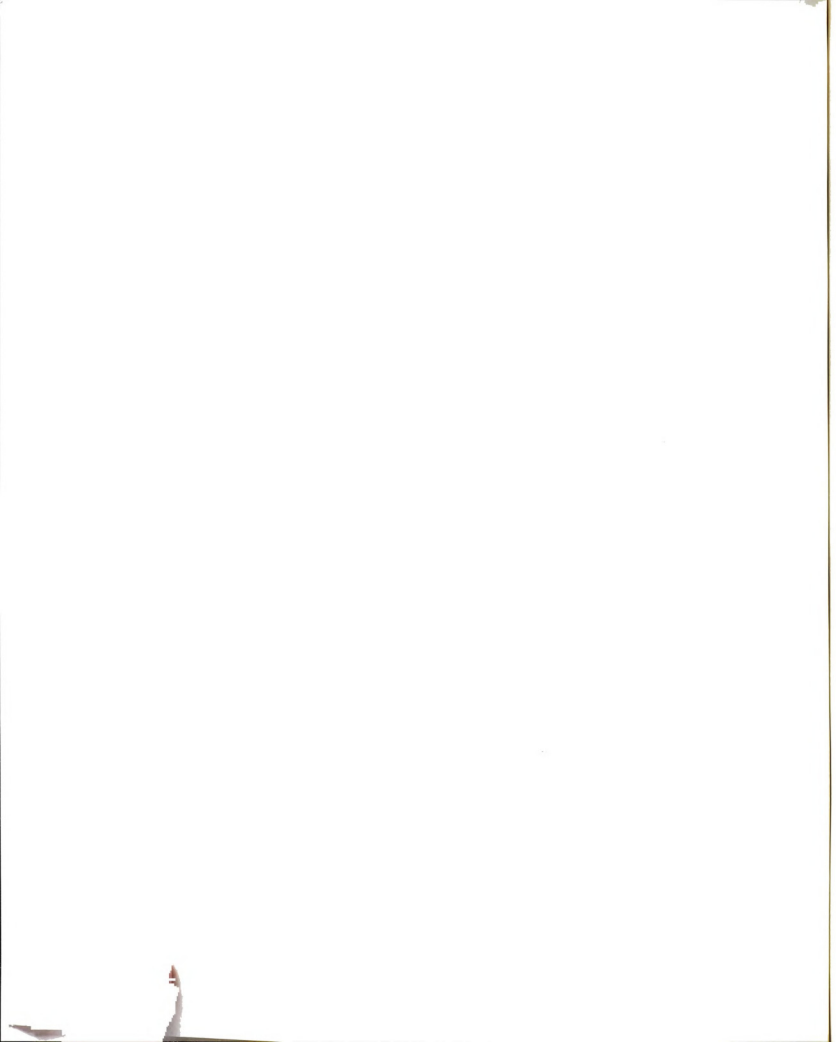
time, or simply difficult classroom situations) are unable to cope, and end up responding in a way that communicates impatience and lack of care to students, even though that is not their heart.

One more aspect to investigate regarding this teacher. Is the teacher/student interaction primarily with target students? To investigate this parameter, a classroom seating chart was constructed. Each time a student/teacher interaction occurred, a slash mark was placed in that position. An interaction would be defined as the teacher calling on a student, a student volunteering an answer, calling out an answer, or asking a question.

Results:

1. Of the 21 interactions counted in a five minute period, three were with student E and X each, one with students O,P,R, and S, four were with student W, and 7 were with student T. Thus four students dominated 3/4 of the student/teacher interactions. With sixteen students no interaction occurred.
2. In another count by the research assistant, five students dominated the conversation: Brent, Tom, Donna, Sarah, and Jack.
3. One male student in the front corner (Stewart) and one girl in the middle left (Connie) seem isolated and do not interact at all, even in casual free time conversation.

In summary, data supports the position that while Mr. Lindeman is liked, respected, and considered a very successful teacher by these students, he also is not equitable in attention to all students. The question still remains if the material selected or the activities used do really prepare them to function in our present technological society.



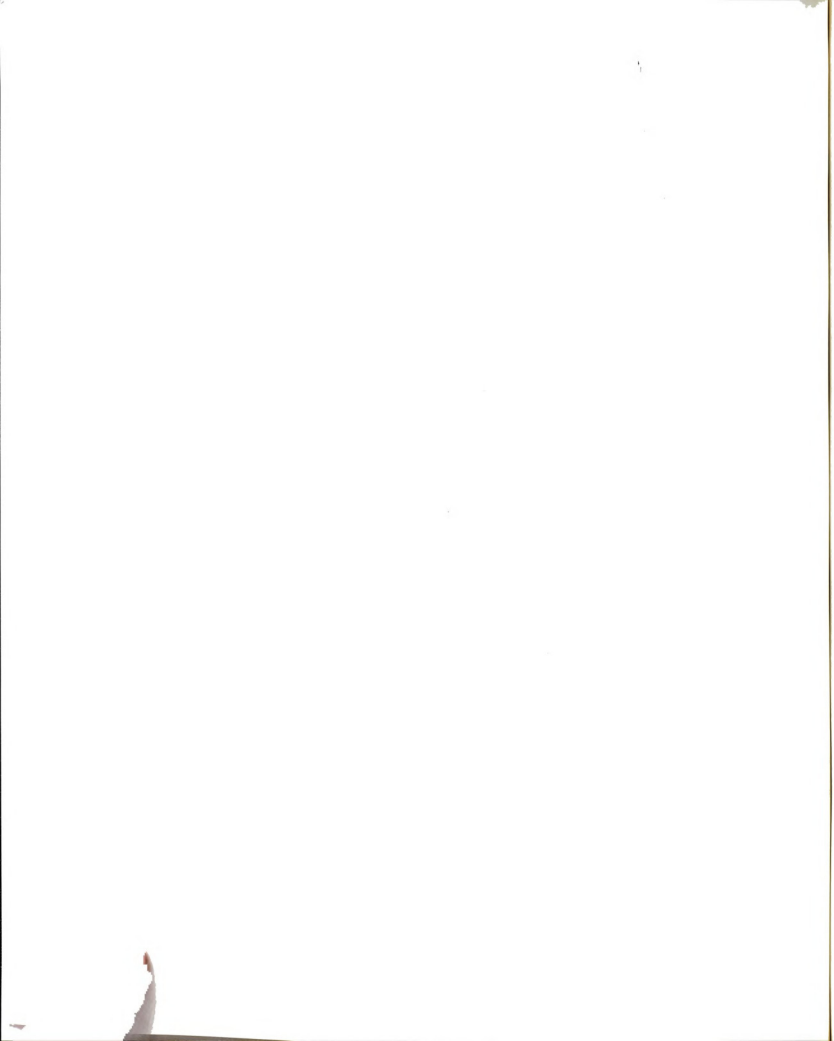
INTRODUCING THE NEW CURRICULUM - AN EMERGING ROLE

The day has finally arrived, November 6th, 1989, the day we had agreed upon to start the new technology curriculum using the unit "Weather." This was a time of high expectations. I would be working with a willing competent teacher, considered successful by students and administration alike. The students in this class were typical of the poorly achieving profile, except that they still did care and want to learn.

At the beginning of the period, Mr. Lindeman asked me to explain to the students the purpose of the project, expectations from students, the research basis of confidentiality, and consent. The teacher then administered the pretest and assigned Lesson 1 to be read for homework. I felt we were off to a good start, but slightly uneasy as it is difficult to be the researcher recording the events and episodes of classroom life when the role of the participant overshadows the role of the observer.

This section provides the opportunity to verify or nullify assertions from Main Research Question Two, as follows:

1. New science curriculum developed out of house, is viewed by science teachers as unworkable for the real classroom.
2. Teachers hesitate using new curriculum activities, especially those that require small group activities, student movement from place to place, or working with materials and equipment.
3. Teachers will use activities and strategies if the researcher is present and works directly with the teacher and students.
4. A teacher returns to the familiar routines when the observer is not present.
5. Teachers adapt a new curriculum to their own teaching style by using topics and content of the new curriculum but retain the same instructional and management strategies.

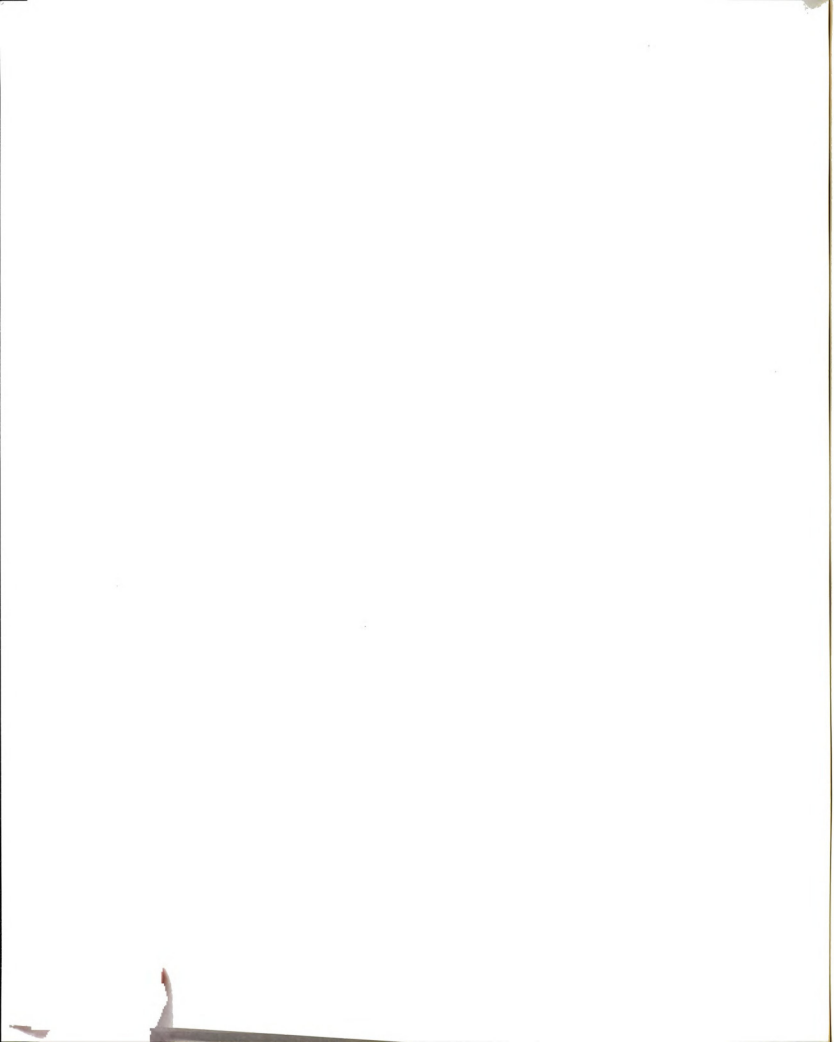


Hesitancy – Initiation of a Changing Role

The hesitancy I sensed in the reluctance of teachers to initially participate in trial teaching of these units, and the reservation stated on October 26th ("Teachers do not dare to use activity type lessons") now began to express itself in action. November 7th, the second period with the new technology materials, started with the usual routines – Chief taking roll while standing up at the overhead engaging students with informal chit chat. Time for class to begin. I waited. Chief just looked at me with a questioning look on his face and waited. Finally, I came up to the front and decided to illustrate the importance of tying ideas together to help students understand what is really happening in science. I started with the question of "Why do clouds have flat bottoms?" Using a demonstration of water condensing on an ice filled glass, we were able to establish that:

1. Air has water in the form of water vapor.
2. The water vapor changes to liquid water when cooled.
3. The "dew point" is a specific temperature at which condensation begins.
4. The temperature falls as one goes up in the atmosphere.
5. The flat bottomed clouds are due to the fact that this altitude represents the temperature at which condensation begins.

This introduction was concluded with the point that the flat-bottomed clouds explanation is an example of how the new materials were designed to help students take various ideas (called concepts) and link them together to make good explanations of scientific phenomena. The hesitancy demonstrated in this lesson substantiates Assertion Two and is further illustrated in forthcoming lessons.



Who's Teaching?

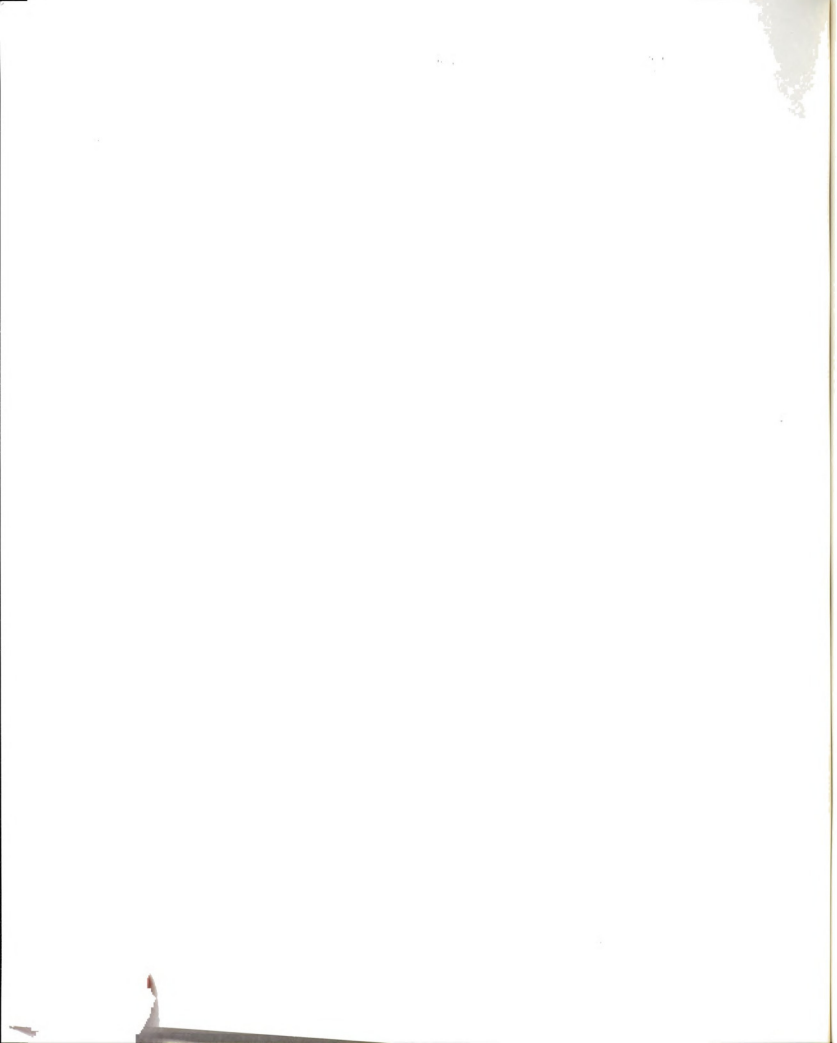
Looking for some way to extract myself from an emerging teaching role, I asked for two volunteers to help carry materials in from the car. Thus the leadership of the class was returned to Mr. Lindeman, who used the rest of the period on Lesson 3 – forming groups, planning materials, and allocating responsibilities. Mr. Lindeman informed me that the weather station itself would be built by three of the boys in shop class. However, the shop teacher does not allow anyone to work in this area without a preliminary plan already designed. Consequently, I spent the remainder of the period helping three boys draw up the specific dimensions for the weather station. Mr. Lindeman assigned the rest of the students to complete the written work for Lesson 1 – Weather Predictions.

Reflecting on this first working day, I was pleased that the students responded favorably to the discussion, but was increasingly uneasy about being involved as a participant to the degree that it would be difficult to collect adequate research data to support the questions proposed for dissertation research.

Purposefully Late

How the mind contrives in a difficult situation! The following thought motivated a slow start in getting to school, "If I would come about five minutes late, surely the teacher would have complete command of the class, and everything would be rolling under his direction upon my arrival."

So on November 8th, I arrived three minutes late at 2:03 PM. Class was already underway with the teacher at the overhead projector as usual and the following assignment on the screen:



Types of Climates

Desert

Polar

Tropical

By now I was scratching my head, not remembering a particular lesson on climates. However, I did discuss with the teacher, at some length, the use of contextual links and conceptual links. What is happening? Is the teacher using my suggestions and using contextual links to make the material relevant to the students? Or...is the teacher simply using some material from former lessons which he happens to be familiar and has materials ready to go? The lesson now takes a new turn with the question, "How does weather influence fall biology?" The teacher now begins to lecture on leaves changing color, migration, and hibernation.

As I try to analyze the hesitancy of Chief to use activities and experiments with "these" students, I am gaining insight into the reluctance first expressed. As an experienced teacher, who also went through the "hands on" discovery era of the sixties and seventies, he must have come to realize that the philosophy of the "teacher getting out of the way" and letting the students "mess around" simply did not convey the ideas intended and often created misconceptions (Smith and Anderson, 1985).

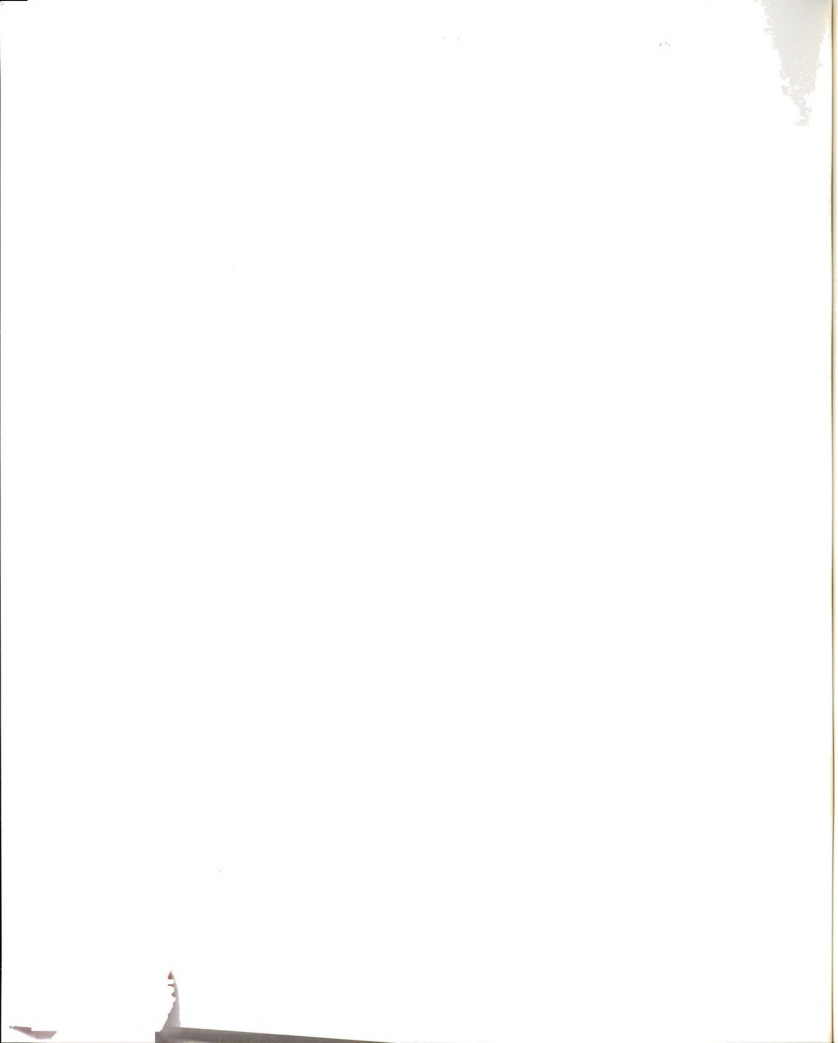
A better understanding of this hesitancy was gleaned on Monday, November 27th, the first day students had an opportunity to work alone in small groups with a "participant involvement type" activity. Project materials called for students to work on concept maps in small groups. On a previous period (Nov. 22nd), we discussed factors used in weather forecasting, the instruments and units used in measuring these factors, and finally what each factor could tell us about the upcoming weather. These were then used to demonstrate the construction of a concept map, writing the factors on small pieces of acetate, arranging them on the overhead projector, to demonstrate

how the various factors and resultant weather are tied together by circles and lines. At the beginning of this period, I briefly reviewed the purpose of concept maps, the factors, instruments, units, and the conditions that are used in forecasting. The students were then given Post-Its on which to write the individual items listed in the brainstorming session. It soon became apparent that students were not used to working creatively in small groups. The reaction was interesting. Most of them just stood around, talking and joking. I tried to figure out what was going on or what was wrong. So I started walking among the students and noticed a new activity. The students were writing their own messages on the Post-Its and pasting them on the back sides of other students: "I'm dumb.....Kick me!". I glanced over to the teacher, who looked back at me with an embarrassed and uncomfortable expression of, "See, I told you so!", recalling the entry statement, "We do not dare these activity type activities."

We then circulated among the students and got the small groups working, encouraging students to write each of these lists on different colored "Post-Its" and arrange them on the large sheets of paper on their own tables.

Reflecting on this lesson, a few impressions come to mind:

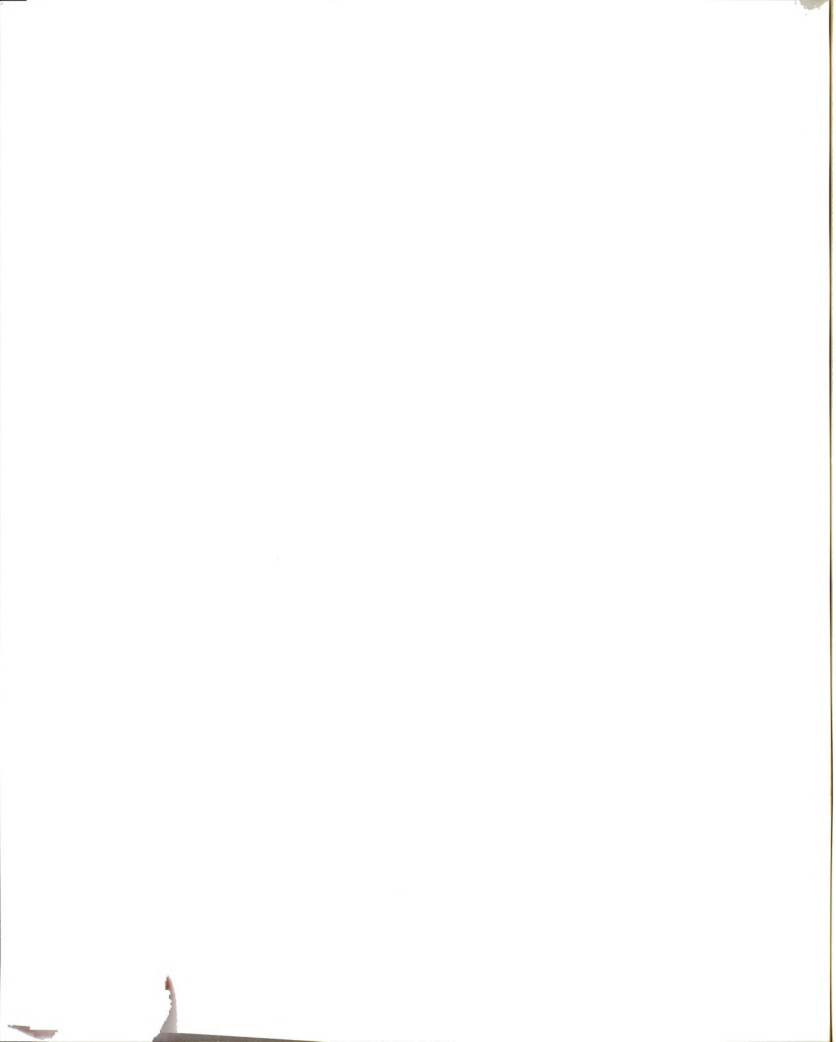
1. The struggle remains to maintain the role of a researcher in the room and observe the teacher interacting with the new curriculum. This first lesson of the new curriculum continues the role of a participant/observer.
2. I wonder about the lack of response among the students and the goofy alternate response to the Post-It Activity:
 - a) With the directions and demonstration having been given the previous period, did the students remember how to complete the activity?
 - b) Did the students fail to see the purpose of the activity and not take the



activity seriously?

3. It has already been established that students do care (p. 144). However, the enigma deepens as one seeks to understand how students who do care are in some ways reserved and hesitant about involvement type activities. Many of these students have experienced failure in the past, and when uncertain, would rather not try again than risk another failure.
4. The second element of the lesson that seemed to stand out was the change in both the attitude and involvement of the students as Chief and I went out among the students and helped each group get started. Expressions changed from a bewilderment to a sense of satisfaction in being able to complete something correctly. This reaction brings to mind the coaching model, as was explained in an article by Anderson, 1987a; Collins, Brown, & Newman, 1987).

The initial inaction, subsequent goofing off, and the terminal change in behavior suggests that the student reaction could be attributed to student inability to process the activity procedures rather than inherent behavioral characteristics of the students themselves. Thus evidence from this lessons supports Assertion Number Three from Main Question One that the poorly motivated, low achieving students do have difficulty following instructions for extended activities given in oral or written form. The question still remains as to how much of this reaction could be attributed to the inability of students to process the procedures and how much is due to inadequate instruction and direction on the part of the teacher. It is clear however, from my thirty years of teaching experience, that the level of procedural direction given in this instance would have been adequate for an average to above average class. This then strongly suggests that another form of procedural direction is necessary with these students, perhaps in the form of modeling and coaching as propounded by Anderson (1987).

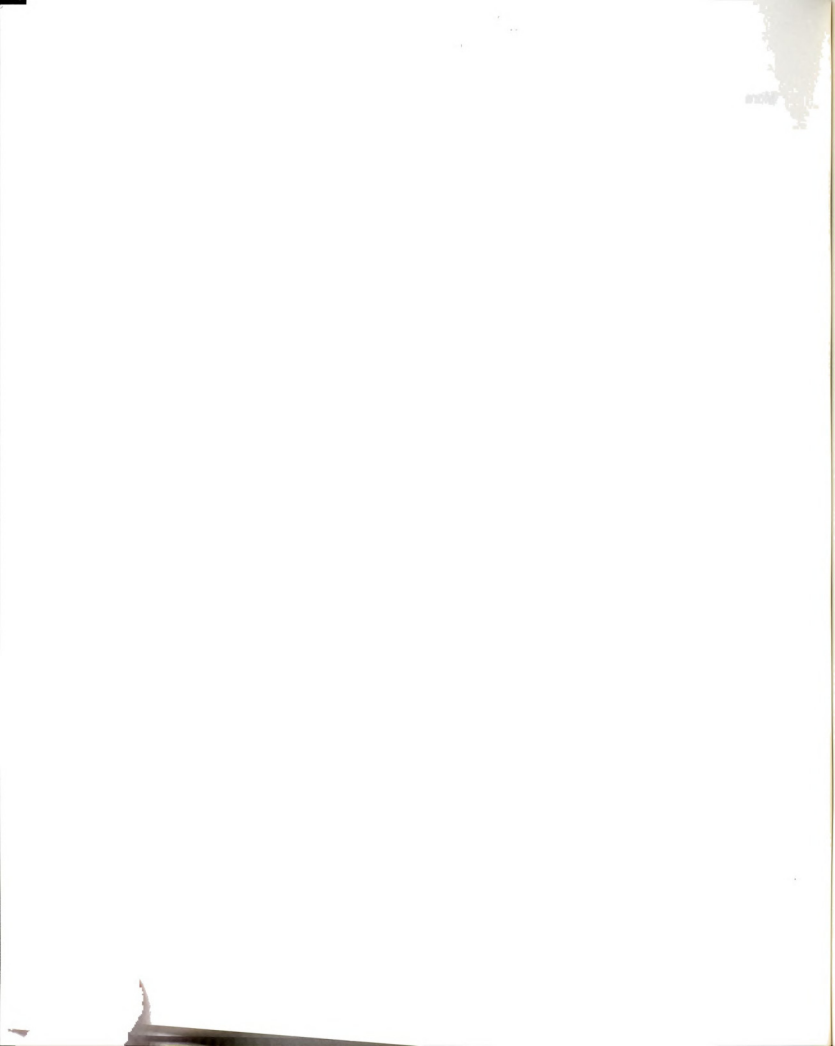


More information will be needed to settle this question.

Abandonment of the New Curriculum

From the beginning of the new unit "Weather", it soon became apparent that patterns of the former teaching routines would be carried over into the new teaching unit, especially in the absence of the project researcher. Both the researcher and the research assistant were absent from the classroom between November 9th and 14th conducting interviews with individual students and between November 15th to 18th assisting in teacher training workshops at Flint and Marquette. We had hoped that, on our return, the weather unit would be going full swing. However, other than the assignment, this last period indicated a total reversion to the study on mammals. The last observed lessons on November 7th and 8th dealt with the topic of "clouds". The assignment given on November 20th was "Do pages 16 and 17 in your Activity Guide Books", indicating that the weather unit was dropped almost entirely from the teaching schedule during our absence, giving substance to Assertion Number Three stating that teachers will use new activities and strategies if the researcher is present in the classroom and works directly with the teacher, but will revert to old familiar routines in the absence of the researcher.

The same pattern continued during our next absences. On Tuesday, November 28th, I was involved at the university and on Wednesday, November 29th, we conducted a teacher training workshop in Lansing. We hoped our absence would allow the teacher to maximize his own creative ability. On our return, I discussed the activities transpiring during our absence with a few students. We were able to establish that, on both days, the time was spent viewing videos, the topics again in the field of mammals. The pattern of complete abandonment of the new curriculum materials and reversion to old content and routines continued during future absences,



on November 29th (Lansing Workshop) and on December 6th (Kalamazoo Workshop) during which time class instruction reverted to the video routine of viewing with commentary, cooperative completion of worksheet, and quiz worksheet

The justification for complete reversion to old routines was not initially clear.

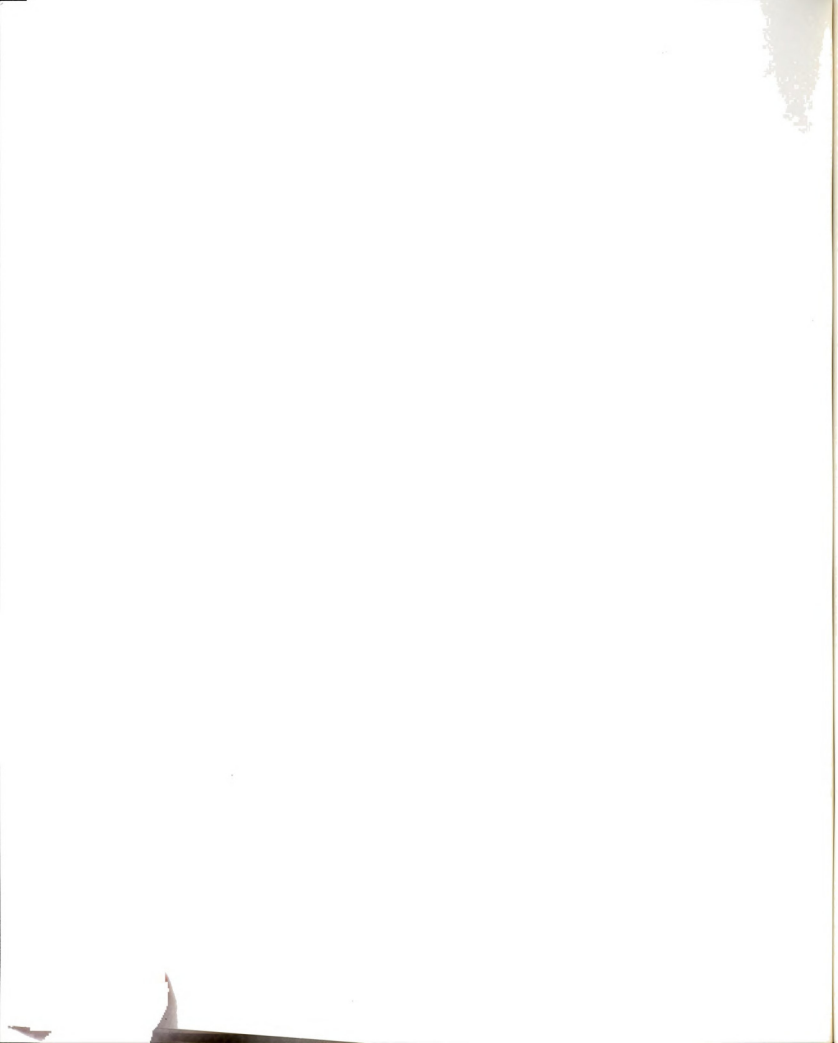
The following assertions were considered for further investigation:

- 1) The teacher was not familiar with the materials and felt uncomfortable going ahead with these type of activities.
- 2) The teacher believed that for these type of activities and for these type of students, one teacher in a classroom was insufficient to give the individual help needed.
- 3) The teacher is using the material from the weather unit more out of commitment to the research agreement and less out of a conviction that this material is worthwhile to use with these students.

Retention of Old Content and Routines

The response of the teacher to the new curriculum not only involved complete abandonment of new materials in the absence of researchers, but also retention of old content and routines while the researchers were present in the classroom, usually allocating about half the period to the old content and about half of the period to weather (Assertion Numbers Four and Five).

The video routine continued to be interspersed between the new weather activities. The video "Kodiak Island" on December 14th again followed the same pattern of commentary viewing, cooperative worksheet, and quiz. Additional videos (January 23rd, 1990, February 8th, February 26rd) further substantiate this assertion.

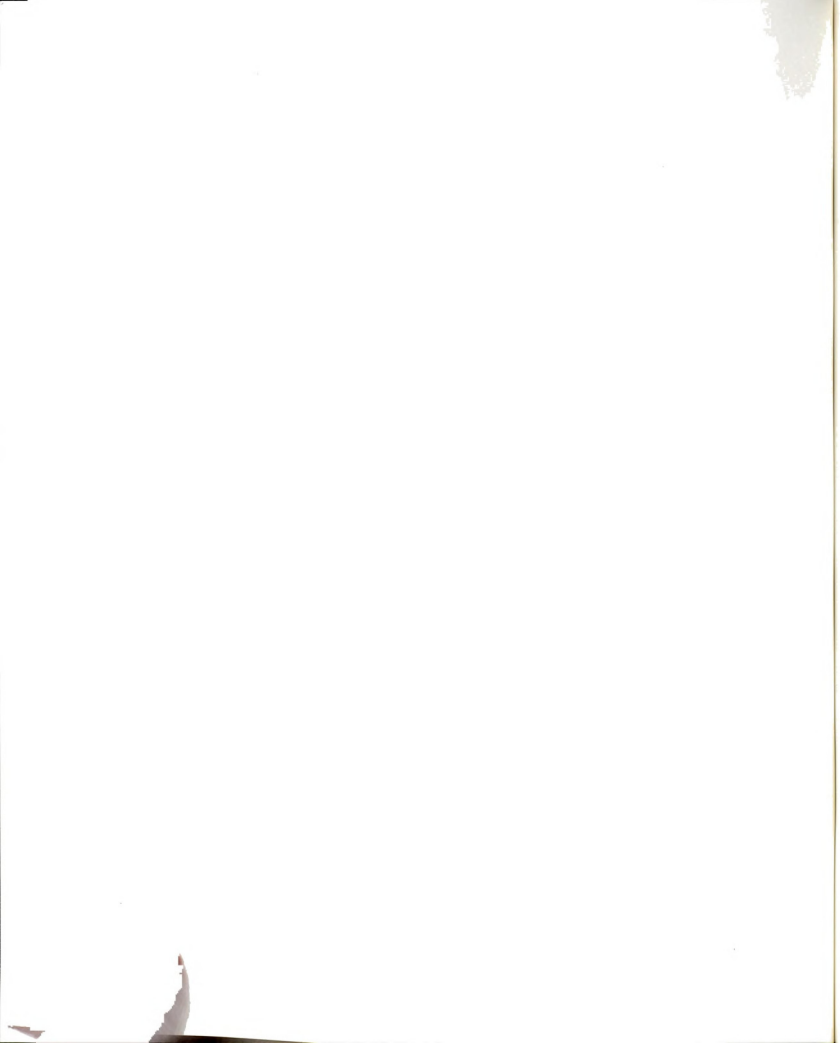


The presentation/lecture routine, so familiar in the mammal teaching in October, 1989 now began to reappear. On November 30th, Mr. Lindeman gave notes on cloud types and then supplemented these notes with a set of slides. A comment on December 1st supports the "drill" aspect, "We are going to review the slides again to see if we can get it into their heads," (pointing to his temple). The element of repetition is again used as a technique for helping poorly motivated, low achieving students master a certain body of material. The slides were shown three times (11/22, 11/30, and 12/1), and with the quiz on slides having been used four times.

The presentation/lecture routine not only included weather topics but occasionally reverted to the old content as on November 20th with a lecture on deer, January 25th and 31st with lectures on the orders of mammals, February 1st and 5th on organs and systems, and February 20th and 21st on fossils. This illustrates the retention of both old content and old routines simultaneously. Quizzes continued not only for the mammal lessons, but were introduced for the weather lessons (Nov. 8th, Nov. 22nd, Dec. 6th, Dec. 14th, Jan. 8th, and Feb. 9th.) Instructions are virtually the same: Sit on the ends of the tables, you may use your notes, no rubber necking, exchange, and correct.

Vocabulary words and spelling lists were also introduced into the new unit and illustrate further retention of old routines and adaptation of a new unit. A spelling list was given to the students on December 4th. The spelling quizzes on November 9th (weather instruments) and December 6th (forecasting words) were vocabulary definition in nature.

The continuation of old routines extended to management routines as well as to instructional routines. In the new unit the teacher is using more student involvement activities, but still tenaciously holds to the TV model of instruction, still switching



between short lectures, quizzes, activities, and inserting videos for a break. The use of the "pause and check" technique continues. These interchanges often take on a lighthearted touch as illustrated on January 8th, "Laura always yells at me!....Can we roll? Is Laura ready? Don't want her to get mad at me on Monday." Another example of the continued use of the "pause and check" technique is on January 31st. This incident also gives an instance of the continued use of the non-confrontive rebound. Peter has a yardstick in his hand and is waving it around in sword-fighting position, at which Chief comments, "Hey Peter, you Darth Vader?" Two days later as Jack has his arm around Claude's neck, Chief remarks, "All right Jack, save it for tomorrow (Jack is on the wrestling team). Later as Claude and Brent are trying to tie Jack up with wrestling tape, Chief remarks, "You guys want to pay for the extra tape?" At the beginning of a quiz on March 2nd the following interchange takes place:

Teacher: Let's do a little writing. Write in your notebooks.

Jack: No!

Teacher: Do it anyway!

Jack: Why should I do it?

Teacher: Number one, I said so, and number two I'll argue later. (Jack gives up the argument and begins work).

(Later on during the same period)

Teacher: No feet shufflin', no nose pickin', no rubber neckin', no rump slidin'.
.... Don't think too hard so think!

(Students work quietly on quiz, rustling around in notes for answers).

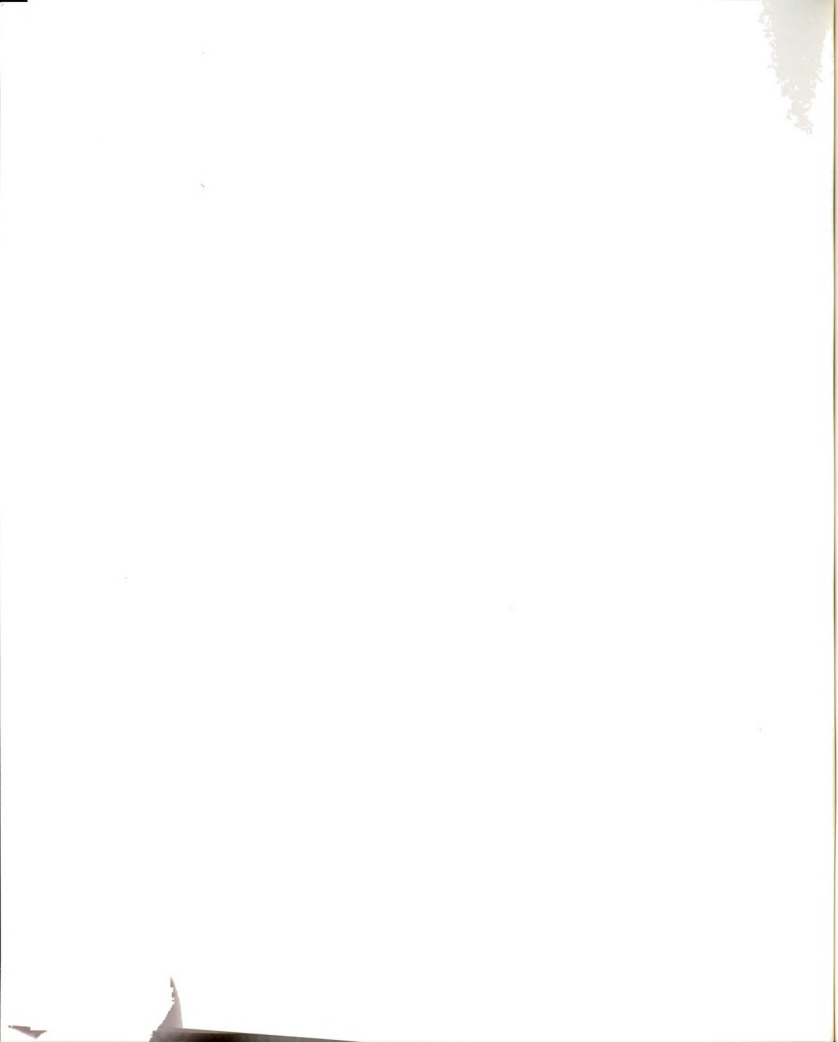
Ross: Gonna get mad! (frustrated when he can't find an answer).

Chief: When you get mad, go to the second page.

Ross: Don't get what I don't know!

Chief: Nothing to lose by guessing.

These last few periods again offered some excellent additional examples of what I had called the "non-confrontive rebound". I have seen instances in classrooms where a student simply says "No!" to a teacher (as the case with Jack above) and the situation escalates into a major confrontation. Chief rebounds in the most unruffled manner with a "Do it anyway".... and then in answer to the question "Why?", answers,



"Number one, I said so, and number two, I'll argue later." Part of the psychology of making this "rebound" work, is 1) accepting students for where they are at the particular moment (Jack – angry, Ross – frustrated, Donna – mouthy), and 2) offering a creative alternative, "When you get mad, go to the second page."

This section shows how a bit of color can both brighten the classroom and establish standards in a non-threatening way. All students understand the quiz instructions, "No feet shufflin', nose pickin', rubber neckin', and no rump slidin'.

Modification and Adaptation

The modification and adaptation, so characteristic of the implementation at Western High School, was again repeated at Cranston High School. Some of these modifications actually improved the quality of the unit. The slides used to teach the kinds of clouds were very effective and added the local touch of realism by including local buildings and people. Secondly, the graphing of the weather data from the long-range weather record was not included in the original material. The decision by Chief to have the students graph the weather data which he had faithfully collected over three weeks (November 21st to December 14th) proved to be a welcome addition to the project materials. This graphic display of the weather data provided a visual link between various instrumental measures and weather conditions. For instance, the correlation of falling barometer pressure with rain following a few days later was easy for students to see and understand. Even the unexpected result of colder weather on sunny days and warmer weather on cloudy days later gave an opportunity to illustrate the greenhouse effect. During this period the identification of "sun dogs" and the following cloudy drizzly weather (correctly predicted) helped to convince students that they could really forecast weather.

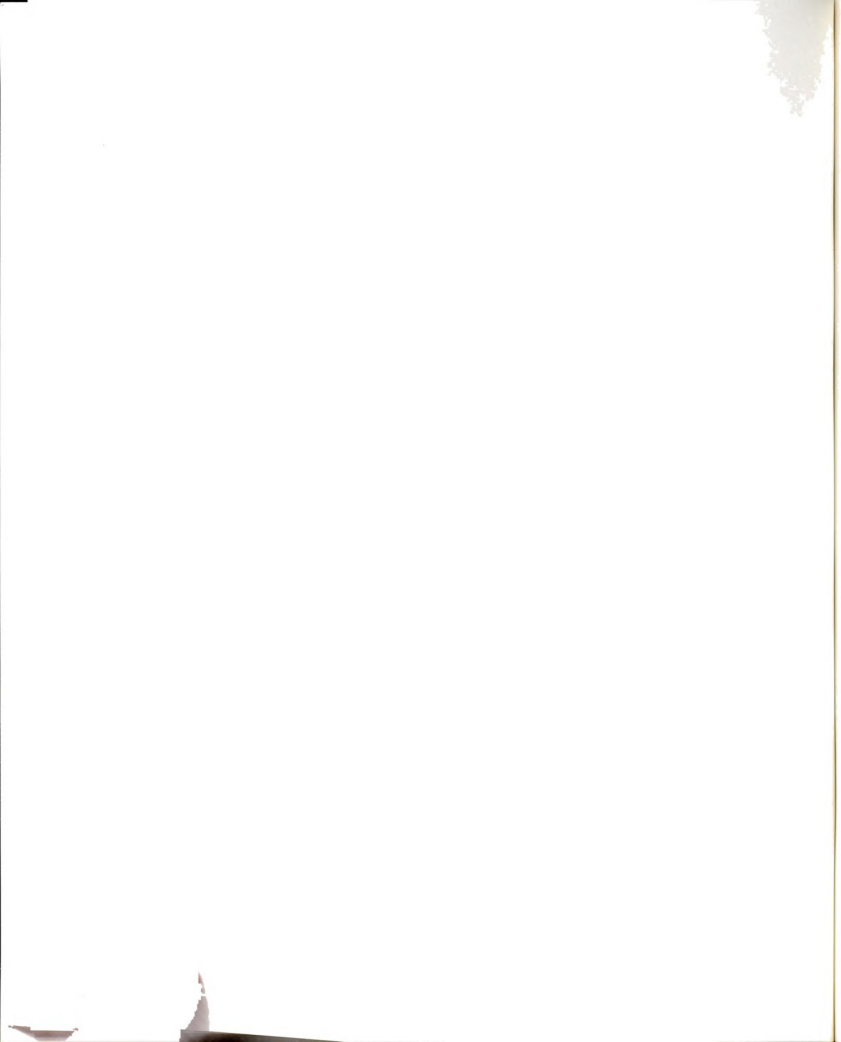
On the other hand, some of the modifications of the unit material constrained

the potential of learning. For instance, most of the data collecting was completed by the teacher himself, rather than having the students read the instruments and record the data. The disadvantage was depriving the students of the experience of using instruments. The advantage of the teacher collecting the daily readings provided an accurate source of data that helped develop understandable links between observations/ predictions and forthcoming weather. Another form of modification was the deletion of whole sections of the unit. The activities that centered around the weather maps were completely omitted. The itemization on completion (next major section) will provide more details on parts completed and omitted.

Student Response

During the course of the implementation period, the teacher began to incorporate more and more of the activity type material with the students, beginning with the creation of concept maps (Post-It Incident) and later with the graphing of weather data. Student responses could be characterized by type (goofing off) and by amount (on/off task behavior). The initial type of student response was characterized by inaction, developing into a "goofing off" activity. This was demonstrated on November 27th with the Post-It Activity, on January 26th when Steward let out a screech in class, "It hurts" (Brent had put tape on his hair and then pulled), and on January 31st (Darth Vader incident - two boys swordfighting). Various cumulative comments helped me understand the logical progression that characterizes traditional thinking and justifies the teacher's response in working with the poorly motivated, low achieving students:

- a) Most students do not get "the point" of these experiments by themselves.
- b) These students have great difficulty in following directions on their own.
- c) In that these students cannot follow written directions very well and do not



know why and what they are doing in experiments, they would rather not try at all than fail again.

- d) Students must be kept busy, or they will creatively find a substitute activity to fill the time.
- e) If given materials, they will use these materials to goof off.
- f) In the minds of students, failure can be attributed to "goofing off" rather than being forced to admit their own personal inadequacy.

The response of the students was significant in that it changed drastically from the beginning of the unit toward the end of the unit. The first significant change during the course of the unit involved a change of "goofing off" during the work period (stunned/substitute response) to goofing off at the end of the period after work was completed (fill-time with fun response). For instance, on February 2nd, Steward and Peter finished their chart, made a puck out of masking tape, and started their own little hockey game using meter sticks for hockey sticks, while Claude and Brent were busy tying up Jack with three inch wide masking tape. The second phase of development involved a decline in the amount of disruptive behavior so that by the end of February total periods were observed without one "goofing off" incident (Feb. 21st & 23rd). By now students had developed a better comprehension as to the purpose of activities, understood the procedures, and were able to make sense of the data to draw valid conclusions.

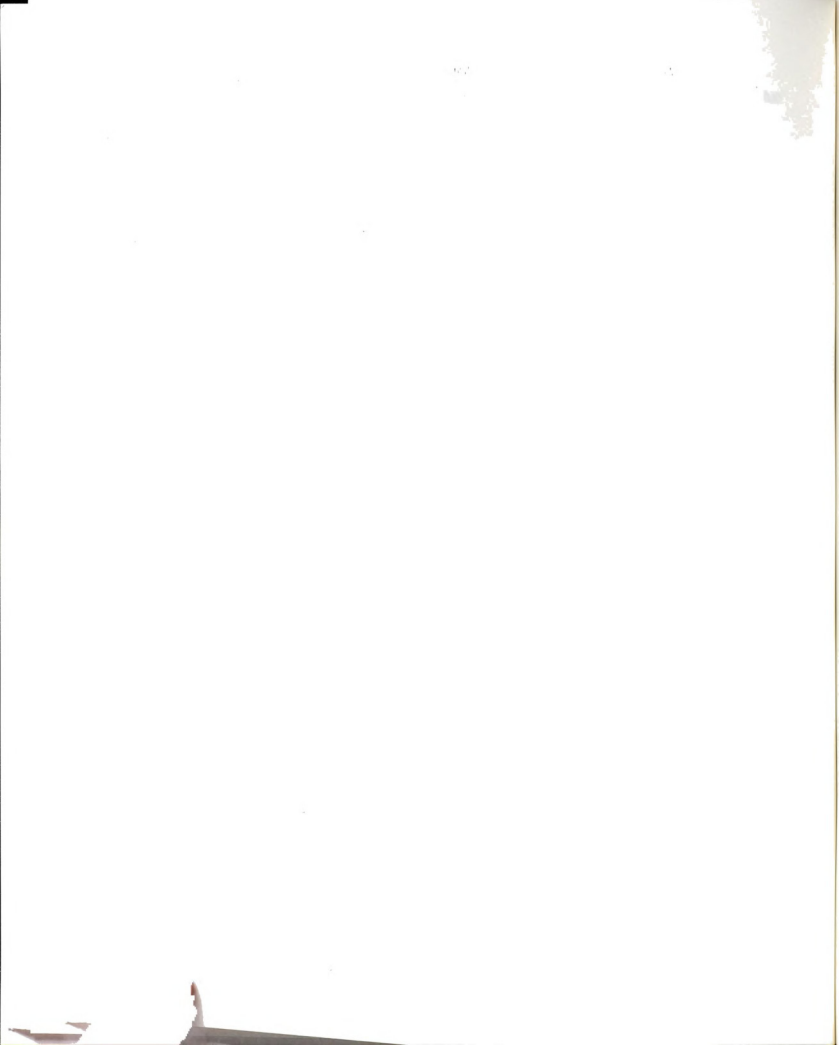
The second dimension involved a change in on-task behavior of the students. The first small group activity on November 30th was characterized by the students spending most of the period standing around, visiting, and completing little work. By January 22nd, engagement in productive work had risen to 65% during small group activity time. By January 31st, spot counts revealed on-task activity up to 96% (22

out of 23 students actively working), the engagement even now near that of direct instruction. Other counts on forthcoming days substantiate this level of on-task behavior (February 22nd, March 2nd).

Another dimension of interest to this research in regard to the response of students involved the development of meaningful conclusions after a series of experiments, and the coherent explanations that conclusions should develop. In Lessons 18 through 20 (January 26th through February 8th), the students completed a series of experiments in class. We discovered that the students did not develop explanations for phenomena or get the point of experiments and demonstrations by working alone. The active role of the teacher was again needed to relate the activities to the corresponding concept in weather, bringing to mind the model expounded by Anderson (1987a) on the nature of science in which he sees four major activities in scientific endeavor; namely observation and description, explanation, prediction, and control. In evaluating the role of each one of these in science instruction, Gallagher (1989b) asserts that science instruction must focus more on observation, description and some prediction, but avoid most explanation in the lower grades. He concludes by explaining that "too much explanation before students are ready is problematic and self-defeating and damages their self-esteem" (Team meeting, Nov. 13, 1989). In designing curriculum for the poorly motivated, low achieving science students, this suggests that the major emphasis should be on observation, description, and prediction, and that the major part of explanation will have to be supplied by the teacher, or worked out cooperatively with the teacher and the students.

Impact on Implementation

The initial handling of the new project materials could be characterized as "token teaching" at best. An analysis of progress yields the following assessment.

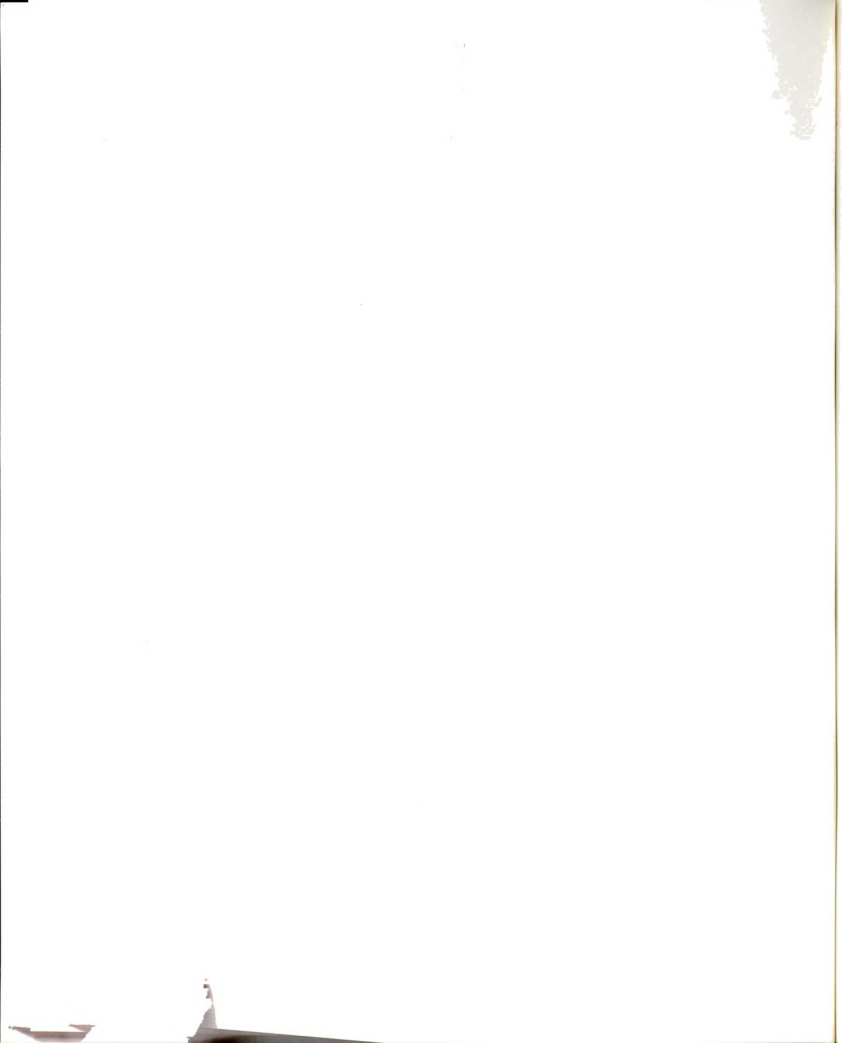


Lesson 7 "Clouds" and Lesson 8 "Air Masses and Fronts" were initiated on November 20. These two lessons were finally finished on December 14th, a full 17 class periods later. This measure of progress in the "Weather" unit is further substantiated by the quiz given on 12/14/89, on the topics of air masses and clouds. During this same period of time, the class viewed seven videos on various mammals (See class progress log and Records 59-66). Many lessons were complete reversion to the mammal content (i.e. videos, lectures, and quizzes).

Many of the weather lessons were modified or dropped. Many of the periods were split, using about half of the time on weather and about half of the time on mammals. The analysis suggests a "pick and choose" utilization of the project materials as indicated by Table 6-1.

Table 6-1: LESSON COMPLETION ON UNIT WEATHER

LESSON NUMBER	LESSON TITLE	COMPLETED	MODIFIED	SKIPPED
1	Weather Predictions	yes		
2	Weather Reports			yes
3	Weather Instruments	yes		
4	Planning a Weather Station	yes		
5	Synthesis		yes	
6	Collecting Weather Data		yes	
7	Clouds	yes		
8	Air Masses and Fronts	yes		
9	Making Sense of Weather Observations		yes	
10	The Weather Map: What's On It?			yes
11	Making a Weather Map		yes	
12	Comparing and Interpreting Weather Maps			yes
13	Local Weather Signs			yes



As can be noted in the Table 6-1, of the first thirteen lessons listed in the "Weather" technology unit, five were completed as intended, four were modified, and four were skipped.

Another interesting comparison is the matching up of planned versus completed lessons as illustrated in Table 6-2. The second column represents the schedule that the researcher and the teacher had established in a cooperative planning conference. The third column represents the final outcome of events that actually occurred in the classroom. This schedule indicates the progress on the Weather Technology unit as intermittent. The retention of old routines and content had a severe impact on the implementation of the new unit "Weather", especially at the beginning.

Table 6-2: LESSONS PLANNED AND COMPLETED

LESSON NUMBER	LESSON TITLE	PLANNED FOR:	COMPLETION
10	The Weather Map	December 7th	Worked on Lesson 8 Lesson 10 not completed
11a	Making a Weather Map Video Planned	December 8th December 12th	Modified Video Shown
11b	Making a Weather Map	December 12th	Modified Another video shown
12	Comparing & Interpreting Weather Maps	December 13th	Never completed Another video shown
13	Local Weather Signs	Not included in planning	Never completed
14	Satellites & Radiosondes	December 14th	December 15th

In conclusion, this section does provide sufficient evidence to support the assumptions made at the beginning of this section. In this classroom, the teacher did demonstrate a hesitation in regard to the new curriculum, did drop activities when the researcher was out of the room, did incorporate existing routines and activities into the

new curriculum, and finally did adapt the new curriculum to existing teaching methodology. In this regard, we find a great similarity in teacher reaction to the new curriculum in both Western and Cranston High Schools.

DEVELOPING CHANGES IN ACTION

In spite of the embedded routines which this teacher tenaciously retains, the massive adaptation of the new curriculum, and continuation of old content, some very significant changes occurred in this classroom that are instructive in regard to the implementation of a new science curriculum for the poorly motivated, low achieving science students. It will be difficult to develop a direct causal link, but a definite correlation seems to exist between certain researcher/teacher actions in this classroom that resulted in an increasing utilization of student involvement activities and a change in teacher beliefs (developed in the next section). This change is in stark contrast to Western High where complete abandonment of the new curriculum was experienced. Assertions from the Main Research Question Four developed in this section include the following:

1. The potential of integrating new science curriculum into a classroom for the poorly motivated, low achieving science students is relatively small.
2. The scaffolding model (using modeling, coaching, and fading) may help to convince teachers to use a new science curricula.
3. The scaffolding model may be successful in helping students use new learning strategies.

The difference in teacher response at the two schools (Cranston High and Western High) requires a careful look at both the two teachers and the implementation process. The development of two situational circumstances, in my opinion, were deciding factors in increasing implementation at Cranston High School, these being

ACQUISITION
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1) developing collegiality and collaboration and 2) the use of the scaffolding model. In addition to this, one design component in this unit which I called "procedure recycling" also contributed to the success of these students, which in turn causes a change in attitude and belief of the teacher. Significant resultant actions included an increasing willingness of the teacher to use student involvement activities, small groups, and changes in the beliefs of both the teacher and the students.

Increasing Collaboration

Collegiality and collaboration could be characterized as a "developing" phenomena to reflect a change from "uninformed indecision" to "collaborative decision" making. At the beginning of the unit, I was virtually uninformed, not knowing from period to period what was planned for coming class sessions. The indecision portion of this term describes the hesitation on the part of the teacher to proceed, waiting for me to take the lead in demonstrating the activities for the students. The significant change toward the end of the unit involved the teacher approaching me ahead of time and collaboratively working to plan the activities for the next week. This collaboration began on November 2nd when we met after school and agreed to redo the concept maps. On December 6th, we first met to cooperatively plan the schedule and activities for the next week as follows:

- Thursday, December 7th - Density Demonstration
 - Lesson 8, "Air Masses & Fronts"
 - Lesson 11 "Making a Weather Map"
 - Activity on isobars and isotherms.
- Friday, December 8th - Video
 - Continue working on Lesson 11
- Monday, December 12th - Finish Lesson 11
 - Plotting on weather map
- Tuesday, December 13th - Lesson 10 - "Station Model" for Detroit
- Wednesday, December 14th - Lesson 14 - Launch weather balloon

As the Research Log and the Completion chart will show, adherence to this schedule deviated substantially from the plans. During this same time period four videos were shown, but the significant trend established in cooperative planning continued (week of December 14th, January 8th, January 22nd). By the first week in February, this cooperative planning began to take a reflective and evaluative character, as well as a lesson strategy, as illustrated in the field notes of February 2nd:

We listed some questions for consideration as we planned our convention presentation on a science program for the poorly motivated, low achieving science student:

1. What is necessary to be successful with this group of students?
2. What do you see as the potential of this program?
3. What does this program contribute?
4. What needs to be considered in a revision?
5. How do the characteristics of this student population fit with the design of this new technology program?

I leave with a feeling that perhaps a communication window has opened with Chief.

This collaboration not only continued to include both cooperative planning and evaluation, but also began to open the door for personal feelings (how well things are going) and perspectives, and elements of the teachers own history.

Probably, the most significant aspect of change was the developing correspondence between what was planned cooperatively and what actually occurred in the lessons. By December 4th, a few encouraging notes begin to appear in the field notes:

1. This is a landmark – A period devoted 100% to the project materials.
2. Another encouragement! The materials are used as intended, except that the spelling list has been added at the request of the Special Education Teacher.

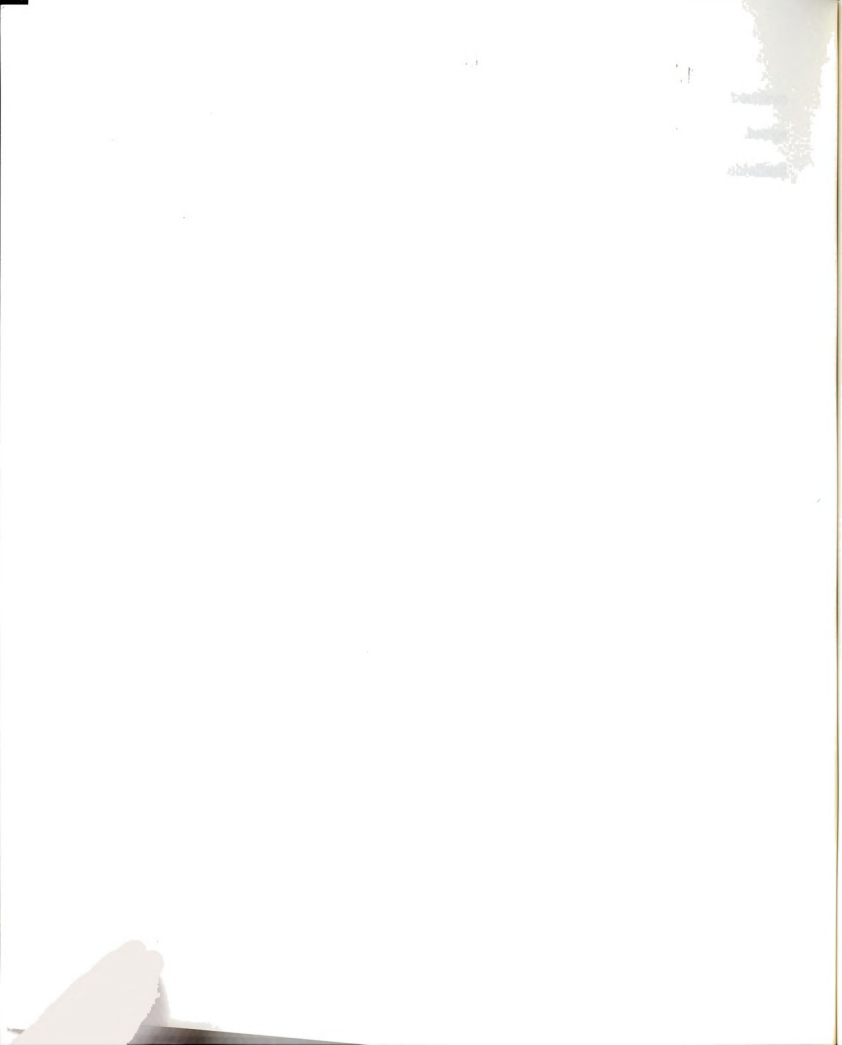
Class work for the first two weeks of January, although still including a video and considerable review for the final, did closely correspond to the collaborative planning of January 8th. The increasing correspondence between agreed upon plans

continued so that by February 15th, the activities planned were completed in class as agreed.

Scaffolding By Necessity

One of the most significant outcomes during this project was the development of a scaffolding network in the classroom at Cranston High School and the resultant impact on both the students and the teacher. Scaffolding in this classroom is termed "developing" because it was not planned, but something that developed during the course of time, more out of frustration and indecision. The scaffolding is also characterized as "by necessity", considering the initial student response to the small group activities and the lack of confidence on the part of the teacher that these materials would really work with this level of students.

Scaffolding as used in the context of this classroom refers to a support system for both the teachers and the students that would allow them to gain knowledge and experience with a minimum of frustration during the learning period. The analogy compares teaching in difficult situations to building construction where a scaffold is used in hard to reach places. Likewise, in education we often are faced with hard to reach students who have a history of failure and who need a support system during the beginning stages when confidence is low. The coaching model, as explained by Anderson, 1987a; Collins, Brown, & Newman, 1987) involves three phases; 1) modeling, 2) coaching, and 3) fading. As described in the literature, scaffolding is conducted by the teacher. In the modeling phase the teacher demonstrates how the activity is to be completed (materials set up, procedures, reading of instruments, recording of data, and analysis of data). In the coaching phase, the teacher is available to help the students (giving hints, asking questions, assisting in setup). In the final phase of fading, the teacher withdraws and only intervenes when students



obviously are in trouble. During this whole process there is a transfer of initiative and responsibility from the teacher to the students.

In this study, scaffolding took on an additional complexity, because both teacher and students were learning to interact with materials and content in new ways, with the support and guidance of the researcher. The researcher thus modeled scaffolding both for the teacher and the students. As the teacher became more skilled, he gradually took over the responsibility of modeling, coaching, and fading for the students. The following data summary will demonstrate this transfer of responsibility in the classroom at Cranston High School.

The development of scaffolding began with the hesitation of the teacher to take initiative, looking to the researcher to demonstrate various activities. This first happened November 7th when I completed the demonstration on cloud formation, on November 8th (demonstration on diffusion), and on November 22nd (demonstration on construction of a concept map). During this time the demonstrations were conducted primarily as a response to a call for assistance by the teacher. The coaching phase was forced upon us November 27th when we gave the students the assignment to make a concept map on weather forecasting. As already described previously, the response of the students was almost complete inactivity. More out of desperation than planning, the teacher and I went from group to group of students to help them get started. The change in the expressions of the students from complete bewilderment to satisfaction in being able to complete this activity was encouraging and instructive for both the teacher and myself.

The scaffolding sequence of modeling, coaching, and fading was again utilized on December 7th in the construction of weather maps. I first demonstrated (at the overhead projector) how points of equal temperature could be connected to form

isotherms (modeling). The students then completed this activity at their desks with help from the researcher and the teacher (coaching). Finally, the students completed the second sheet connecting lines of equal pressure to form isobars (fading).

The scaffolding sequence was again repeated on December 15th with a new dimension, the classroom teacher now doing the modeling for the students instead of the researcher. Mr. Lindeman demonstrated how to set up the two axis of the chart, using the range of data from the cumulative weather record on the wall:

(teacher at the overhead) We are going to be recording three bits of information: 1) Pressure, 2) Humidity, and 3) Temperature. Record the first day's temperature. Represent it by a little dot. The first day's temperature is 30 degrees Celsius. Second day is 28 degrees. Find 30 degrees and then go over to the second day ... go straight up.

After the explanation and demonstration on the overhead, the students began to work in small groups at the tables. The teacher moved from group to group inquiring, " Anyone totally lost? Bring your book over to this group."

Students stand around without starting the assignment. The teacher works with one group. I move to another group and work first with Andrea and Katie, then with Tom, Barbara, and Roger. After help from the teachers, all students are plotting on their own.

This lesson on graphing weather data again illustrated the utility of using the scaffolding model to give students the confidence to complete work correctly. In retrospect, observations from preceding classes suggest:

- a) Many of these students have difficulty following directions, and would rather not attempt an activity than admit they are completely lost and are reluctant to add another failure to an already accumulated history of failures.
- b) Some of the goofing off by students is a cover-up to mask embarrassment of not being able to follow directions.

- c) When a clear visual demonstration of how to complete an activity is given, and when immediate help is available to diagnose problems, the students will settle down, work quietly, and complete the work.

The continual use of modeling and coaching began to reap results in the attitudes and on task behavior of the students. This is illustrated in the field notes form February 1st:

The first half hour of this period is spent on continuing work on the weather graphs. As the period starts, I notice Katie is just standing and waiting. As I approach, she comments, "Doris is not here today, so Mr. Lindeman said I don't have to work.

I answer, "How about if I help you? The conversation continues as follows:

Katie: OK! (we get out paper and work on setting up the grid and axis).

Teacher at 2:10: Start picking up!

Jack: We gonna get more time to finish?

Teacher: You will get all the time you need (he must mean on another day because at 2:11 he turns on the overhead projector and begins to give notes on primates. Except for one incident of Chris twisting Tonya's arm the period ends as usual.

The coaching continues the next day as reflected in the field notes:

At 1:55 Chief comes to the back table and examines Ross's chart.

Teacher: Slick lookin' lines. Now you have to plot. Looks like you have everything marked out. Just match up the temperatures and the pressures.

I move around the room, examine charts, and ask questions of groups. The charts look good – the lines are spaced apart equally, the scales are numbered in equal intervals. I suggest that Simon and Tom add clouds and weather conditions to their chart. Doris is absent again, so I spend some time helping Katie mark out the scales. Chief is also circulating around the room, going over to George, Roger, and Claude.

In spite of a portion of each of these two lessons again being spent on mammals, a few developments provided some encouragement. First of all, Chief is following through on graphing the weather data, is allowing the students to become actively involved in data analysis, and is out among the students coaching the

graphing, being available for help when and where needed. We see continued improvement in the functional level of small groups, the engagement level now nears that of direct instruction. Other than the one incident with "Darth Vader" the class focused their energy on completing the graphs.

Finally, there seems to be a change in the initiative of students. Upon given directions to complete an activity involving scientific apparatus or data analysis, the reaction of students at the beginning of this unit was to sit and do nothing (as if stunned by unrealistic expectations) or to goof off (probably to hide their embarrassment in not being able to complete the task alone). Students coming and asking for help (Katie on February 1st came to me for help – the first time a student took the initiative and came and asked for help) seems like a minor thing, but in terms of student self-perception can be a major indicator of a change of attitude. Most of our help (teacher and researcher) offered up to this point was initiated by the adults approaching non-working students, asking questions, and offering assistance. Now students were regularly approaching us and asking for help as demonstrated in the field notes for February 6th:

At 1:56, some students finish their mammal worksheets, while others begin working in small groups on Weather Lesson 21, Activity 1 and 2. A group of girls were at the screen, shining flashlights at different angles to illustrate the brightness of the sun's rays at different angles. With my help (keeping the distance constant), they were able to see the relationship between angle, area covered, and brightness. Roger needed help measuring a 30° angle. Donna came over and asked how to complete drawing the diagram on p. 56. Claude and George needed help working out the temperature averages for cloudy and clear days. They thought something was wrong since the cloudy days turned out to be warmer.

At 2:10, Brent, Jack, and Scott finally settle down and work on their graph. They have fooled around most of the period. At 2:20, Ross calls, "Chief," and the teacher goes over to help. I work with George and Claude and help them recalculate averages.

Other forms of coaching involved measuring angles (February 6th), helping set up equipment (February 15th), taking temperature readings (February 23rd), catching mistakes before "the whole thing is all wrong" (December 19th) as when we needed to circulate and check the interval spacing on each axis, and simply giving assurance (February 27th) as when Brent and Ross asked me to come over and check if they are "on track."

The scaffolding described here is distinctive of the classroom at Cranston High, having developed more out of necessity rather than planning. Following information indicates that significant changes in both student and teacher attitudes and activities did occur in this classroom. In my opinion, the scaffolding contributed significantly to this change.

Constructing Meaning

Another form of coaching that helped build a sense of accomplishment for the students were activities specifically designed to build understanding and create meaning. The development of conceptual and contextual linkages were used to give relevance and tie new concepts in to existing prior knowledge. For example, on December 4th as we enter the room, Chief is at the overhead projector giving notes on warm fronts and cold fronts (to help the students answer the questions in the Study Activity Guide). The notes make frequent reference to local weather in Cranston. On December 7th, he asked, "What kind of air mass came through yesterday?"

Discussion and summation of experiments were found to be necessary after experiments to help students interrelate various phenomena and thus create understanding. For instance, after the experiments of Lesson 20, Chief and I used the following questions to conclude each experiment:

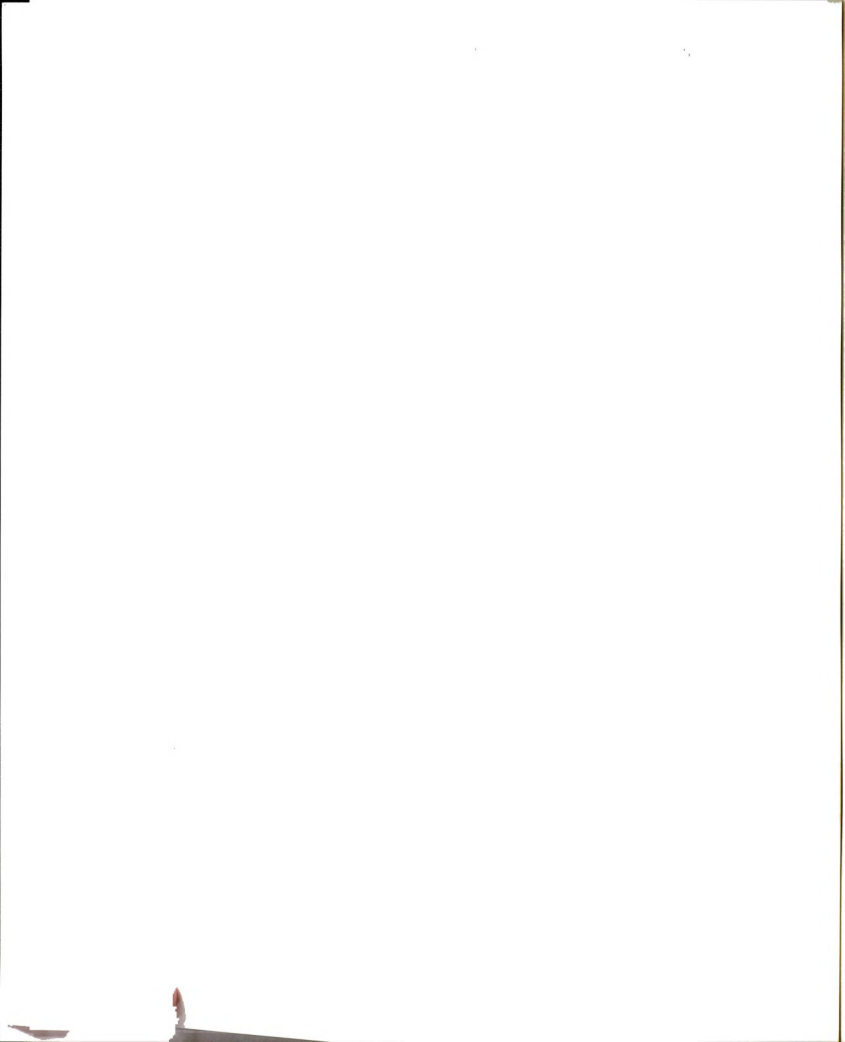
1. What we did?
2. What happened?
3. What we learned.

Many of the activities were designed to analyze data and make conclusions more obvious and visible. For instance, the charting of the weather data provided some interesting correlations that the students could easily recognize. When the barometer dropped, rainy weather usually followed within a few days. In winter, the temperature usually dropped on clear nights, providing insight into the concept of the greenhouse affect. Interpretation of the bar graph (February 23rd) and the line graph on February 26th needed discussion to draw valid conclusions.

The concept maps were another summary technique that linked various concepts together to create coherent understanding. In the exit interviews, concept maps were specifically mentioned as having helped create understanding (Sarah, Brent).

Procedure Recycling

Considering that following directions is one of the more difficult tasks for the low achieving science students, procedure recycling added significantly to the ability of students to succeed in experiments. This methodology involved having an experimental procedure modeled by the teacher and then having students complete a series of experiments that are additional trials and variations of the same procedure, using much of the same equipment. This allows for more coaching time with the students, and allows the students to be more intricately involved in design of experiments as they are already working with something familiar. In the last series of lessons, we have seen the utility of this approach in a number of different ways. The students were able to construct isobars as they had just finished plotting isotherms (same procedure, different material and conclusions). The concept maps were first



used in relating weather factors to weather forecast. In February, the concept map was used to tie wind, barometric pressure, insolation, humidity, rising and falling air, and gravity into an explanation of "What makes the wind blow?"

As a more specific illustration, the graphing of the weather data followed this recycling schedule:

Graphing weather data: Round One

12/14 – Samples of weather graphs are handed out with the ranges, intervals, and scales all worked out for students (modeling).

12/18 – Teacher models plotting the data and students begin to plot weather data. To begin with, most of them simply stand around, until a teacher comes to help them set up the graph (coaching). Once the scales were set, they were able to do most of the plotting by themselves.

12/19 – Students continue to plot data.

Graphing weather data – Round Two

1/31 – This time the modeling by the teacher was much briefer, covering only setting up the range and interval.

2/1 – This period was used in plotting data with coaching by the teachers.

2/2 – Students finish plotting and interpreting data.

Interpreting graphical data

2/6 – Average temperature on cloudy days and sunny days.

Graphing experimental data: Round Three

2/7 – Plotting temperature and volume from Lesson 20 – Activity One.

Note: After helping students set up the range and interval, the plotting was completed in this one period.

Graphing experimental data: Round Four

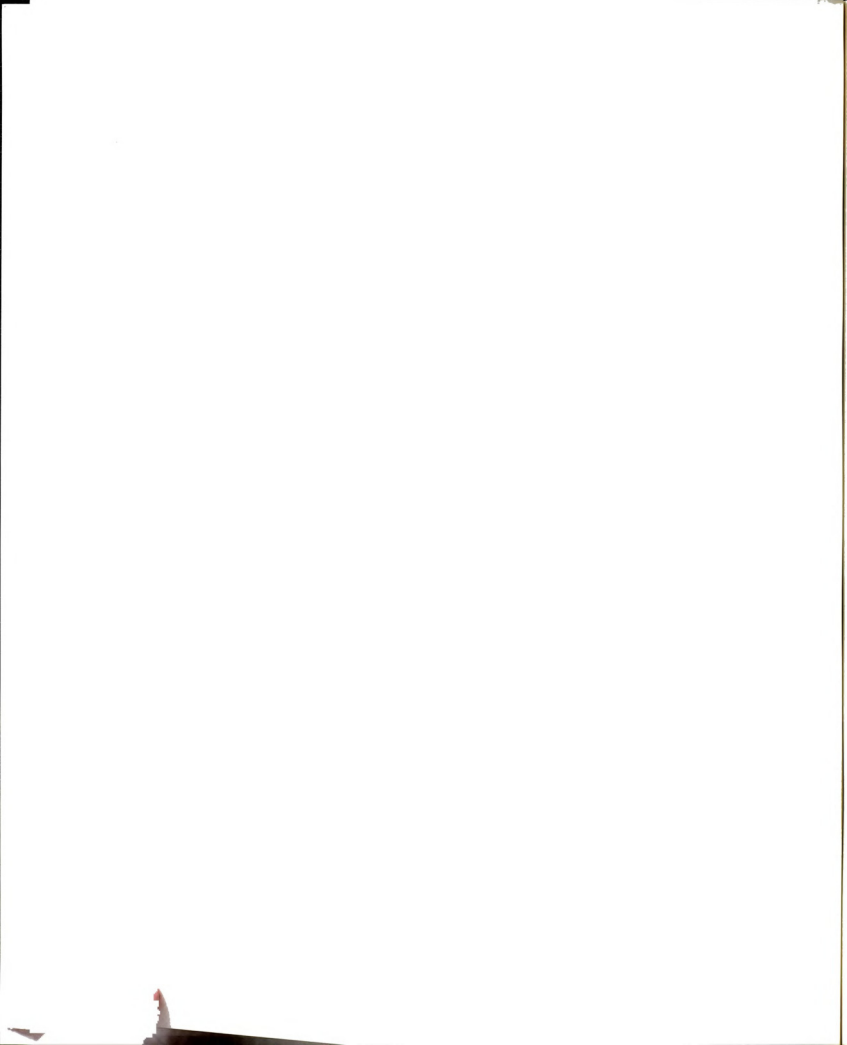
2/23 – Plotting temperature and color (bar graph)

Graphing experimental data: Round Five

2/26 – Plotting land and water temperatures (line graph)

Examination of the above data will reveal two sets of progressions:

- a) In the beginning first round of weather plotting, much more time was spent on modeling than in later rounds where the students were able to work by



themselves once the teacher helped set up the range and intervals (first actually making the scales for the students, then in the second round working it out with them together – teacher on the overhead and students working simultaneously in their books).

- b) After modeling in round one, the students just stood around and did very little graphing until a teacher came to help them. This round took parts of two periods for the coaching part (completing the scales and plotting the data). Round Four and Five offer a marked contrast where the graphing was essentially completed in one period, with a minimum amount of help. Each time students proceeded with more confidence, less hesitation, and above all, a conviction that they could do this level of work.

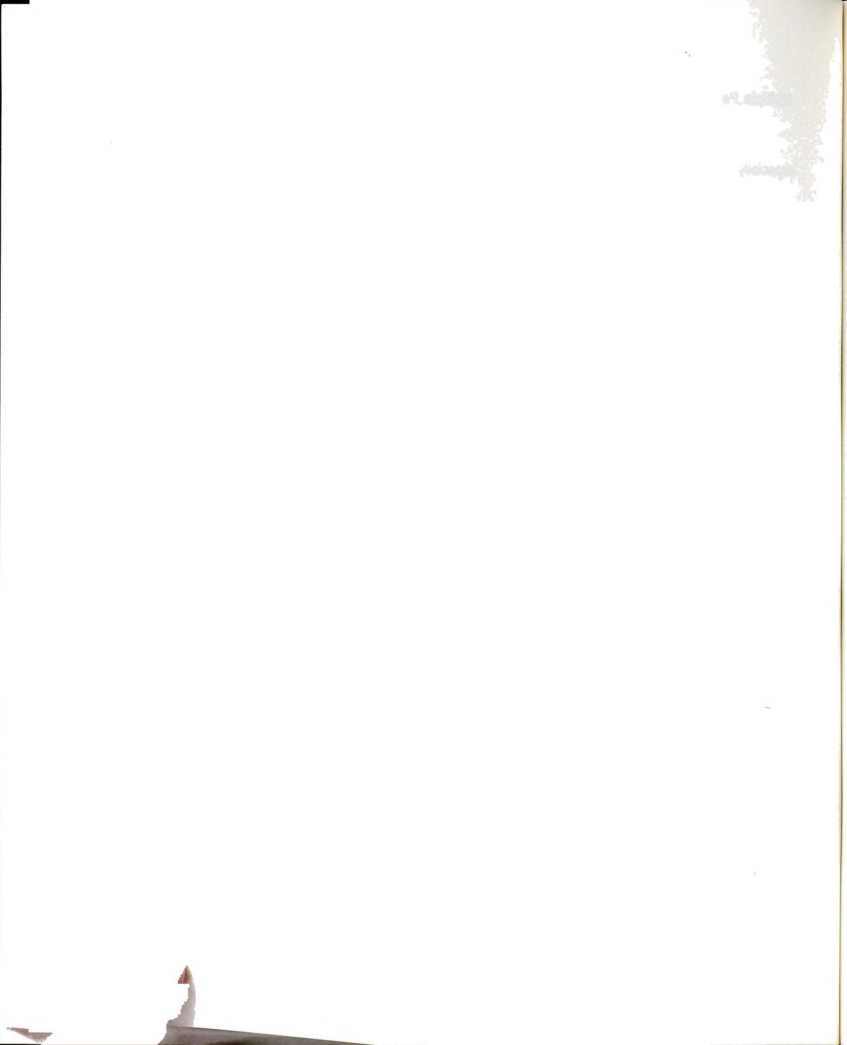
The same kind of procedure recycling was used with the solar heaters. The explanation of how a solar panel can collect heat was first explained on 2/6. Then on 2/13, a demonstration by the teacher modeled the setup and operation of the solar heaters. On 2/20 the teacher again modeled experimental design in planning the experiment on color and heat absorption. In addition, the material on "greenhouse effect" was reviewed. On 2/21 the students completed the experiment on heat absorption by different colors. By 2/23 an experiment to measure the difference in heat absorbed by land and water was set up and completed by two students. This use of the same equipment with additional trials or variations of the same experiment (a planned reoccurring procedure) allows students to work in an experimental area and have success, and still feel that they are not being treated in a elementary "babyish" fashion.

Multiple Perspectives

In helping the poorly motivated, low achieving student find success in school, especially in the area of comprehending scientific concepts, a model that can be successful is what I call a "multiple perspectives" model of conceptual development. An analogy would be the examination of a object like a fish. A front view will give a picture of its sleekness. A side view will nicely display all its fins. A top view will look darker. A bottom view will look lighter. So also in the development of a concept, the examination may take many forms. A picture will give a concrete idea of what we are talking about. However, a sketch diagram may highlight important characteristics even better than a picture. Moving pictures can show functional relationships and operations. Experimental evidence may stimulate interest and convince students of the validity of a theory used in explanation. The textbook may fill in details that the teacher does not have time to cover in class. The teacher can provide information on vocabulary, help the students organize information, answer questions, and clear up misconceptions. A concept map will show hierarchal relationships, cause and effect, and component parts. A graph will show trends, give visual comparison, or a concrete summarization of data. Rather than boring students by drilling the same material over and over with the same form of pedagogy, a concept can be examined from many informational perspectives, and simultaneously obtain a more comprehensive understanding of the concept.

A series of experiments that were less successful involved those set up as a series of stations with each station having a different set of procedures and equipment.

In retrospect, the modeling aspect of this lesson was weak. The demonstration modeled the activity for station one, but the following stations each had a different set of directions. These experiments did include a good deal of coaching, but the

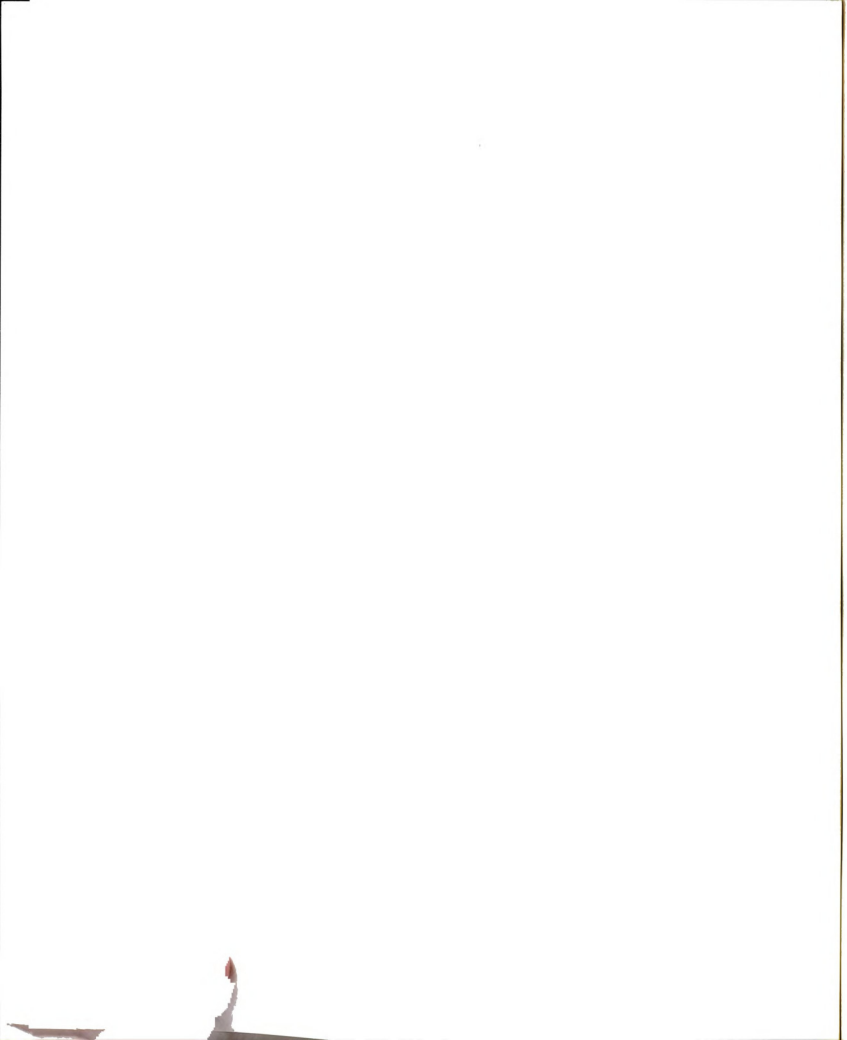


coaching needed to be more directly linked to the modeling of phase one. The lesson could have been strengthened by modeling a procedure and then having students complete experiments that are additional trials or variations of this procedure.

Teacher Initiative and Responsibility

During the implementation period, a welcome change was the increasing initiative and responsibility assumed by the teacher. The initial hesitancy of Chief to use activities and experiments with "these" students may be related to two factors: 1) Former experience where classroom control was difficult and students spent more time "messaging about" 2) As an experienced teacher, Chief also went through the "hands on" discovery era of the sixties and seventies, and came to realize that the ESS philosophy of the "teacher getting out of the way" and letting the students "mess around" simply did not convey the ideas intended and often created misconceptions (Anderson & Smith, 1985).

During the latter part of the Weather unit, Chief assumed increasing responsibility to plan instruction involving this unit. During the first week of instruction in this unit, he would look at me, wait, and I would end up giving directions for the lesson. On 12/7, I first demonstrated how to plot isobars and had students complete their sheets. On the next day, Chief demonstrated plotting isotherms and finished the exercise with the students. By 12/14 he organized the chart for recording weather data. This increasing transfer of initiative and responsibility from the researcher to the teacher was again demonstrated with the data analysis and summary on 12/18, when he gave directions for plotting weather data on graphs. By February, 1990, Chief was taking initiative and responsibility for most activities including demonstrations (1/26), graphing (2/9 & 2/26), experimental design and setup (2/20), and data analysis and summary (2/23).



Small Group Activities

Lastly, the increasing involvement of students in small groups marks a change from a transmission mode of learning to one of training students to develop thinking skills (designing experiments, following procedures, recording data, analyzing data, and forming conclusions). Already on February 2nd, the field notes indicate:

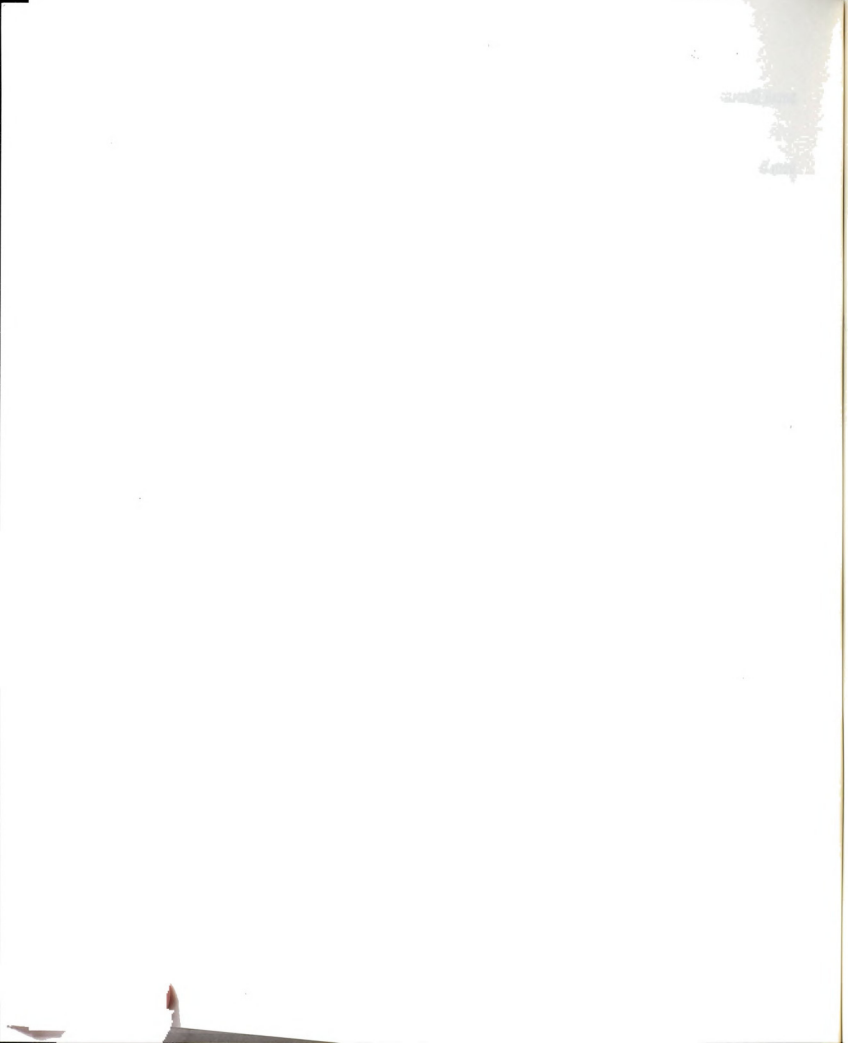
Chief is following through on graphing the weather data, is allowing the students to become actively involved in data analysis, and is out among the students coaching the graphing, being available for help when and where needed. We see continued improvement in the functional level of small groups, the engagement level now nears that of direct instruction. Other than the one incident with "Darth Vader" the class focused their energy on completing the graphs.

Pre-teaching

Another change of instruction during the implementation period is the development of more pre-teaching before the students begin an activity. The field notes for 12/4/89 (clouds) and 12/7/89 (warm & cold fronts) are examples of the teacher taking a direct instructional role to supplement the activities planned in the weather unit. Brophy and Good (1986) in Teacher Behavior and Student Achievement cite numerous research projects where higher student achievement is correlated with a continual active role of the teacher instructing the students. As one considers the strengths of each approach and the goals established, it may be productive to consider the following questions regarding the technology curriculum:

- a) Are we expecting the written materials to accomplish too much in conveying content to the students?
- b) Have we diminished the teaching role of the teacher too much?

During the time of this study, the role of the teacher changed from total responsibility for informational input (transmission view), to a hesitant management position with students depending more on the activities and materials (discovery view),



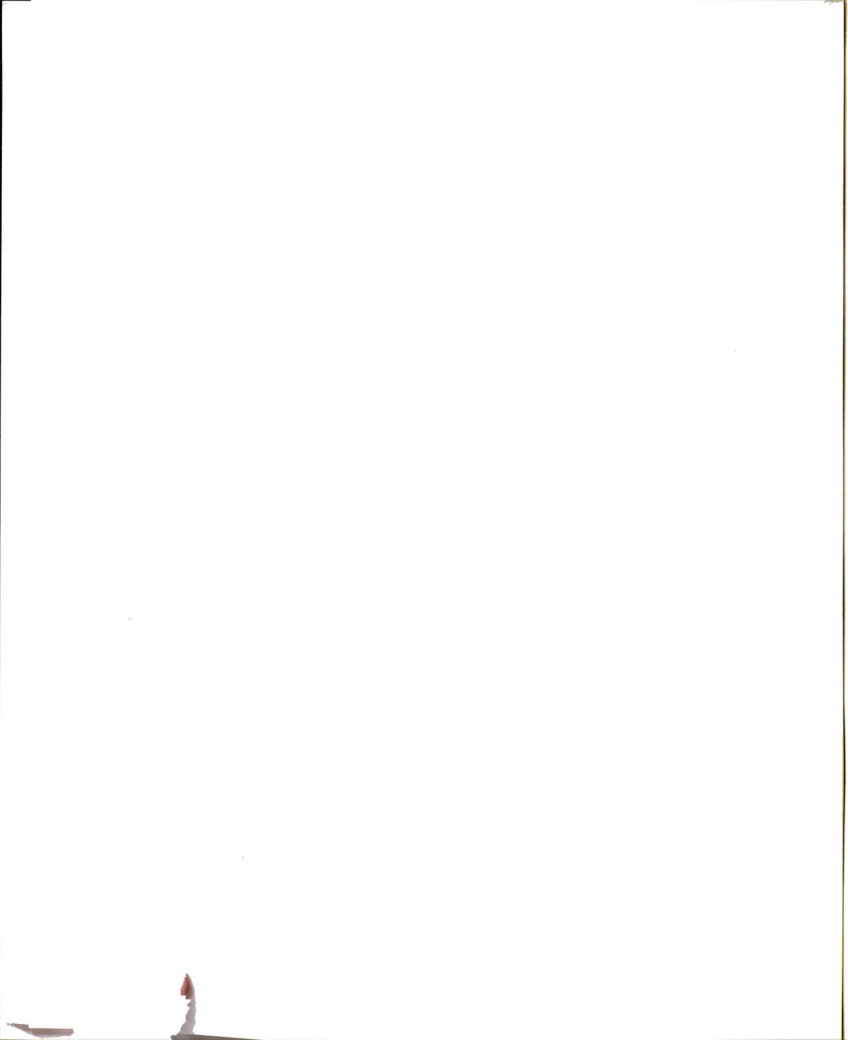
to a modified coaching position with the teacher taking an increasing responsibility for giving the students the training and knowledge necessary to be successful with the activities.

CHANGING BELIEFS AND ATTITUDES OF THE TEACHER

The assertions under Major Research Question Three uses the basic assumption that teacher and student actions are a reflection of underlying attitudes and beliefs. This means that changes in attitude and beliefs could be assessed by what is actually expressed and by a change in behavior on the part of the teacher and the student. Both forms of evidence will be considered in addressing the following assertions:

1. The teacher's beliefs about and experiences with these students impact their methods of dealing with these students.
2. Teachers are not confident that students can be trusted to act properly and learn independently.
3. Teachers view these students as having limited potential.
4. Teachers are unwilling to put in extra time and effort needed to make a new curriculum a success.
5. Teachers failure to implement a new science curriculum for the poorly motivated, low achieving science students can be attributed primarily to a management and control concern.

One of the most significant developments during the time of this study was a change in beliefs and attitudes on the part of the teacher and students. The expressed position of the teacher upon entry was that these "activities do not work with these kids." However, during the course of the five months spent in this classroom, changes on the part of the teacher have increasingly pointed toward an acceptance of



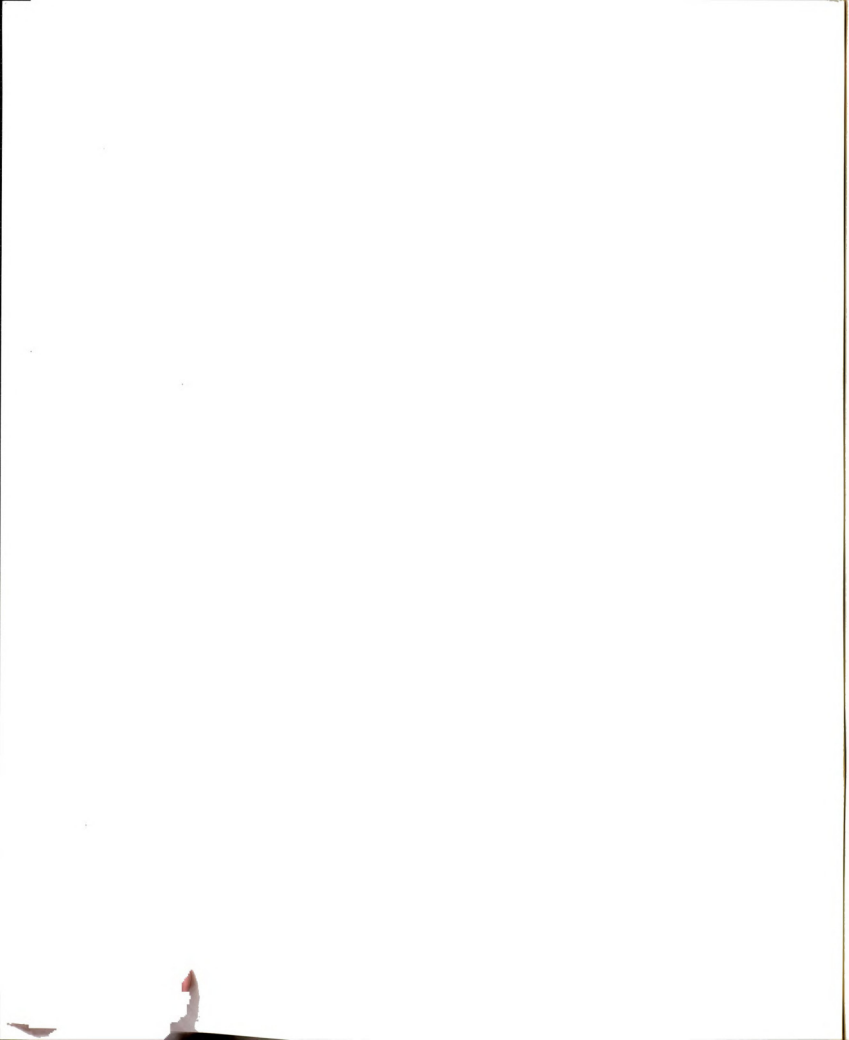
the utility of using student involvement, experimental based, data handling activities with the poorly motivated, low achieving students. These changes included a change in perspective, a growing initiative and responsibility in leading activities, and inclusion of activities in other classes.

Until 2/28, this position was largely based on inferential interpretations, on the inclusion or exclusion of student involvement activities, and on the willingness of the teacher to discuss and plan with the researchers. Now, two more direct forms of substantiation are available.

First of all Chief's statement, "I am really impressed with how well the students have done, especially the students who have done most of the work on their own." This is significant as a belief in the students' capability is necessary for the teacher to even bother scheduling these type of activities for students to attempt. Secondly the statement, "I'm going to use the concept maps for evaluation of vertebrates and invertebrates" indicates a broader acceptance beyond just this unit. Contrariwise, it could be argued that Chief included these activities simply out of commitment to the project, or out of a personal favor to the researcher. But the above quote reveals a willingness to use these type of activities with the poorly motivated, low achieving students in Basic Biology, being more convinced of their utility in instruction.

Informal interviews with Chief substantiate a change in attitude as I ask about his feelings toward the activities. By February 2nd the response already indicated a positive change:

The activities are great. I had some hesitation about discipline at first, when allowing students to work with the activities and in small groups. Safety is always a concern. Students are becoming more involved. In the lesson on stations, Tom sat for a whole period doing nothing. Now he worked for two periods straight. Students are gaining more confidence that they can do the work.



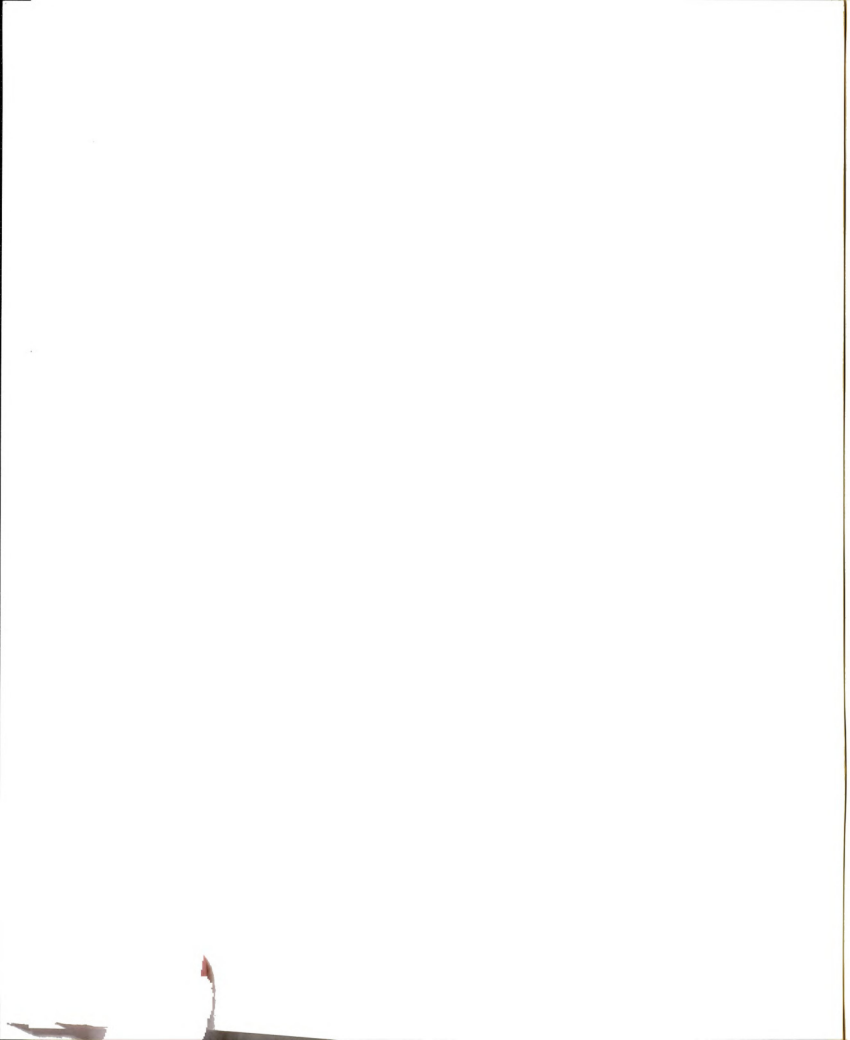
I was surprised at the teacher's statement, "the activities are great." Chief did verify the hesitation due to concerns regarding discipline. This confirms, to a certain extent, my suspicion that class structures (the activities) were chosen primarily as a function of class control rather than for educational efficacy. It is noteworthy that the goofing off and standing around happened at the end of the last period when students were already finished with their work, in contrast to the first time we tried to make a concept map with Post-its when the goofing off started from the very beginning of the activity.

It was rewarding to have the teacher note a change in the students; "becoming more involved" and especially "gaining more confidence as they do their work." He may realize that with adequate preparation and careful structuring of the modeling and coaching, the activity approach can be valuable in the education of the poorly motivated, low achieving student.

In that success for students is an essential criterion for motivation of this particular group of students, the impact of teachers is becoming increasingly clear. Teachers must teach the students how to follow a procedure before expecting them to do it. It seems that the sequence of modeling, coaching, and fading may have more applicability than before recognized.

By February 14th the teacher's confidence seemed more self-assured as he noted, "How well things are going." By March 6th, the teacher concludes by commenting on a much higher level of student work, noting that Claude, Scott, Sarah, Stewart, Simon, and Brent have especially good concept maps.

Another indicator of the growing teacher confidence in this pedagogical approach for these students is the changing level of responsibility in starting activities as already described. This initiative not only applied to teaching material outlined in

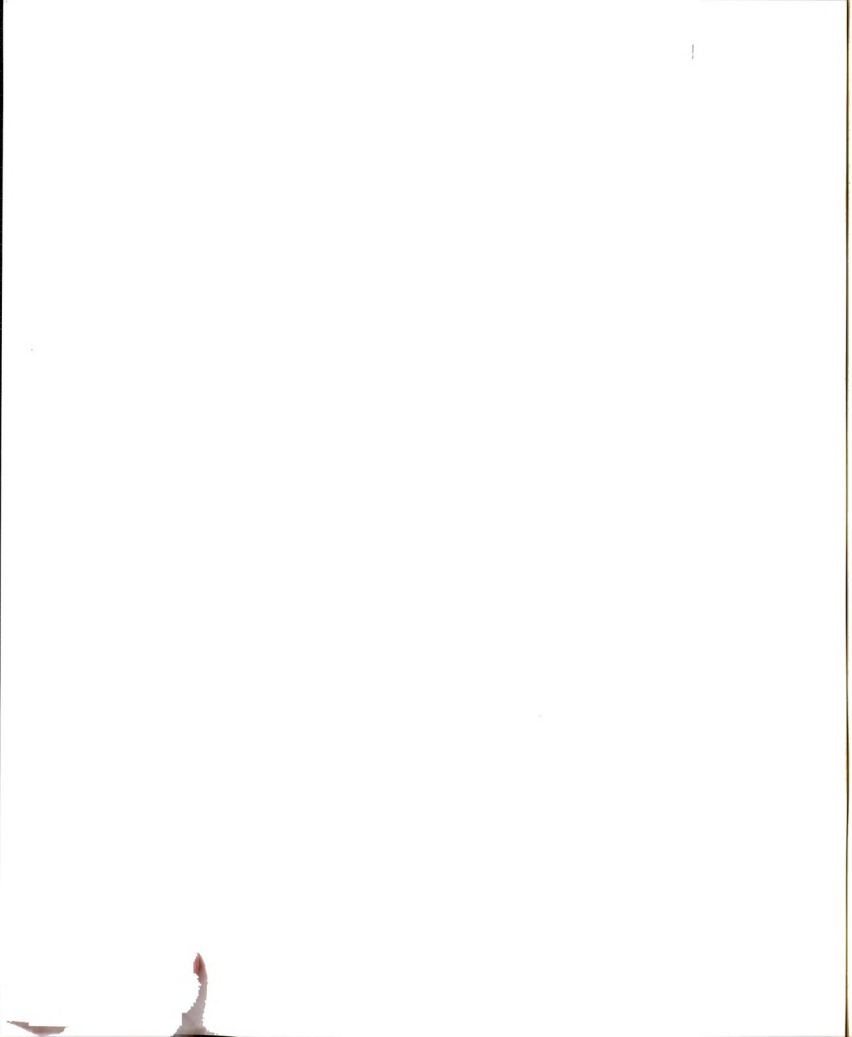


the text, but designing additional materials to improve the curriculum as written. On December 4th, a noteworthy development occurred. Chief assumed the responsibility to take the readings of the various weather factors each day and record them on the large wall chart mounted by the door. Students were then instructed to copy this data onto their own data charts. On December 14th, he instructed the students to graph the weather data in such a way that temperature, humidity, and barometric pressure could be correlated with the present weather conditions (this activity was not in the weather unit itself). By February, he would immediately step forward, introduce the lesson, and demonstrate the necessary procedures. Even more significantly, by the beginning of February, Mr. Lindeman now takes time, ahead of class, to prepare materials for a class activity. Perhaps the most assuring indicator of a changed teacher attitude toward involvement type activities was the decision to use some of these activities (as concept map for example) in other classes.

The direct statements by the teacher, the growing initiative to take the lead as a teacher, both in preparation and in explaining the activities, all point to a change in both attitude and beliefs as to what pedagogical approaches are workable with the poorly motivated, low achieving science students.

CHANGING ATTITUDES AND BELIEFS OF THE STUDENTS

As with the teachers, changes in the attitudes and beliefs of students can be assessed by both what they say (about themselves, the activities, and the classroom) and by what they are willing to do (participation). In regard to behavioral changes on the part of students, consideration will be given to their willingness to participate in activities, the growing productivity of their work, and the increasing pride in their final work product. Assertions that developed from classroom observations are as follows:



1. Students' failure to participate in classroom activities can be attributed to their embarrassment of not being able to follow complex procedures, and fear of another failure.
2. Students do care about being successful in their school work.

Attitudes as Reflected in Student Work

The willingness to participate in the activities grew from an initial complete non-participation in the first lesson (post-it activity) to an expressed desire to do their best. As you will recall, the reaction of students at the beginning of this unit was to sit and do nothing or to goof off. Help was offered by teachers approaching students. However, by February 6th, the situation has changed. Students are now approaching teachers and requesting help. Ross called to the teacher, Claude and George came for help to recalculate averages. By March 4th Brent, Scott, Laura, and Donna ask for help to get started. After a bit of coaching they continue on their own. Even the detached (Tom), the aloof (Brent), and "teen world" involved (Doris) are now coming for help. The increased participation and involvement of the students is encouraging.

This change in initiative was not only reflected in a willingness to come for help during an activity, but also to ask clarification questions during presentation periods, as when Andrea asked, "What does the "g" stand for?" on the diagram.

Another measure of the change in attitude of students, especially increasing self-confidence, is the increased productivity. Students are getting started on a task with less help and completing more of the work on their own. By March 2nd, the concept maps were totally completed in a period and a half compared to the first time in which this task stretched out over three periods until they were completed.

Attitudes & Beliefs as Expressed in Pride Concerning Work

By the beginning of February, field notes indicate a new level of development.

Attitudes & Beliefs as Expressed in Pride Concerning Work

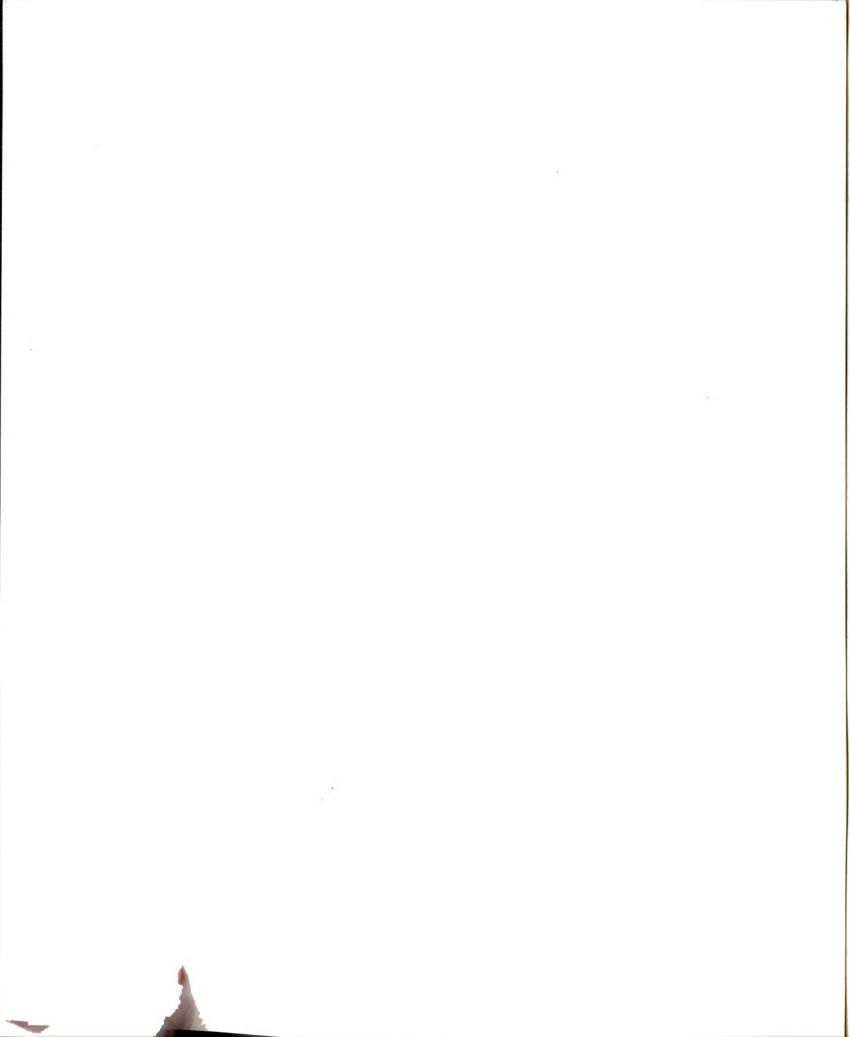
By the beginning of February, field notes indicate a new level of development. The change in student involvement from inactivity and lack of response to guarded and reluctant participation, to pride at accomplishing a task successfully is now becoming evident.

With this increasing initiative is the increased desire to "do it right." More students are asking en route to check if they are "on track" and even the concern for appearance (Barbara) indicates a pride in their work. Katie's pride in her work was shown (February 13th) in bringing up her drawings and saying, "See my drawings!" By the end of February, the desire for quality work has expanded. Katie beckons with her finger and comments, "I want it to be neat." Brent and Ross ask me to come over and check to see if they are on track. Tom calls for help. Barbara asks for some pink Post-its, not wanting two different colors "for looks sake". The students work steadily for the rest of the period. By early March the spirit of the classroom has changed. Students have gained confidence in their ability to complete work successfully, begin work on their own, ask for help when needed, finish work in less time, and take pride in work accomplished. The response of the students was gratifying.

SUMMATION OF DATA FROM CRANSTON HIGH SCHOOL

As one analyzes the mass of data collected and attempts to make sense out of various actions or inactions on the part of both teachers and students, and tries to evaluate the effectiveness of a new program that is not taught enough to evaluate adequately, it may be well to reconsider the original questions and assertions and reevaluate which areas the data from Cranston High School lends credible support.

As will be developed in the next section (Data Summaries and Comparisons), there were great similarities between the classrooms at Western High School with Mrs.

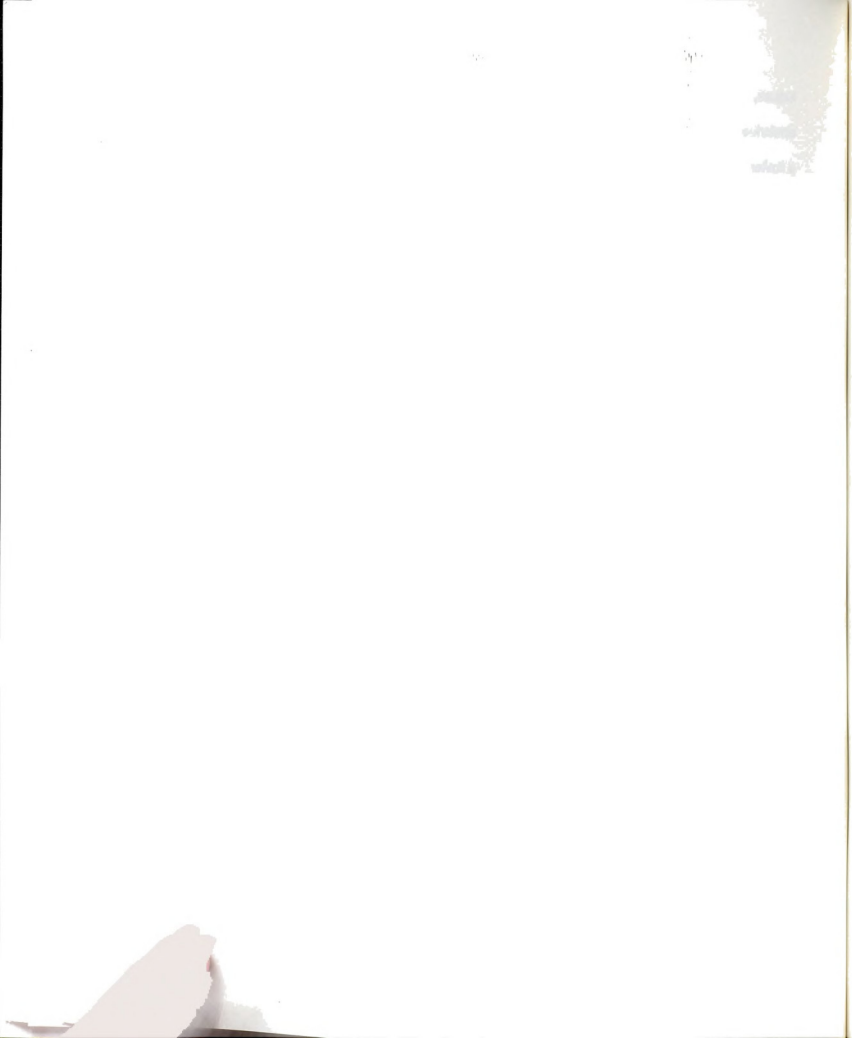


Krauss, and the classroom at Cranston High School with Mr. Lindeman. These similarities included embedded teaching routines, a limited repertoire of activities, and a limited expectation of student abilities. Additionally, both teachers showed initial hesitation in the use of the new curriculum, reverted to old content and routines in the absence of the researcher, modified and adapted the material used during the course of the unit.

There were, however, significant differences. While the level of implementation at Western High School continually decreased, the implementation of the curriculum at Cranston High actually increased. The one significant difference in the two classrooms is the development of the scaffolding model at Cranston that involved modeling, coaching, and fading. The modeling allowed the teacher and students to learn the procedures, which are problematic for this group of students. This pre-teaching essentially provided the information, structure, and confidence for students to take the initiative to work on their own. The coaching gave them the ability to proceed with the activities, reduce discouragement, and build confidence. Finally, the procedure recycling allowed a greater degree of fading for both the researcher (in regard to the teacher) and for the teacher (in regard to the students).

Another significant difference in the two classrooms is the freedom allowed students. While the students at Western High School were confined to their seats and talking was not allowed, students at Cranston were permitted much more freedom. It is to be admitted that the more relaxed classroom at Cranston may also have contributed somewhat to a greater degree of implementation.

The most rewarding aspect of this study was to see the change in a teacher who initially stated "these activities do not work with these students" to a point where unsolicited response expressed amazement at the work the students were producing.



CHAPTER SEVEN: FURTHER INTERPRETATION AND COMPARISON

Contrasting Mrs. Strauss' & Mr. Lindeman's Classrooms

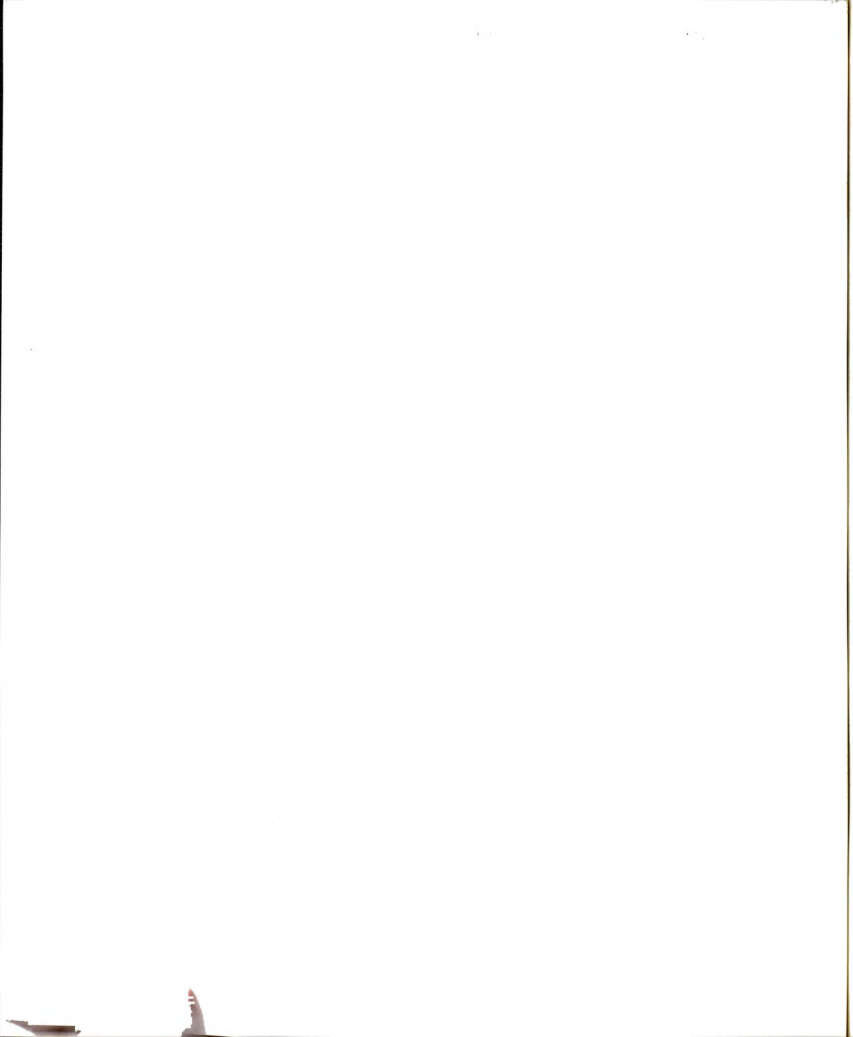
In this last section of the data and data analysis, a comparison will be drawn between the implementation of the technology program by Mrs. Strauss at Western High School and by Mr. Lindeman at Cranston High School. I will identify similarities and differences between the work of these two teachers and then attempt to establish a link between the results (acceptance of the new program) and the procedures used in the implementation process. This comparison should also help to identify other variables that may have contributed to their differences in implementation.

A summary review of what happened in each of the two classrooms will first be presented. In view of the variety of activities used on a day to day basis, the activities will be averaged over a three day period, which equates to approximately three lessons in the materials as written. This method of data handling helps to identify trends in time spent on the project and in the types of activities used.

Class Time Spent on the Technology Project

As noted on Figure 7-1, classroom time spent on the technology project at Western High School declined over a span of 18 class periods observed, until these materials were dropped entirely. As indicated in the descriptive section, the researcher attributes this fall-off in class time used to a conflict between the established structure of the classroom and the design of the new curriculum.

In contrast, the technology project at Cranston High School (Figure 7-2) also experienced some repetitive declines in class time used, but these are associated to times when the researcher was out of the room. During segments 2, 3, and 4, the



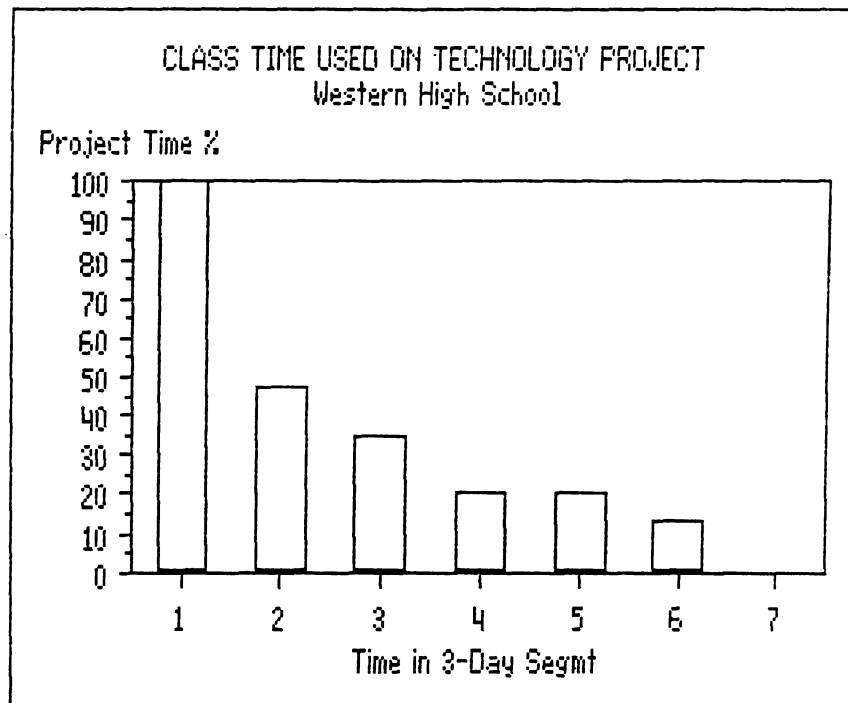


Figure 7-1: CLASS TIME USED ON TECHNOLOGY PROJECT - Western High School

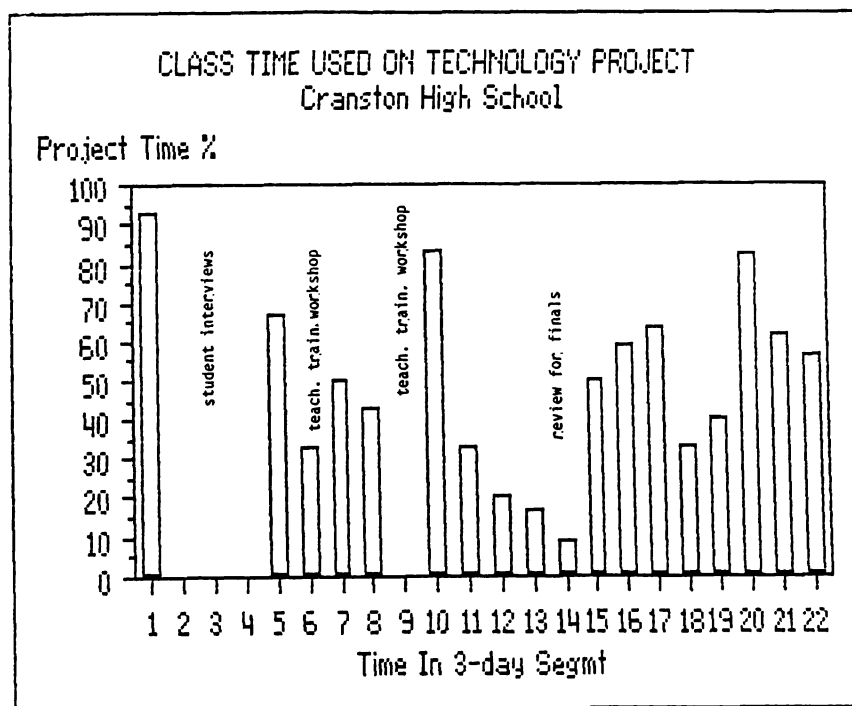
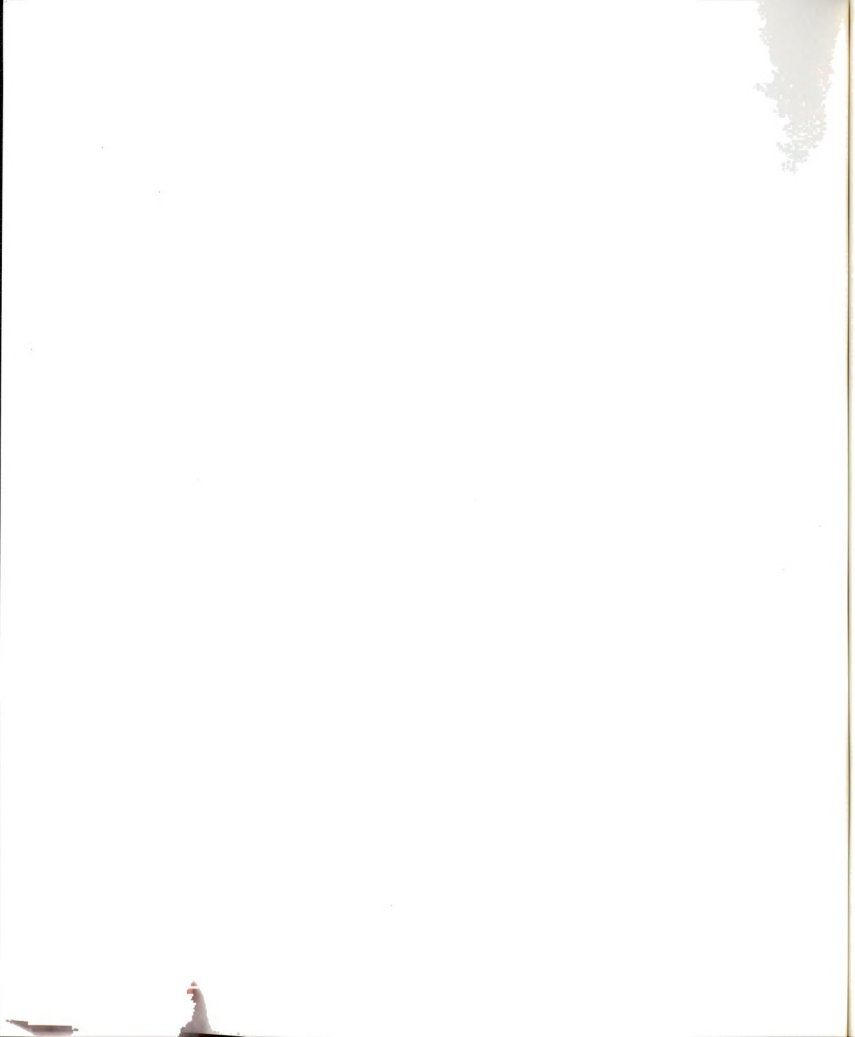


Figure 7-2: CLASS TIME USED ON TECHNOLOGY PROJECT - Cranston High School



researcher was out of the room for student interviews and Mr. Lindeman went back to teaching "Basic Bio". The second drop off occurred during the time the researcher was out of the classroom assisting in teacher training workshops at other locations. The third drop off occurred during the time the teacher helped the students review for semester finals.

The significant contrast is the complete abandonment of the materials at Western compared to the strong finish at Cranston. A line graph of Class Time Used On the Project (Figure 7-3) at Cranston High School actually identifies the trend to a greater degree.

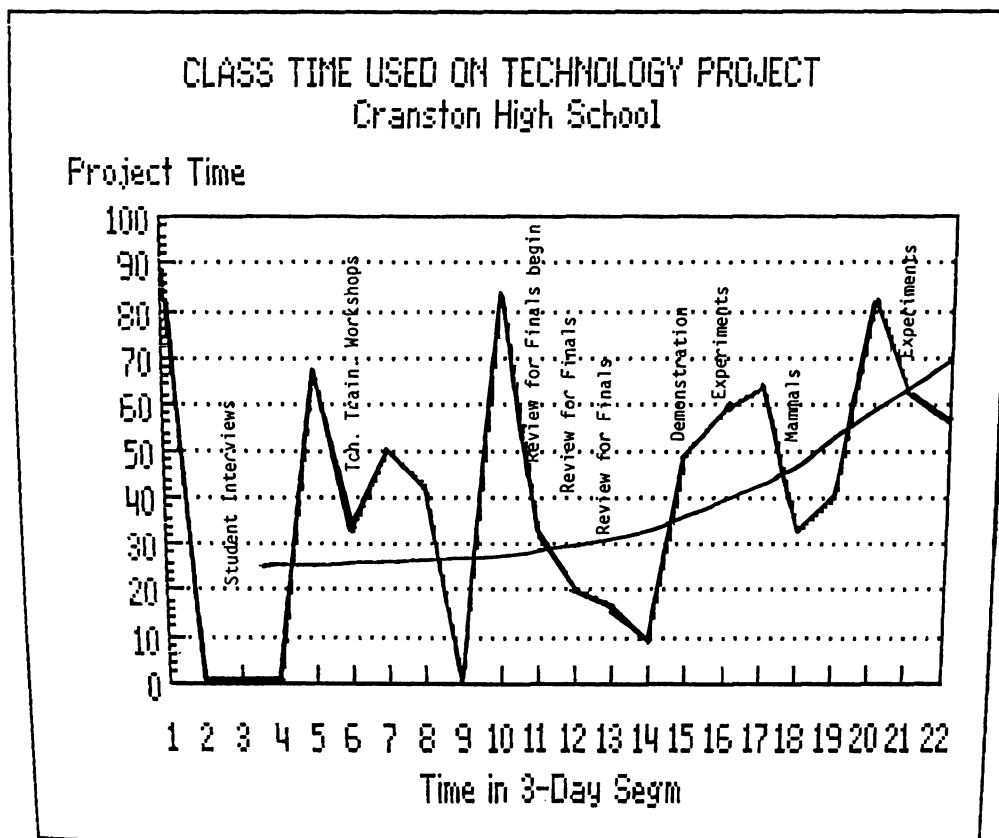


Figure 7-3: CLASS TIME USED ON PROJECT IN PERCENTAGE

10/10/10

10/10/10

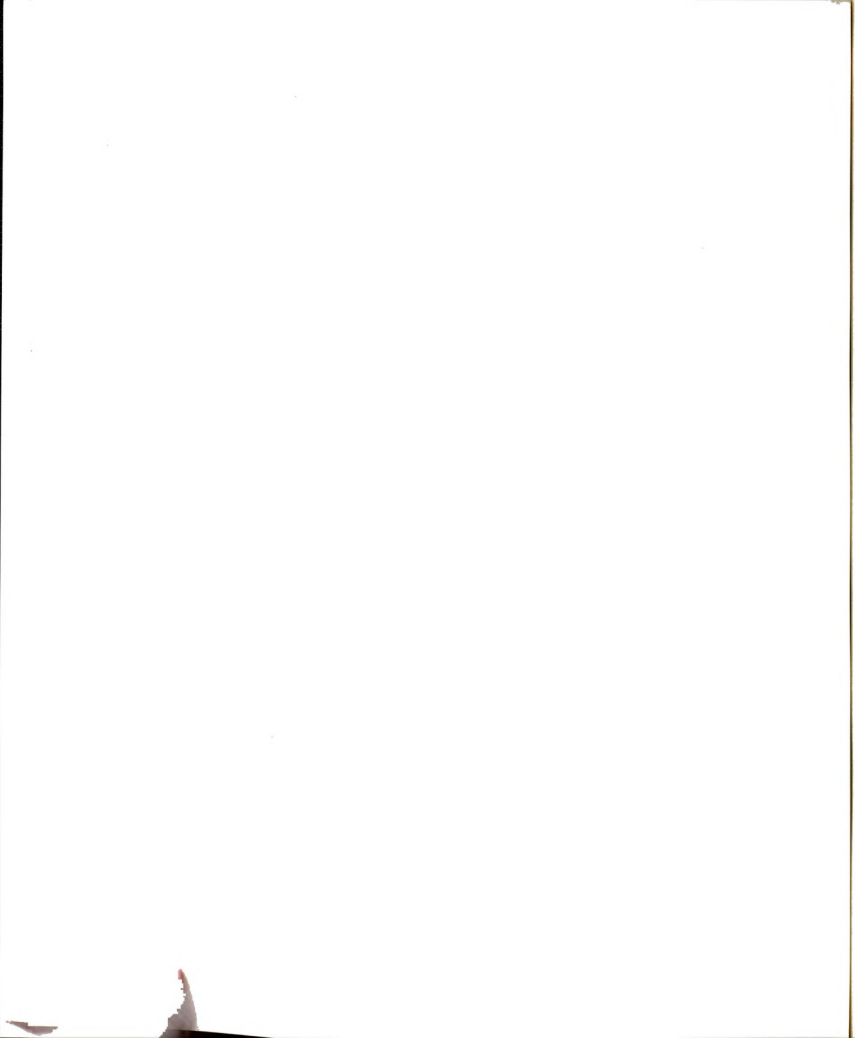
10/10/10

Activity Completion With the Technology Units

As indicated previously in the descriptive section, both teachers involved modified and adapted the activities in the new technology unit to align more with their own style of teaching and mode of classroom management. Reversion to former materials differed to a degree. Mrs. Strauss at Western would simply substitute parallel activities or lessons from the IIS text or lecture on previously prepared notes, while Mr. Lindeman from Cranston would revert to teaching Basic Biology from the Holt Rinehart text.

A count of activities from each lesson indicates that each teacher did make an honest effort to use the material in his/her own classroom. Figure 7-4 from Western High School shows about a 64% usage of materials for the first 9 days, a drop off to 17% for the next three, an increase to 83% for the next three days, and then complete abandonment of the materials. Overall, during the period of 15 days in which Mrs. Strauss actually used the technology materials, about 58% of the activities were used.

At Cranston High School about 74% of the activities were completed with the completion rate somewhat constant during the 24 days observed (See Figure 7-5). To better understand what happened at Western and Cranston High Schools, the activities were broken down into type of activities. Two types of activities showed significant trends - experimental work and written work (see Figures 7-6 and 7-7). At Western High School, the amount of experimental work initially declined as the amount of written work increased. Figure 7-6 shows that the large increase in activities during segment 5 was actually due to change of activity type from experimental to almost totally written exercises.



ACTIVITIES COMPLETED IN PERCENTAGE

Western High School

Completion in %

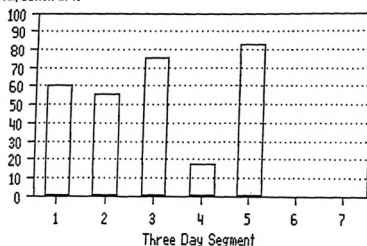


Figure 7-4: ACTIVITIES COMPLETED IN PERCENTAGE: Western H.S.

ACTIVITIES COMPLETED IN PERCENTAGE

Cranston High School

Completion in %

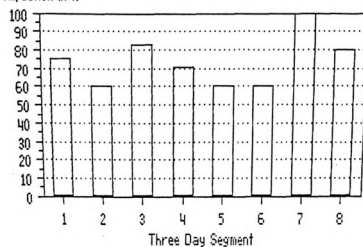
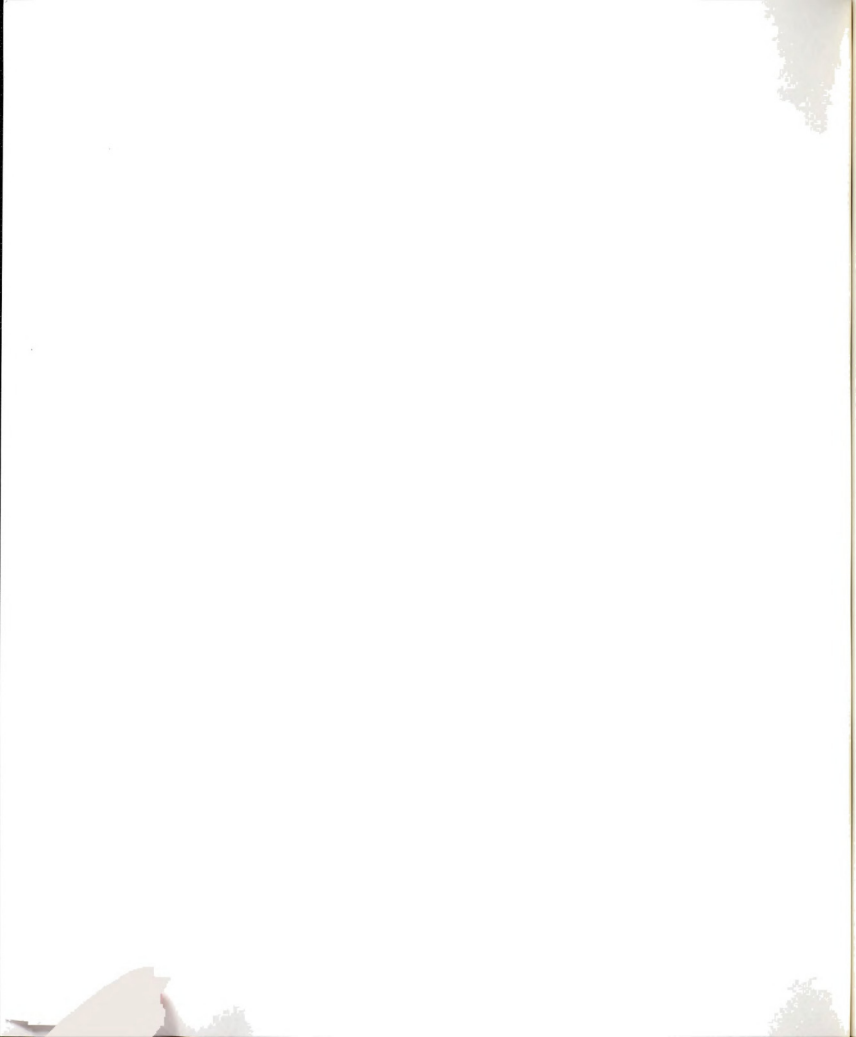


Figure 7-5: ACTIVITIES COMPLETED IN PERCENTAGE: Cranston H.S.



ANALYSIS OF ACTIVITY TYPE

Western High School

Experimental Written Work

Per Cent Time

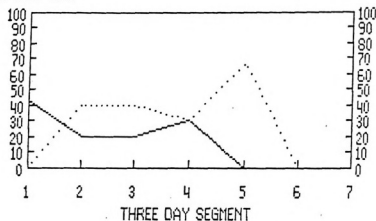


Figure 7-6: ANALYSIS OF ACTIVITY TYPE - Western H.S.

ANALYSIS OF ACTIVITY TYPE

Cranston High School

Experimental Written

Per Cent Activity

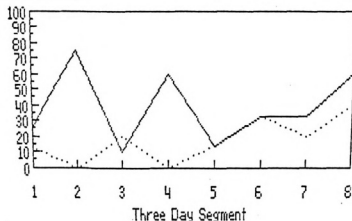
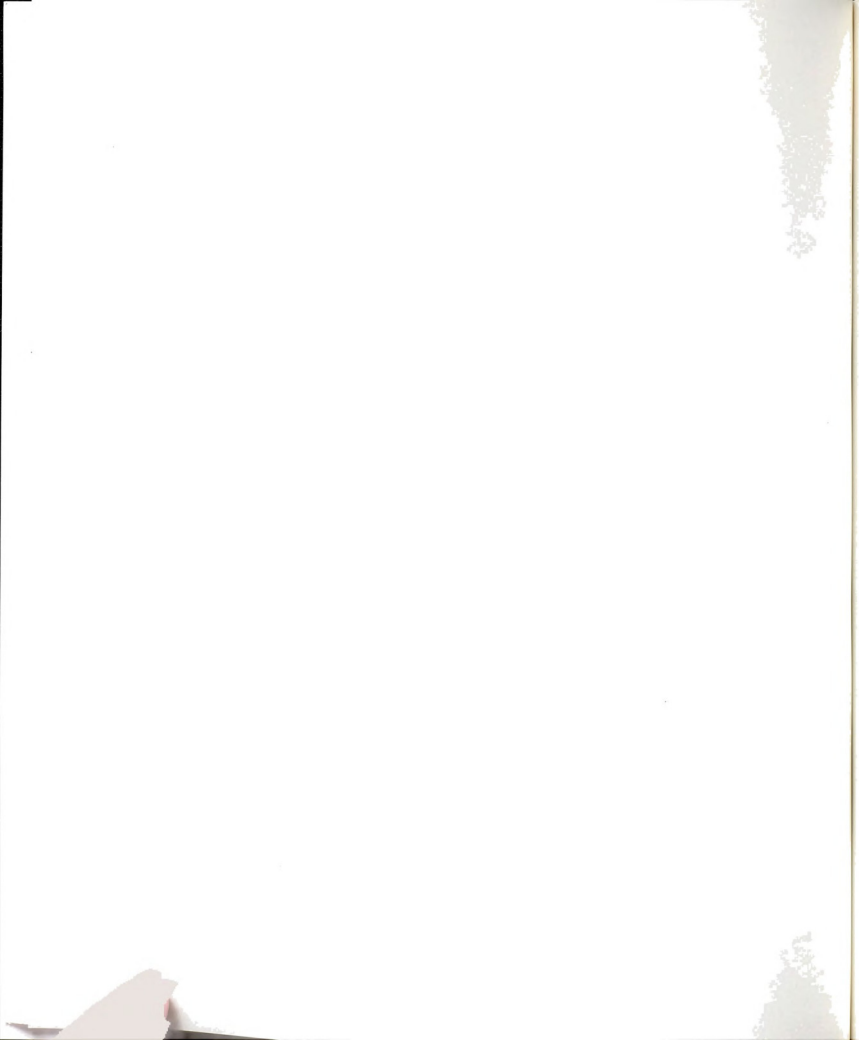


Figure 7-7: ANALYSIS OF ACTIVITY TYPE - Cranston H.S.



In contrast, the analysis of activity type from Cranston High School (Figure 7-7) shows an initial trend of written work decreasing as experimental work increased, but finished with an increase of both written and experimental work. As both a science teacher and a researcher, I believe this is significant in that written work is necessary for maximum benefit of an experimental approach to learning. Planning of experiments, data recording, and interpretation of results all dictate a certain amount of written work.

Changes Observed in Teachers During the Technology Units

As indicated in the previous section, one of the most significant developments was the extent of adaptation of the new technology units to old teaching routines and management structures. In both schools, a degree of adaptation took place. For example, Mrs. Strauss had students make outlines of the textual material and assigned vocabulary words. Mr. Lindeman also assigned vocabulary words and modified some lessons to include more analysis (graphing) than originally written into the technology materials.

At Western High, Mrs. Strauss almost completely modified the new materials to fit her established teaching and management routines. At Cranston, Mr. Lindeman initially reverted to old teaching routines, but with the participation of the researchers (modeling, coaching), the acceptance of multiple modes of learning was indicated, both in attitude as well as by incorporating the new activities into teaching plans.

Another response observed in both classrooms was the inclination to drop the technology units when the researcher/project assistant was absent from the classroom. The response of Mrs. Strauss at Western High School was more of radical adaptation (outlining material, giving notes on the same topic, and assigning worksheets), while the initial response of Mr. Lindeman at Cranston was a complete switch of topical



matter back to Basic Bio. I believe this difference in response could be attributed to a greater initial hesitation of Mr. Lindeman to use these types of activities with this class. The significant factor is the later difference in response. Toward the end of observation period, Mrs. Strauss at Western completely dropped the technology material, while Mr. Lindeman at Cranston continued using these materials even in the absence of the researcher/project assistant.

Another change observed is in the type of activities used. One of the important differences between the previously used teaching routines and the new technology materials is the source of information. Previously used teaching routines focused almost entirely on the teacher: lecturing, giving notes, oral review, and quizzing. The technology units focused more on the students: planning in small groups, completing experiments activities and experiments, summarizing, and analyzing data. At Western High School, the amount of activities demanding student involvement initially was high, but dropped off quickly as the teacher sensed a loss of close control in this more fluid environment. The same pattern emerged at Cranston, but as the researcher switched from the role of an observer to more of a participant/observer (11/7, 11/22, 2/13), the amount of student involvement activities used by Mr. Lindeman increased again.

Another significant difference in the response of the two teachers had to do with initiative. Due to the unfamiliarity with the materials, and the difficulty to maintain close control, Mrs. Strauss at Western High responded with initial hesitation that led to progressive withdrawal and eventual complete reversion to the old program and style of teaching. Mr. Lindeman at Cranston, initially displayed the same hesitation, but would look to the researchers for help and involvement. This led to acceptance of increased responsibility on the part of Mr. Lindeman for taking the lead into incorporating the project materials into classroom planning (1/26). Moreover, Mr.

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Lindeman took the initiative to utilize some of the types of activities in other classes, whereas at Western a complete reversion to the familiar routines and materials was observed.

Another significant teacher response to the technology materials was the method of analysis, summation, and interpretation of results from the experiments. Mrs. Strauss at Western High School depended on students using the Student Activity Books as the primary mode of forming conclusions. On the other hand, Mr. Lindeman from Cranston took a more active teacher-centered role in analyzing data and forming conclusions. Examples of this are illustrated on the greenhouse experiment (Feb. 6th), the activity on wind (Feb. 12th), and the convection box (Feb. 20th). Another significant mode of analysis used by Mr. Lindeman was graphing in the summation and interpretation of the on-going weather record.

The final difference in response between the two classrooms has to do with attitude and the recognition of the utility of student involvement activities with this particular population of students. Up to the very end, Mrs. Strauss at Western still believed that "these students" are unable to follow instructions enabling them to use experimental work profitable. In contrast, Mr. Lindeman at Cranston recognized the ability of these students to complete experimental work, but also given support through modeling and coaching would settle down and behave making this type of activity possible. A summary of this comparison is given in Table 7-1.

Changes Observed in Students During Teaching of the Technology Unit

An interesting finding among the students in both schools was the initial frustration level of students – not being able to follow directions and not having the confidence to proceed on their own. In both schools, the result was an increased level of off-task and disruptive behavior. During the first few days, students would wait for

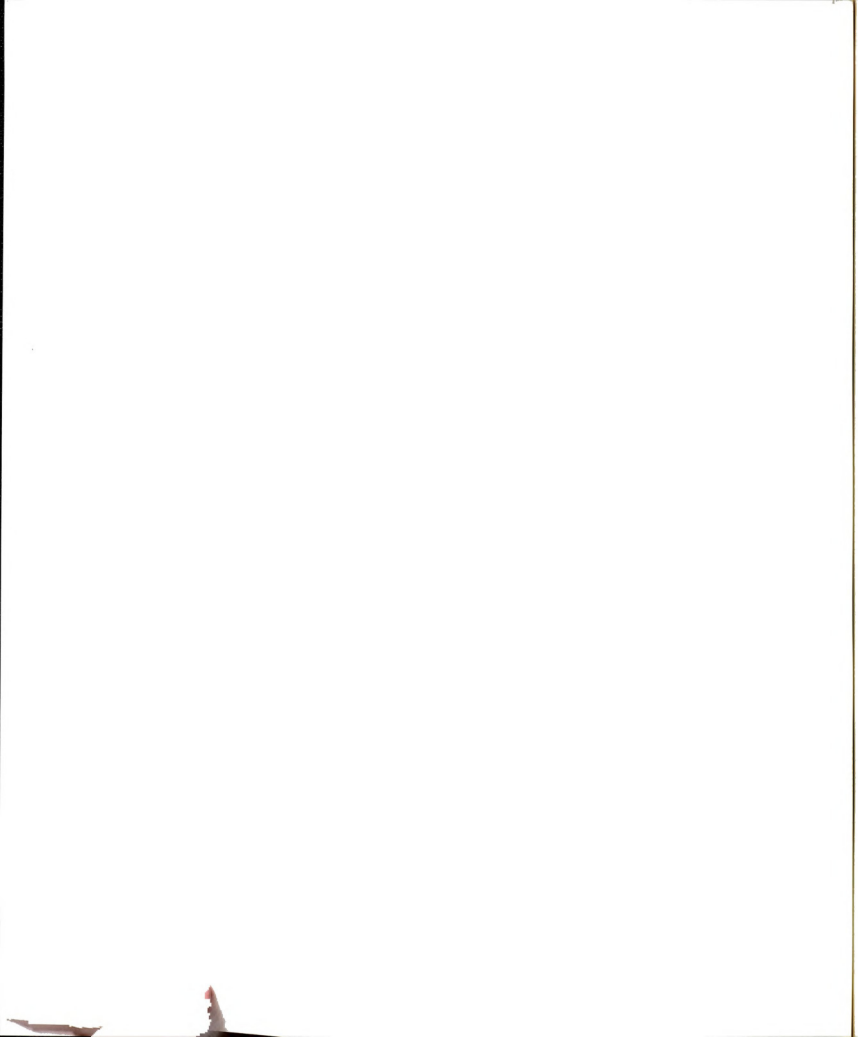


Table 7-1: CHANGES OBSERVED IN TEACHERS DURING THE TECHNOLOGY UNITS

WESTERN HIGH SCHOOL (w/o scaffolding)	CRANSTON HIGH SCHOOL (with scaffolding)
Adaptation of unit observed (p.37)	Adaptation of unit observed (11/22, 12/4)
Teacher reverts to former teaching routines	Initial reversion to old routines, with later use of "multiple modes of learning (p. 153), incorporating techniques into other classes (p.157)
Technology lessons dropped when the researcher was not present	Technology lesson initially dropped when researcher was absent, but later continued in the absence of researcher
The number of activities requiring student involvement decreases	Activities requiring student involvement initially decreases and then increases
Initial hesitation leading to withdrawal	Initial hesitation leading to initiative later on in the unit (1/26)
Teacher begins with full use of technology curriculum but gradually switches to former IIS materials	Use of technology unit initially drops off, then increases again toward the end
Experimental interpretation left to students	Experimental interpretation and summation led by teacher: Greenhouse lesson, 2/6; Wind lesson, 2/12 Convection box lesson, 2/20
Teacher sees experimental work as "the pits"	Teacher recognizes the utility of student involvement activities and scaffolding (2/2 and 2/27)

Table 7-2: CHANGES OBSERVED IN STUDENTS DURING TECHNOLOGY UNIT

WESTERN HIGH SCHOOL (w/o scaffolding)	CRANSTON HIGH SCHOOL (with scaffolding)
Initial frustration remains high during the course of the unit	Initial frustration decreases with time during the course of the unit
Off-task behavior during activities remain high	Off-task behavior initially high, but decreases during the course of the unit
Students continue to depend on the teacher for information	Confidence increases as students do more work alone
Student involvement in investigative activities decreases during the course of the unit	Level of student involvement increases during the course of the unit
Questions teacher initiated	Students initiate more questions during the course of the unit
Student requests for help remains minimal	Increase in student requests for help during the course of the unit
Students hand in workbooks at teacher's request	Students bring work to teacher for approval and to check to see if they are "on track"



help, visit with each other, read other materials (magazines), and find creative ways to amuse themselves.

After a period of time, a significant difference developed between the two classrooms. At Western High, the students continued to depend on the teacher as a source of information. This resulted in the teacher reverting to lecture and note summaries. The majority of questions remained teacher initiated – primarily used in review sessions. The level of student involvement activities decreased correspondingly. Student initiated requests for clarification and help remained minimal. Students continued to feel frustrated with the work and much of the written work in the Student Activity Guides remained incomplete.

In contrast, students at Cranston High gained confidence as postulated from a number of indicators. First of all, the number of student initiated questions and the requests for help increased. Secondly, the level of student involvement increased as students changed from inactivity to participation and interest in the activities. Thirdly, the willingness to begin a task and proceed on their own demonstrates an increased level of confidence. However, the most rewarding aspect was a marked decline in the off-task and disruptive behavior. Last of all, a sense of pride developed among the students as they would bring up their work for us to see "how are we doing" and to find out "how do you like it?". Table 7-2 gives a summary of this contrast.

In the perspective of the researcher, two significant differences contributed to this change in students at Cranston High in contrast to Western High. First, the role of the researcher at Western High was almost exclusively that of an observer. However, at Cranston High the role of the researcher quickly changed to that of an participant observer. Mr. Lindeman looked to the researcher to demonstrate activities (modeling), to help the students get started (coaching), and help in cooperative planning.



CONSIDERATION OF OTHER VARIABLES Students, Classroom, and Teacher

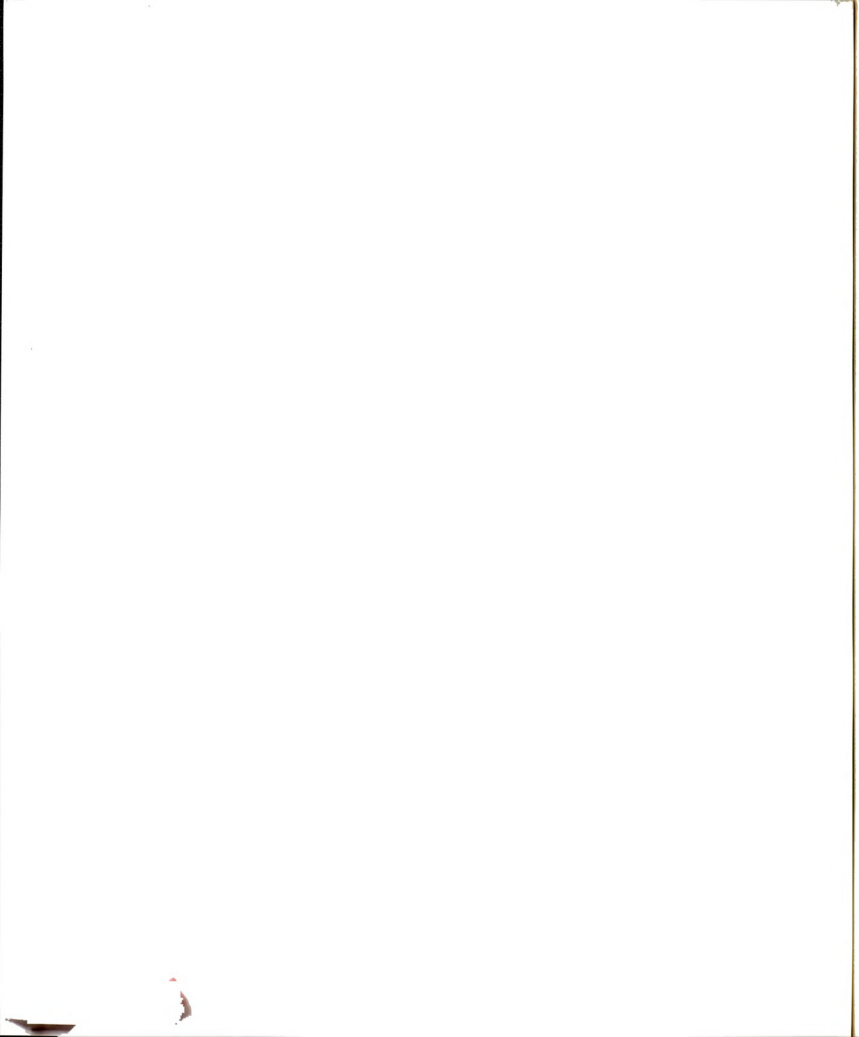
In the last section, a comparison of the two classrooms in which an attempt was made to implement the new technology revealed some significant outcome differences in both the teacher and students. As one examines this data, the question could be asked, "To what could this difference be attributed?" Are there significant differences in the personality or teaching style of the teacher? Do the teachers have different attitudes and beliefs about the students? Is the classroom structured in a different mode to allow implementation in one case and not in the other? Hopefully, a point to point comparison of the two classrooms will reveal a striking similarity in classroom structure, in techniques of teaching, and types of activities used.

Table 7-3: COMPARISON OF CLASS AND STUDENT CHARACTERISTICS

WESTERN HIGH SCHOOL	CRANSTON HIGH SCHOOL
Students with varied academic needs	Students with varied academic needs
High average daily attendance	High average daily attendance
Students care about success	Students care about success (p. 116)
Students seldom read the text	Students seldom read the text
Students seldom complete homework	Students seldom complete homework
Students ask few questions	Students ask clarification questions (p. 134)
Little student to student interaction	Little student to student interaction

Student Characteristics

A comparison of the students in these two classrooms reveals a very similar background as to composition – low ability students, students brought in from other classes in which they were failing, some mainstreamed from special education, and some with an average ability whose work output has severely hampered their academic progress (see Table 7-3).



It may be assumed that students in both classes like the class and the teacher, based on comments by the students, and by the high average attendance in both classes was over 90%. This is in contrast to another inner city school (South Central), where the average daily attendance for the classes observed was about 60%.

Indications from the descriptive comments and the concern about grades suggest that students care about school and about doing well in the class. This may seem incongruent to the casual observer, considering the fact that students in both classes read the text only to find answers, complete almost no homework assigned, and ask few questions directed at gaining a clearer understanding of the material.

While questions at Cranston High were primarily directed at clarifying assignments, checking the accuracy of notes, and asking about the daily schedule, almost a complete absence of student initiated questions was observed.

Teacher Characteristics

As one examines the various aspects of the teacher that would impact the outcome results in regard to implementation, again a striking similarity emerges; in personal characteristics, in foundational beliefs, in management techniques, and in teaching methodology (see Table 7-4).

Both teachers expressed and exhibited similar foundational beliefs about students that in turn shape the management and methodological techniques used in teaching. As indicated in the descriptive commentary, both teachers viewed the students as incapable of following directions, incapable of using experimental work profitably, and nonproductive while working in small groups. This view was consequentially expressed in their practice of seldom using small groups and complete exclusion of experimental and developmental activities that require following directions in a series of steps.



Moreover, while both teachers exhibited a limited view of the students' potential, they both treated their students with kindness, concern, and respect. While these expectations were limited as to the students' future professional potential, each teacher expressed a desire for his/her students to succeed in this science class,

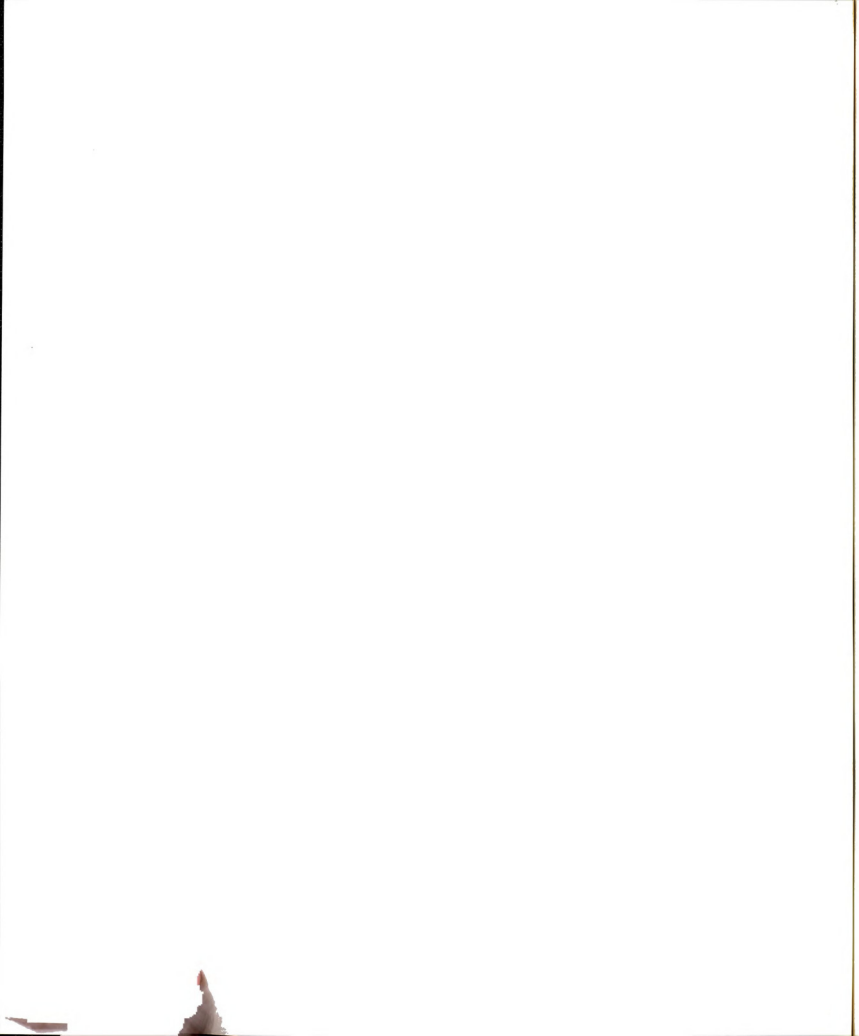
Table 7-4: COMPARISON OF TEACHER CHARACTERISTICS AND BELIEFS

WESTERN HIGH SCHOOL	CRANSTON HIGH SCHOOL
Views students as incapable of using experimental work profitably	Views students as incapable of using experimental work profitably
Views students as incapable of following written instructions	Views students as incapable of following written instructions
Limited view of students' potential	Limited view of students' potential
Treats students with respect	Treats students with respect
Teacher cares for the students and works to help them succeed in class	Teacher cares for the students and works to help them succeed in class
Constructs instruction for success: - gives note summaries - oral review for tests - virtually covers content and questions for test - frequent review quizzes	Constructs instruction for success: - gives note summaries - oral review for tests - virtually gives content and questions for test - frequent review quizzes
Is well liked by the students	Is well liked by the students
Sees these students as not interested in school	Elicits an interested response from students

and constructed instruction to help insure success. This included giving note summaries of the content, oral review & drilling for quizzes and tests, and a virtual identification of content and questions for the quizzes and tests. Quizzes averaged two to three per week and formed the basis for larger tests at the end of the quarter.

Comparison of Classroom Management

Upon entering each of these two classrooms, an observer is impressed with the order and class control. Students are in their seats, respond when the teacher asks them to be quiet, and do settle down and complete work in class. Both Mrs.



Strauss and Mr. Lindeman exhibit a high degree of what researchers call "with-it-ness", meaning teachers are continually aware of what is going on in the classroom and deal with a problem immediately before it escalates into a major confrontation. This includes hearing comments the students make to one another, leaving of seats, and incidents of "goofing off". The effectiveness of the management system a teacher uses can be measured by the initial period routines such as attendance, assignments, and announcements. In both classrooms, this period never exceeds five minutes and in most cases is completed in less than two minutes.

The mode of control in each of these two classrooms has some similarities and some differences, but each are very effective in their own way. Mrs. Strauss used immediate parent contact and parent conference should the work of a child indicate a possibility of failure. In personal student conferences, she used threat of summer school, veiled in gentle humor. To remedy tardies she used noon detentions. On the other hand, Mr. Lindeman used extensive use of humor to develop a good relationship with the students and to confront problems immediately. Both teachers refrained from using sarcasm or public humiliation as a means of control.

To remove frustration from the students, both Mrs. Strauss and Mr. Lindeman were very clear as to expectations, supplying required content directly to students through lecture and notes. To avoid embarrassment of students who may not know the answer, both teachers depended on volunteer answers or used target students when calling on students for answers.

An examination of the strategies used to keep students on task reveal that Mrs. Strauss' class is more tightly structured than Mr. Lindeman's class. Both teachers used assigned seats and placed themselves in a position to be able to continually monitor the activities of the whole class (See Table 7-5).

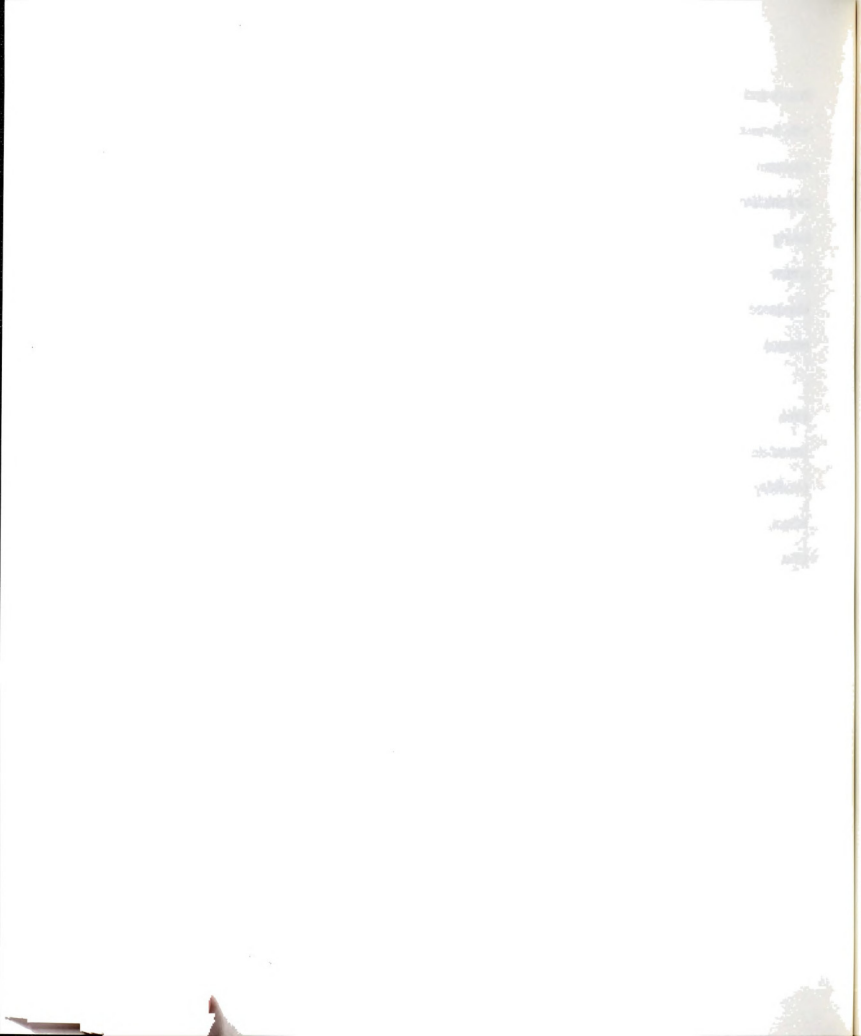
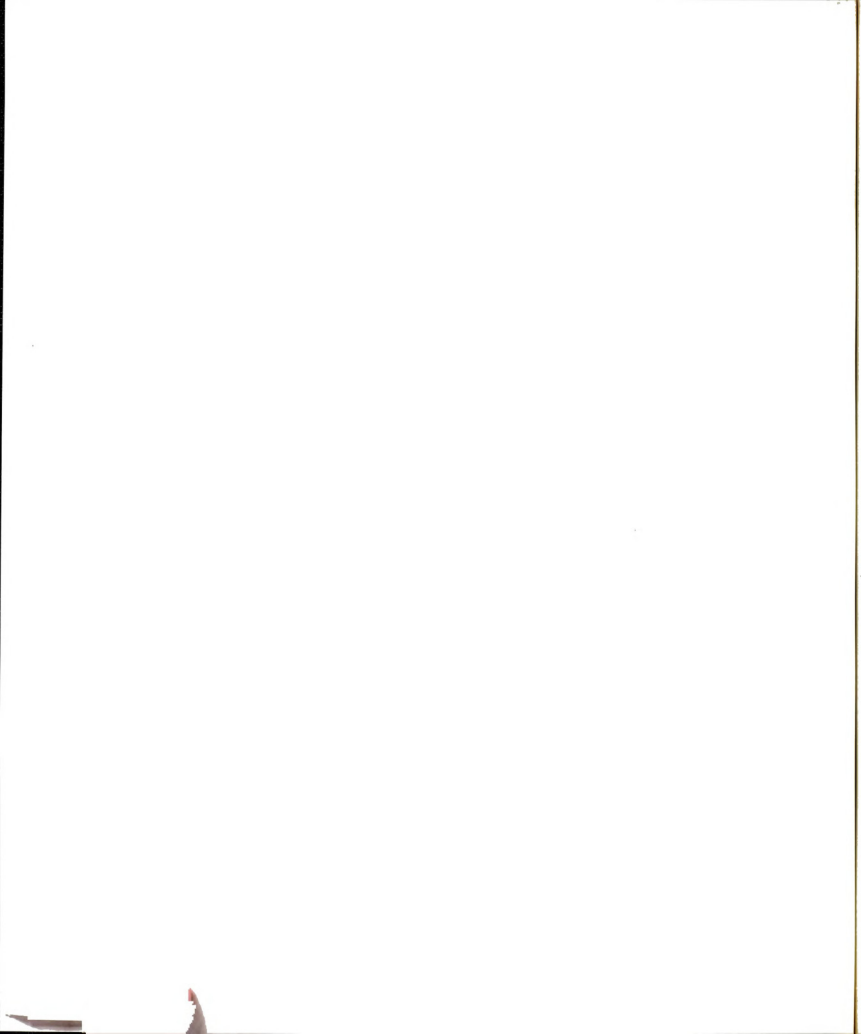


Table 7-5: COMPARISON OF CLASSROOM MANAGEMENT

WESTERN HIGH SCHOOL	CRANSTON HIGH SCHOOL
Keeps class in control. Exhibits "with-it-ness" (p. 28-29)	Keeps class in control. Exhibits "with-it-ness" (p. 81-82)
Minimum time spent on management - Initial period routines less than five minutes	Minimum time spent on management - Initial period routines less than five minutes
Uses parent contact and threat of failure as major management tool	Uses humor as a major management tool (non-confrontive rebound)
Sarcasm or public humiliation seldom used as a control device	Sarcasm or public humiliation never observed as a control device
Procedural information supplied directly to students	Procedural information supplied directly to students
Utilizes target students	Utilizes target students (p.72)
Strategies to keep students on task: * assigned seats * continuous monitoring * no talking allowed during work sessions * no talking allowed during quizzes (cheating not observed) * students confined to desks * instructions given by direct commands Classroom tightly structured	Strategies to keep students on task: * assigned seats * moderate monitoring * talking allowed during work period * talking allowed during quizzes (considerable cheating observed) * students allowed to walk around the room (10/27/89) * non-confrontive rebound (1/8, 1/31) Classroom more loosely structured
Motivational devices: Positive teacher feedback * praise for good work * pause and wait * last five minutes of the period to talk as a reward for being good and working hard	Motivational devices: Positive teacher feedback * praise for good work (1/8) * pause and check (p. 64) * students allowed to talk last five minutes of the period for being good and working hard
Negative teacher feedback: * noon detention as a consequence for being tardy * write sentences * threat of failure, with summer school * kick out of class * grades announced publically	Negative teacher feedback * No consequences observed for being tardy (10/27/89) * students come up to see their grade
Considered a good teacher - by administration - by students	Considered a good teacher * by administration * by students (p. 81-82)



However, the similarity stops here. In Mrs. Strauss' class the students were confined to their seats while Mr. Lindeman allowed the students to walk around during a work period. Mrs. Strauss did not allow talking in either the work period or during a quiz. Mr. Lindeman allowed talking during a work period, and ignored comments during a quiz. Consequently, cheating was observed in Mr. Lindeman's class, but never once in Mrs. Strauss' class. An interesting difference in dealing with off-task or behavioral problems involved the use of direct comments by Mrs. Strauss, but the non-confrontive rebound by Mr. Lindeman.

Motivational devices can be divided into both positive and negative stimuli. On the positive side, both teachers used praise for good work, and would reward students with the last five minutes of class to visit and talk, if they worked hard during the period. While Mrs. Strauss would pause and wait for students to finish taking notes, Mr. Lindeman would "pause and check", asking students if they are ready to proceed.

The greatest difference in motivational devices used by these two teachers falls in the area of negative stimuli. Mrs. Strauss gives noon detentions for tardies, while Mr. Lindeman ignored most tardies (10/27/89). If the students didn't show up for the noon detention for Mrs. Strauss, they had to write sentences. If the sentences were not completed, they would be kicked out of class or received a failing grade for the semester.

One embarrassing motivational method used by Mrs. Strauss was to announce quiz and semester grades publicly. Mr. Lindeman would have students come up and see their grade on his sheet.

Both Mrs. Strauss and Mr. Lindeman were considered good teachers. The administration appreciated their effectiveness in classroom management, and the students appreciated their kindness and commitment to help students be successful.

Comparison of Teaching Routines

An examination of the teaching routines in Mrs. Strauss' classroom at Western High and Mr. Lindeman's classroom at Cranston High again demonstrate a striking similarity in basic teaching routines and overall classroom procedures. This section will be divided into two parts, first an itemization of similarities (Table 7-6) and then an itemization of differences in the two respective classrooms (Table 7-7). Each of these will in turn be subdivided into Assignments/Expectations, Methodology, Organizational Devices, and Motivational Devices.

An examination of Table 7-6 reveals that in regard to assignments and expectations, the two teachers involved in this comparison are virtually identical on eight points, except for a few minor details in application. The one area of difference in expectations is that Mrs. Strauss assigned students to outline the chapters and Mr. Lindeman did not ask this of his students.

As to methodology and teaching routines, Table 7-6 again notes seven areas of great correspondence. Table 7-7 lists the seven areas of differences, which to the casual observer may seem significant, but in reality are still variations of the same mode of operation. Mrs. Strauss relied on the printed textbook more heavily than Mr. Lindeman, for whom the primary source of content remained the teacher. Mrs. Strauss used the chalkboard extensively to give notes, while Mr. Lindeman used the overhead projector and videos. One significant difference is the proportion of time spent on written versus oral work. Mrs. Strauss assigned more worksheets and questions from the textbook while Mr. Lindeman spent much more time giving notes to the students on the overhead projector and using oral review. One technique often used by Mr. Lindeman and seldom used by Mrs. Strauss was relating the new material to contextual links, both in the immediate environment and to former experience.

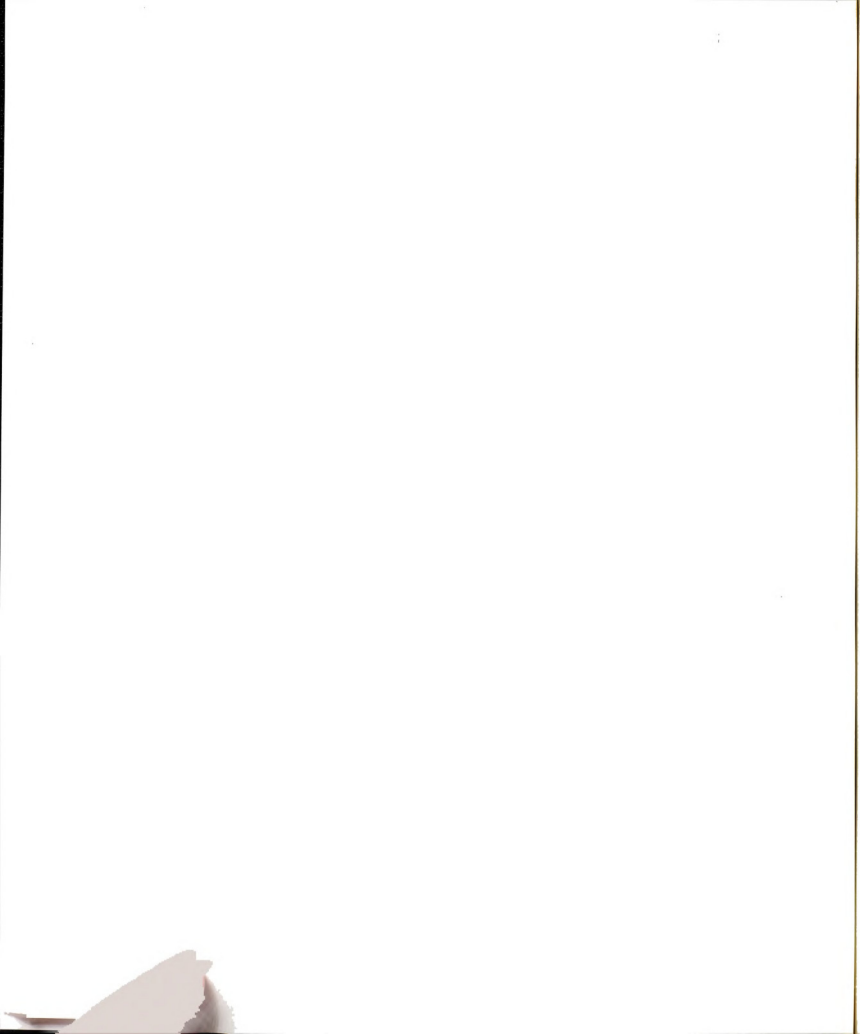


Table 7-6: SIMILARITIES IN INITIAL TEACHING ROUTINES

WESTERN HIGH SCHOOL	CRANSTON HIGH SCHOOL
Assignments and expectations: * daily assignments written on the chalkboard * textbook chapter read in class * little homework assigned * vocabulary words assigned (10/26) * review worksheets assigned * notebook required (10/30, 11/27) * questions assigned on worksheets and in textbook	Assignments and expectations: * daily assignments written on overhead projector * textbook chapter read in class * little homework assigned * spelling words assigned * review sheets assigned * notebook required * questions assigned on worksheets and in textbook
Methodology and teaching routines: * lesson progression a constant pattern established routines and sub-routines (p. 4, 16, 17) * note summaries given on the chalkboard * questions primarily posed by teacher answers given by students * no student to student class discussion * test questions provided by specific oral and worksheet review * approximately two quizzes given per week * quizzes and worksheets corrected orally	Methodology and teaching routines: * lesson progression a constant pattern established routines and sub-routines * note summaries given on the overhead projector * questions primarily posed by teacher answers given by students * little student to student class discussion * test questions provided by specific oral and worksheet review * approximately two quizzes given per week * quizzes and worksheets corrected orally

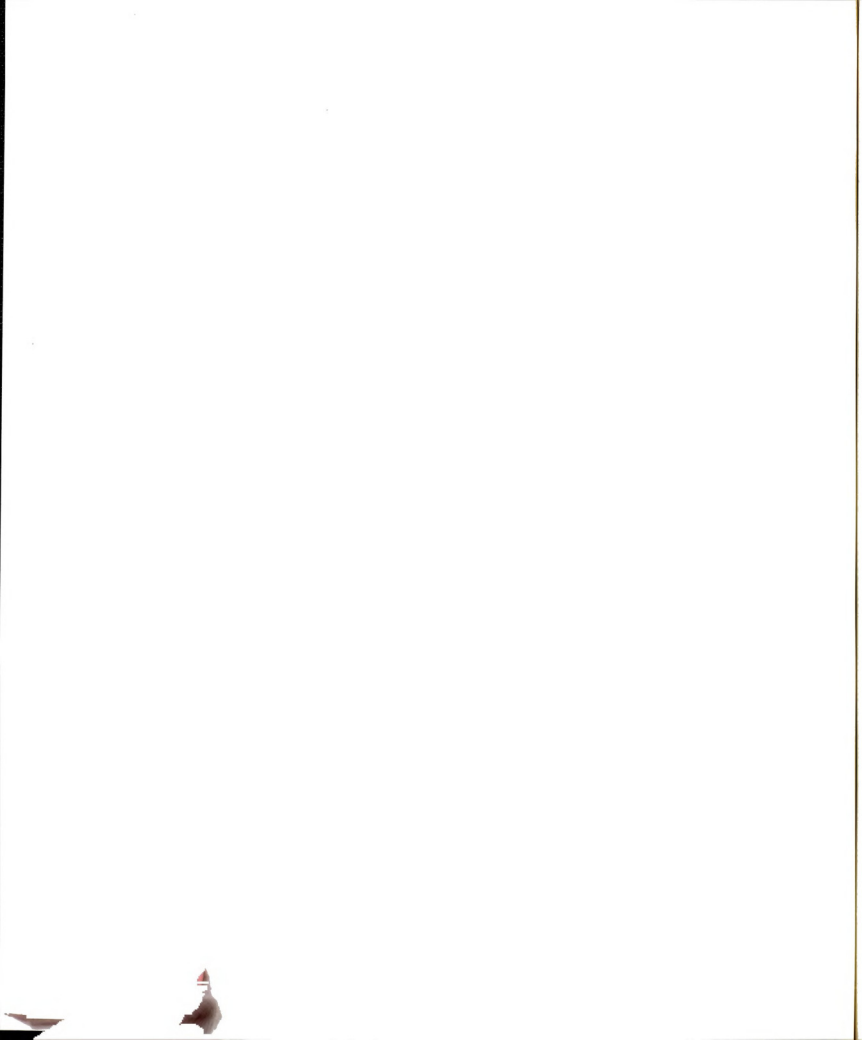


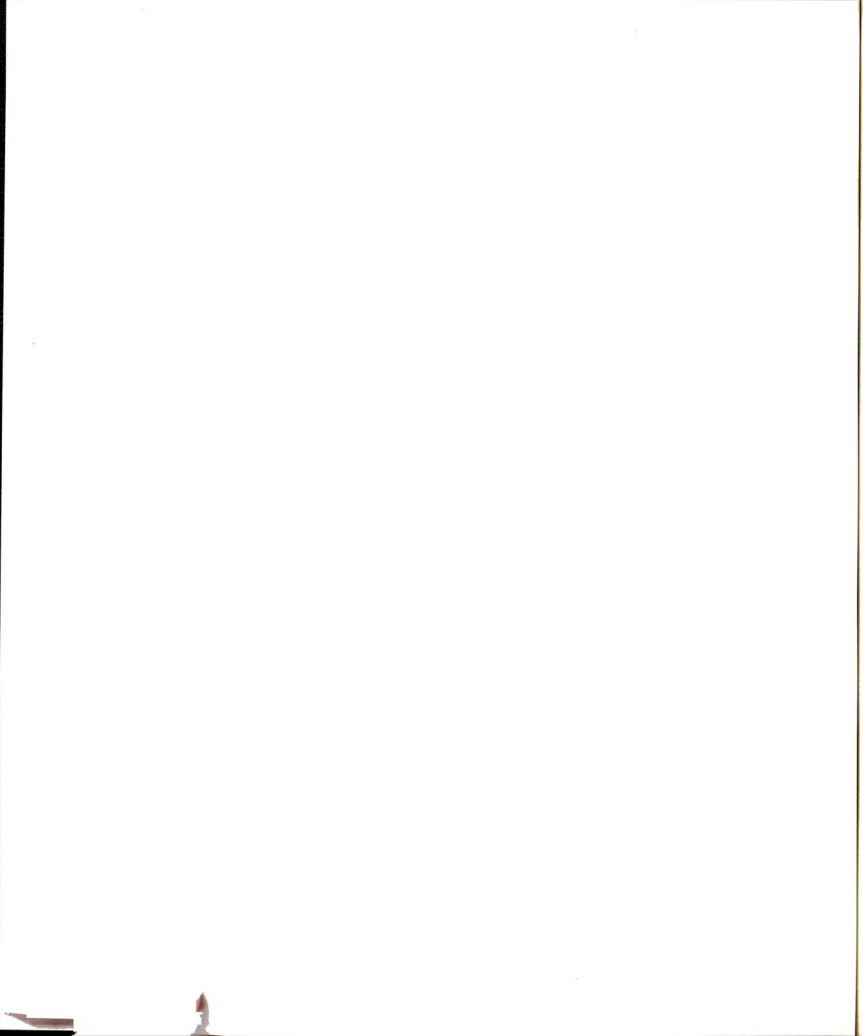
Table 7-7: DIFFERENCES IN TEACHING ROUTINES

WESTERN HIGH SCHOOL	CRANSTON HIGH SCHOOL
Assignments and expectations: * chapter outline assigned	Assignments and expectations: * outlining of chapter not observed
Methodology and teaching Routines: * textbook used routinely * limited use of media * little discussion * little contextual linkage * students work alone * more written work than at Cranston High School (worksheets and questions from text) * notes used occasionally during a quiz	Methodology and teaching routines: * textbook occasionally used * generous use of media (overhead projector, videos) * some discussion (question and answer, clarification questions from students) * contextual linkage common * students sometimes work together * more note summaries and oral review than Western High School * notes routinely used during quiz time

As one compares the likenesses and differences of these two classrooms, the basic operational structures are very much alike. However in the later part of each observational unit, the response of each classroom, including the teacher and students, was very different. In the next section we will consider, what I believe as a researcher, contributed to the difference in the implementation of the technology units in each classroom.

Consideration of Impacting Variables

One of the characteristics of ethnographic research is the consideration of many variables simultaneously, looking for verifying instances, disconfirming evidence, hopefully identifying patterns in routines, beliefs, and values. A strength of this method is observation of social interaction in the natural setting, without eliminating the influence of the social, structural, and philosophical milieu. While this mode of research more accurately depicts reality as to what really goes on in a classroom, it is



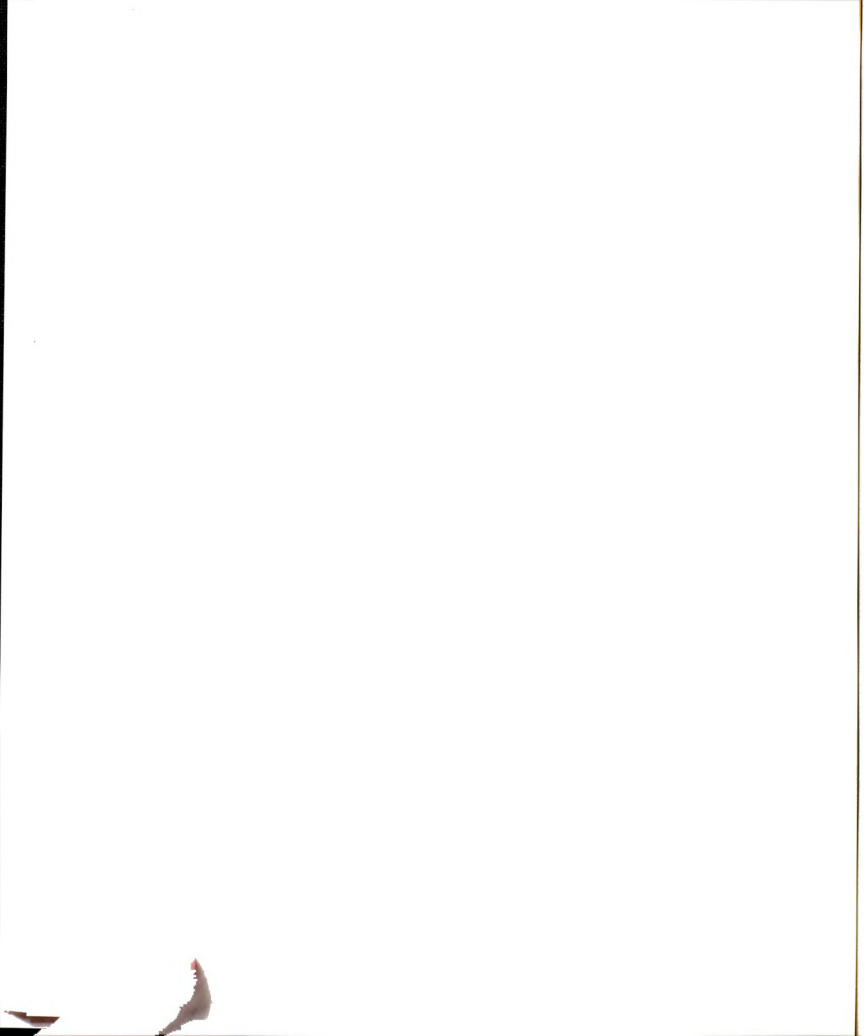
much more difficult to directly link cause and effect as to what variable or interactions contribute to the observed result.

Thus, two final comparisons will be drawn in an attempt to identify the factors that I as a researcher felt contributed most to the marked difference in response and the degree of implementation of the technology units in these two classrooms (See Table 7-8 & Table 7-9).

We begin with the assumption, based on the detailed descriptive narrative of the classrooms and the interview data, that with the poorly motivated, low achieving science students, teachers have developed routines of class procedures to help them maintain control and secondly to generate some degree of success for these students. This assumption was borne out in our observations. As each of the teachers in these two classrooms began to use small group activities and experiments from the new technology unit, class control began to disintegrate. Each of the teachers responded to this deterioration of class control in a different manner. Thus we can further assume that the teacher's response will in turn be linked to the student response. Which in turn raises the next question: What was different in these two classrooms (on the part of each of these two teachers) to elicit a different response from their students and in turn affect the degree of implementation of the new program?

Technology Instruction in Two Different Classrooms

The first comparison will be drawn between the teacher initiated action in Mrs. Strauss' class at Western High and Mr. Lindeman's class at Cranston High (See Table 7-8). To begin with, the technology units are designed to involve students in small group activities and experiments. At the beginning of the technology unit in each classroom small group activities were attempted and class control deteriorated as students had difficulty following instructions, lacked self-confidence in going ahead on



their own, and above all sensed a lack of preparation on the part of the teachers. It was at this point that we noted a different response on the part of each teacher. Mrs. Strauss adapted the material to old routines. Mr. Lindeman switched back entirely to Basic Bio when the researcher was not in the room. But when the researcher was in the room, Mr. Lindeman would stop, look at the researcher and wait for me to come up and demonstrate the new material. This initiated the change of the researcher from the role of observer to participant observer. It also established the use of demonstrations as a preparation for the students to complete activities. This is in marked contrast to Mrs. Strauss who first of all adapted the material to the old teaching routines, and secondly switched to demonstrations to take the material out of the hands of the students. This whole scenario was the basis for developing a modeling pattern in the classroom at Cranston, but not at Western.

Table 7-8: INSTRUCTION IN MRS. STRAUSS' ROOM COMPARED TO MR. LINDEMAN'S ROOM

WESTERN HIGH SCHOOL	CRANSTON HIGH SCHOOL
Small group activities attempted, dropped, and switch made to demonstration	Small group activities increased
Researcher takes the role of observer	Researcher takes the role of participant/observer
Demonstration used primarily as a substitute for experiments (1/12/89, 3/12/89)	Demonstrations used a preparation for activities and experiments (11/22, 12/7, 12/18)
Teacher uses time for correcting	Teacher circulates among students, coaching & encouraging (11/20, 11/22, 11/27, 12/19, 1/27, 1/28)
One period lesson	Long-range project
Teacher makes all decisions regarding planning	Cooperative planning (1/8, 1/22, 1/26)
Intended very different from implemented curriculum	Intended much closer to implemented curriculum (p. 120)

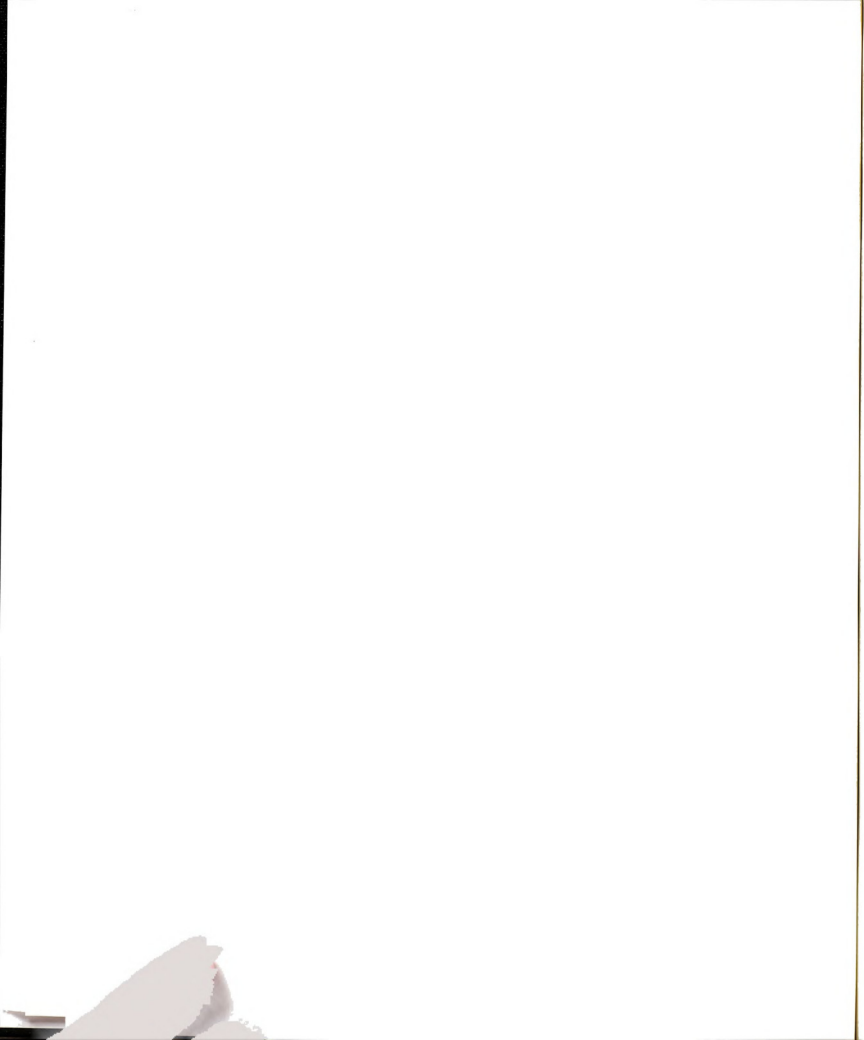


The second difference in teacher response concerned teacher action during the time students spent on experiments. In Mr. Lindeman's class, both the teacher and the researcher spent circulating among the students helping them get started; making suggestions, doing an example for them, and giving general encouragement. This difference represented the "coaching" phase of a scaffolding approach to helping students complete work beyond their intuitive ability. In Mrs. Strauss's class, most teacher time (during student work time) was used for correcting workbooks, quizzes, and studying the teacher's manual.

A third difference between these two classrooms concerned the introduction of a long-range project – setting up the weather station, gathering weather data, analyzing the weather data by constructing graphs, and identification of related factors using concept maps. Most of the work in Mrs. Strauss's class involved material that was completed in a single period segment and did not involve summative analysis.

One final difference involved the relationship between the researcher and the classroom teacher. In her position as classroom teacher, Mrs. Strauss held the prerogative to make all decisions as to scheduling classroom activities and planning future lessons. In contrast, Mr. Lindeman was more open to share his classroom plans with the researcher, discuss the reaction of students, and toward the end engage in cooperative planning with the researcher.

These differences contributed to a different outcome in each classroom. In Mrs. Strauss's classroom, the implemented curriculum was very different from the intended curriculum. In Mr. Lindeman's class, the implemented curriculum was much closer to the intended curriculum, and in some respects, showed improvements over the intended curriculum.



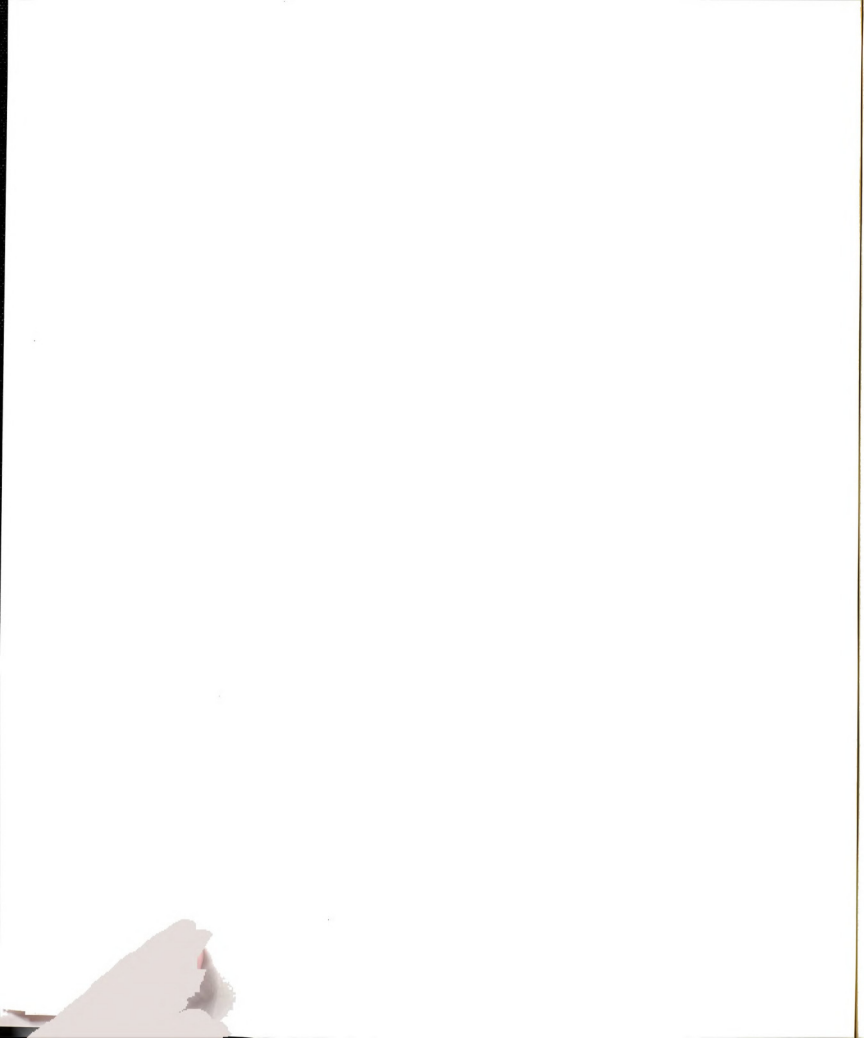
Changes in the Classroom Where a Degree of Implementation Occurred

Both teachers had indicated in previous conversations that experimental activities do not work with "these" students and could verify such a position from former experience. This then raises the question, "What happened in Mr. Lindeman's class that experimental/developmental activities were viewed as productive for "these" students, a distinct change in teaching methodology was observed, and a significant degree of implementation of the new unit took place? The change in teacher action is outlined on Table 7-9.

Table 7-9: COMPARING INSTRUCTION IN BASIC BIO AND WEATHER

BASIC BIO - GENERAL SCIENCE	TECHNOLOGY UNIT - WEATHER
Small group activities used only to find answers in the text book.	Small groups used for planning, experiments, data analysis, concept map creation. Use of small groups increased.
Majority of student content received through lecture on overhead projector	Some content now received through experimental observation, analysis of data, and summation
Majority of class time spent on lecture, giving notes, and taking quizzes	Experiments and long-range projects conducted, with follow-up analysis and conclusion development (graphing, concept maps, summaries)
Demonstrations not observed	Demonstrations used to acquaint students with activity procedures (11/22/89, 12/7/89, 12/18/89)
One-shot activity type	Repetition of activity - procedure recycling, p. 151 (graphing, solar heaters, concept maps)

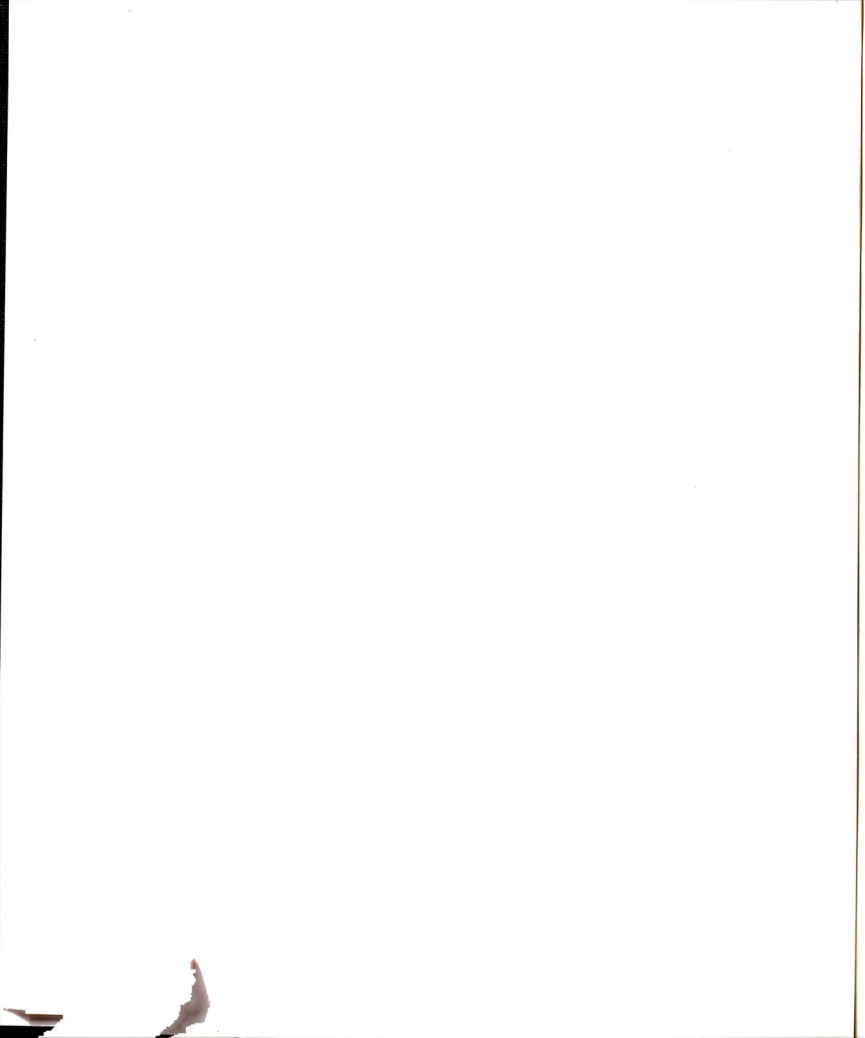
First of all, during the time Mr. Lindeman was observed teaching Basic Bio, no demonstrations, lab periods, field trips, or small group activities were observed, except for students working together to find answers to questions in the textbook. During the technology unit, the amount of small group activities increased, which included planning, data collection, construction of graphs, construction of concept maps, and completion of experimental work.



Secondly, the source of informational input for students changed. In Basic Bio, the major source of content for the students came from lecture with notes given on the overhead projector. This mode of teaching also represented the majority of class time. In contrast, in the technology unit the students spent a majority of time completing experiments, collecting data, analyzing data, and developing conclusions.

A third difference in teaching Basic Bio and the Weather Unit concerned demonstrations. During the period of observations, no demonstrations were conducted in Basic Bio. However, during the Weather Unit, demonstrations were used as a means of helping students visualize the materials setup, understand the procedures, and organize the collection of data. As previously mentioned, this formed the basis for modeling.

Another factor that contributed to the implementation success of the Technology Unit "Weather" concerned "procedure recycling", which involved repeating the same type of activity or experiment using different variables. This helped generate confidence in the students, who now felt they understood what to do and could complete it on their own. Possibly for the first time in their lives, these students assumed an element of control in the area of scientific investigation.



CHAPTER EIGHT – SUMMARY AND CONCLUSIONS

This chapter will briefly summarize the context of the study, overview the findings, present an interpretation of the data as related to present available literature, evaluate the assertions in light of data collected, and finally give implications and recommendations.

The Context of The Study

The design and development of the Technology units, which formed the subject matter context for this study, was based on research on the learning characteristics of the poorly motivated, low achieving high school science students, on the functionality of previous programs, on former experience of the writers of this program, and finally on some assumptions used in the design of the Technology Program. By the fall of 1989, five units were complete and ready for trial testing in actual classrooms. The trial testing of these units was designed to substantiate design decisions, work out "the bugs" in the material, and evaluate the effectiveness of the new program.

The data for this study were primarily derived from observations in two general science classrooms composed of poorly motivated, low-achieving students, but also considered observations from other classrooms and relied on literature for corroboration. In each classroom, data were collected in the form of field notes, taped interviews, student work, and structured in a two phase sequence as follows:

- 1) **Pre-project** – observations on the regular course of study in use at the time of entry. In both classrooms, instruction during this phase was characterized by teacher lecture and individual student seat-work.
- 2) **Project Implementation** – observations on teaching during the new technology units; *Wheels* at Western High without intervention and *Weather* at Cranston High with



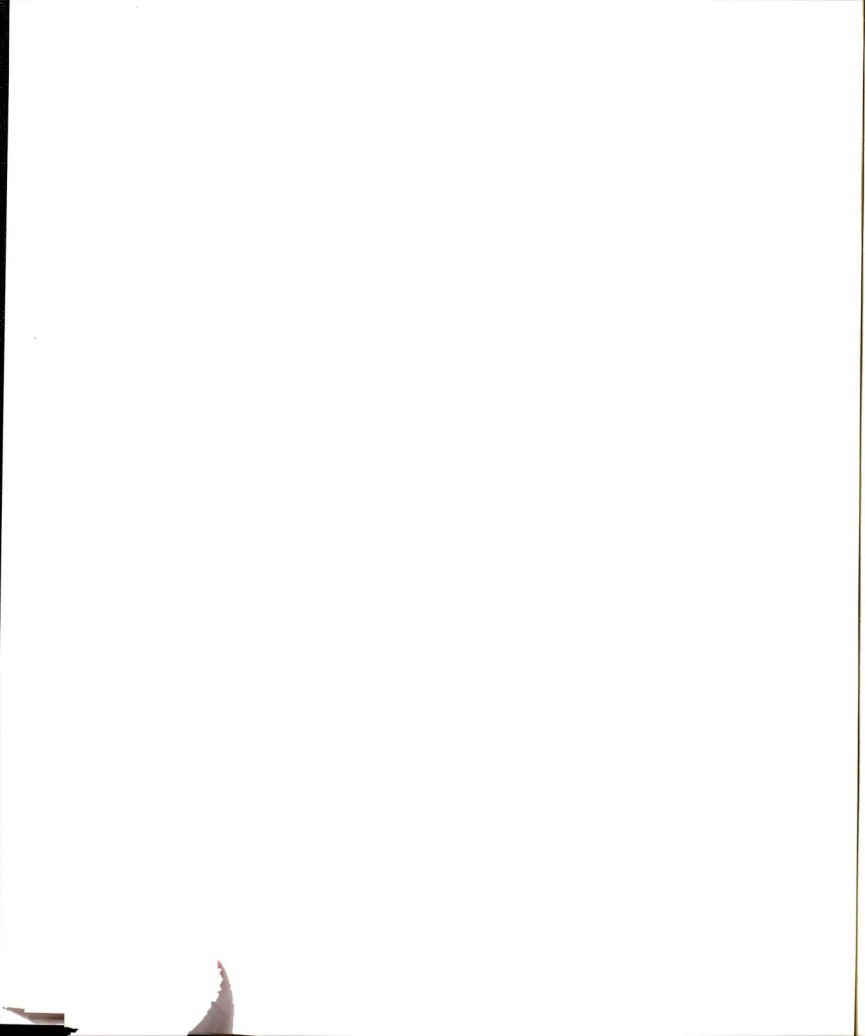
intervention. The new materials used in this phase demanded more student involvement activities and attempted to engage students in scientific investigation.

Summary of Observational Data

The following is a summary of observations significant to the intent of this dissertation, to the logical development of assertions made, and integrate existing literature with the data interpretations and conclusions. These observations are grouped according to the main research questions. The first main research question was stated as follows: **What classroom routines and modes of teaching that could affect the implementation of a new program are in the previously established repertoire of these teachers?** Relevant to this question, two major observations were established and supported:

1. These classrooms operated with a limited, repetitive, and highly directed structure. In their normal course of teaching with the poorly motivated, low achieving science students, the two teachers observed in this study used a repetitive and carefully selected repertoire of activities, which did not require much reading, writing, or creative thinking. Communication of subject matter content was limited to interaction between the teacher and individual students. Discussions between students concerning science was almost completely absent.

We documented a striking difference between the normal everyday teaching/management routines used in these classrooms and those proposed in the new technology curriculum. Upon entry into both of these classrooms, the existing teaching routines were organized with the textbook as the primary source of information and organizer of instruction. The teaching cycle in both classrooms included these components in a context of teacher-centered whole-class teaching,



combined with individual seat-work:

- * Read the text
- * Do the questions furnished in the textbook
- * Teacher lecture with students taking notes
- * Complete worksheet
- * Complete definitions of vocabulary words
- * Oral review for the quiz
- * Final quiz

This sequence was essentially repeated in a cycle chapter after chapter. Of special note is the absence of classroom discussion, experimental work, long range activities, and small group work. An obvious characteristic of this teaching was drill and repetition in preparing students for the weekly quiz.

2. Different, more restrictive management and teaching strategies were used for poorly motivated students than for regular and advanced classes. One of the interesting side benefits of this field study was the opportunity to watch the same teacher operate in both a low level class and an upper level class. This was true in both high schools studied. It became very obvious that both classroom management techniques and teaching methodology differed for these two levels.

In managing lower level students, detailed directions were given and repeated for almost all classroom procedures, such as where to hand in a paper and when students had to be in their desks. Supervision was close and constant, and little talking was allowed during a work period. On the other hand, in the regular and upper level science classes, the atmosphere was more relaxed, students were allowed to move around and talk more freely, and given more individual choices. Management



was much less directive, supervision was not as intense, and directions were not as precise.

Management routines are used by teachers as coping mechanisms in dealing with low achieving students in what are commonly perceived as difficult classroom situations. The work is kept relatively easy – all answers can be found in the book. The tests are predictable – the questions have been virtually given ahead of time. Labs with procedural difficulties and unpredictable results are avoided. Thus the students demand little help from the teacher, whose sole attention can then be directed to monitoring the class and correcting written work. Students primarily work alone and the need for talking is minimized. The teacher can immediately identify a student causing a disruption. The overall impression to a person visiting these rooms is a well managed class, good control, and clear teaching.

The teaching methodology for lower level groups was much more didactic, directive, and structured than for higher level groups. One of two modes of instruction were usually used – either teacher-centered whole-class oral instruction (with the teacher doing most of the talking and with students taking notes) or students working alone completing worksheets generated by the teacher or completing questions from the textbook. Moreover, classroom activities followed the predictable cycle as described on a previous page. Our observations note a great hesitancy in teachers to depart from these tried and familiar routines useful in management of students, which for them takes a higher priority than academic achievement. This reluctance on the part of teachers extended particularly to activities that involve materials, experimentation, and student actions.

A feature in both low-level classrooms studied was the completion of a science notebook, which then became part of the quarter grade. This notebook became a



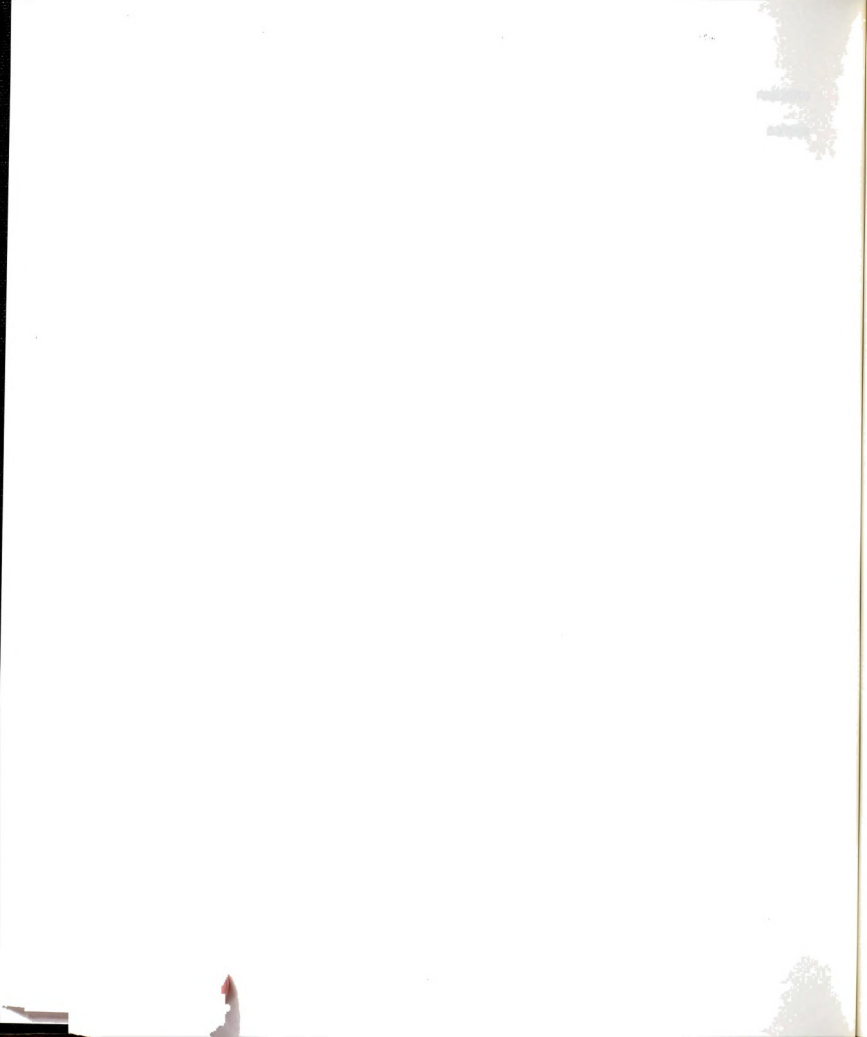
collection of facts, rules, and definitions and in a sense characterized the nature of science for these learners. It also provided a predictable body of information that needed to be memorized for the next test (Anderson, 1987, pp. 77 ff).

The preparation for, and passing of tests, then became the major focus of instruction for the teacher and effort on the part of the students. Further, because tests were based almost exclusively on recall of facts, real understanding (ability to place these facts into meaningful relationships) took remote second place in these classrooms.

Another characteristic of these lower level classrooms was the treatment of subject matter. The attempt was made to simplify the explanations (so the students could comprehend) and reduce the amount of material covered. The net result is characterized by Prawat (1989, p.317) as an "emphasis on breadth of coverage instead of depth ... mentioning topics rather than developing them ... in which textbooks jump from fact to fact, topic to topic, without getting into sufficient depth in any one area to foster real understanding."

This mode of teaching is reminiscent of traditional teaching as described by Goodlad (1984), Stake & Easley (1978), and Gallagher (1985b) where the activity structure was predominantly lecture, directed toward recall of information (basic facts and definitions), with little student to student interaction. Thus we see that these low achieving, poorly motivated students are often kept from doing real science, even though it has been demonstrated that they can do real science (Rowe, 1975).

On the other hand, the teaching methodology for the regular and upper level classes allowed for more individual initiative and provided a greater degree of variety in the activities. These included science labs, small group work striving to solve problems, teacher lecture, discussion summaries, and independent work. The



teaching methodology for the poorly motivated, low achieving science students were in marked contrast to exemplary teachers (Tobin and Fraser, 1986; and Treagust, 1991) who used a wide variety of activity structures and classroom organization to monitor for understanding as well as participation. These exemplary teachers encouraged discussions with student input, included problem work and lab activities, and set high expectations for their students.

The second section of this data summary deals with the second main research question stated as follows: **How is the new science/technology**

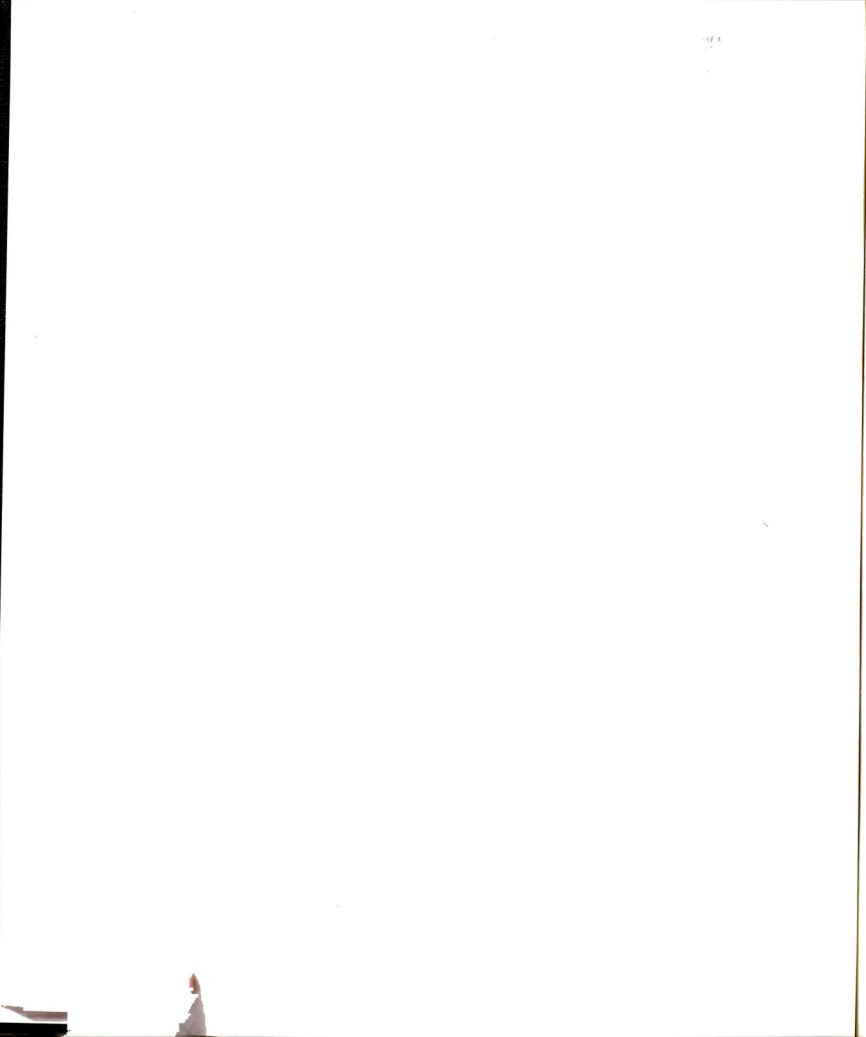
curriculum viewed and used by teachers and students in the

implementation phase of development? The introduction of new

technology curriculum provided a methodological contrast to the instruction existing in the classroom at the time of entry. It planned for and expected a much greater variety in instruction and activities. These included large group presentation sessions, demonstrations, small group planning sessions, experimental work with lab materials, data summary activities such as creation of concept maps and graphs, and long range projects such as building the weather station, accumulation of the weather record, and analysis of weather data. The summary of this section will first take a look at how the teachers responded and then how the students responded to the new curriculum.

1. How Teachers Responded to the New Technology Curriculum?

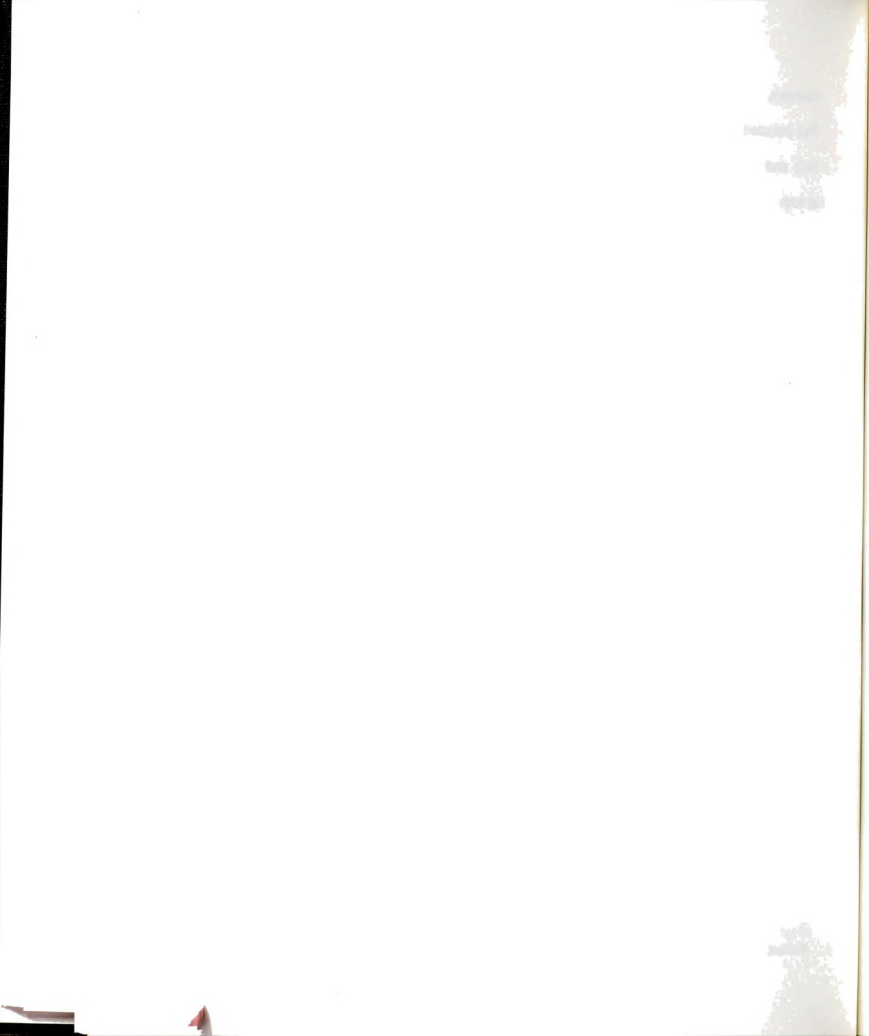
At the beginning of each new technology unit, I assumed that the teachers would follow the instructions in the Teacher Guide Book and students would complete the activities from the written instructions. The initial teacher response at both schools was somewhat similar. During the first week with the new materials, both teachers made a sincere effort to use the new curriculum materials as written.



However, when student centered activities were used, classroom control deteriorated. This included increase in passivity, alternative activities (visiting, reading magazines, etc.), and disruptive activities normally classified as "goofing off." This was observed at both Western and Cranston High. The most obvious response on the part of teachers was a hesitancy and reluctance to use the new program. When the observer/researcher was present, the technology curricular material was used. If the observer was not present, there was an almost immediate reversion to the existing textbook material. Not only was there a change in content, but also a reversion to the limited, repetitive, and highly directive routines used in former teaching routines. This action was consistent with the expressed belief of these classroom teachers at the beginning of the project that small group, involvement type of activities are not beneficial to the poorly motivated, low achieving science students. Initial use of the new material seemed to confirm these beliefs.

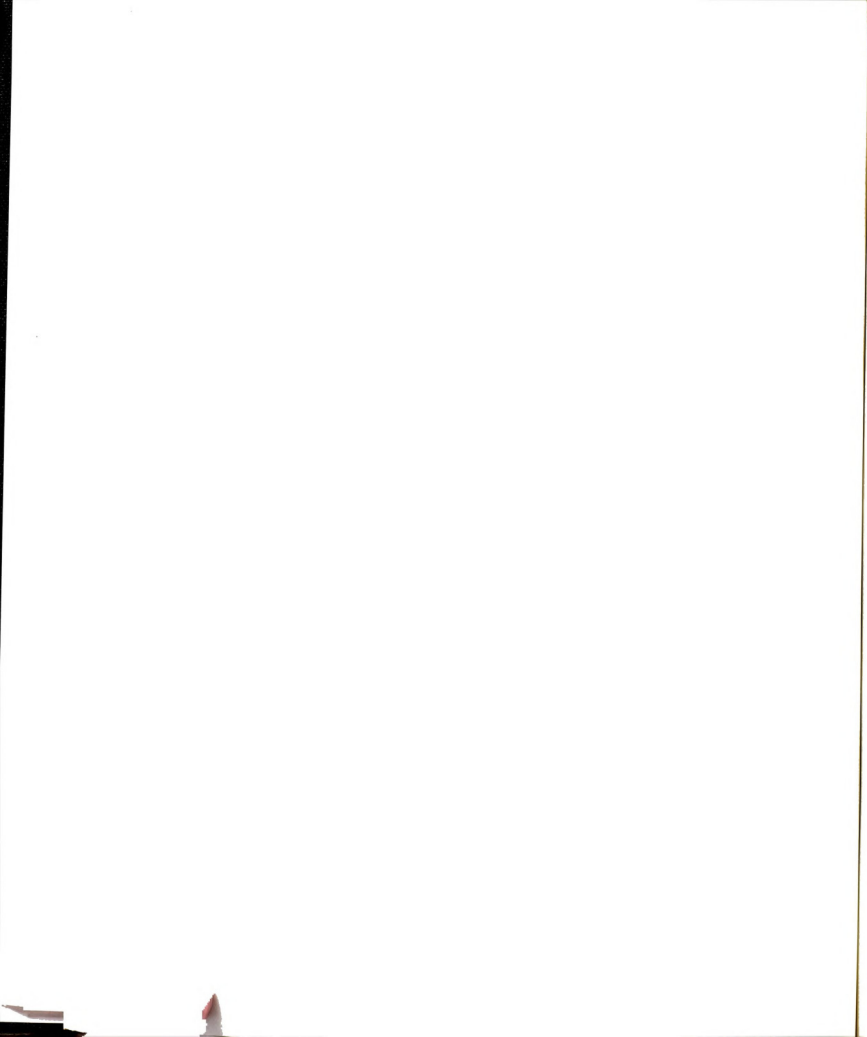
The structure of activities used in traditional teaching carried over into teaching with the new technology units. Teachers modified and adapted the material in the technology units to fit their own management and instructional routines or simply used the new content with the old embedded routines. This form of adaptation was neither successful in utilizing the strengths of the new curriculum or in implementing the curriculum on a long term basis. Implementation at Western High was marginal at best. Implementation at Cranston High was marginal initially, but improved during the course of the unit, as a result of my extended personal intervention.

It became obvious that much of the teacher acceptance of the new curriculum was determined by the student response. On task involvement of students dropped to the lowest point when they were asked to follow a procedural set of directions. This student hesitancy was most prominent at the beginning of a new activity and at the



beginning of the class period. This is where I as a researcher at Cranston High School changed my role from observer to participant/observer and to then to primary teacher/modeler. I first demonstrated the activities, modeling the making of concept maps, showing how to set up equipment and going through the procedures of experiments. Even after our explanations and demonstrations, the students did not work on their own. The teacher and I then circulated among the students to help them get started – watching, giving hints, showing how to arrange equipment, and take measurements. Finally, by the third round of the activities, students were able to complete work on their own. This was true for the graphing exercise, the formation of the concept maps, and experiments with the solar panels. When a clear visual demonstration of an activity was given, and immediate help was available to diagnose problems, students did settle down, work quietly, and complete their work. With specific support measures (such as procedure demonstration & immediate help) students were able to complete involvement type activities. This led to the implementation of an instructional model called scaffolding (Collins, Brown, & Newman, 1987) to support these students in following directions. This was further augmented with a process developed within the project called procedure recycling, in which a basic set of procedures were developed and taught for an activity and experiment, and then used again and again in various other applications and modifications. With scaffolding and procedural recycling, students developed the ability to follow directions, complete activities, and gain a sense of pride and satisfaction in their work. As students gained experience and success in completing work during the course of the study, the level of "on-task behavior" continued to increase at Cranston High.

This change in student response at Cranston High made an impression on the teacher. During the latter part of the unit, the attitude of the teacher changed from



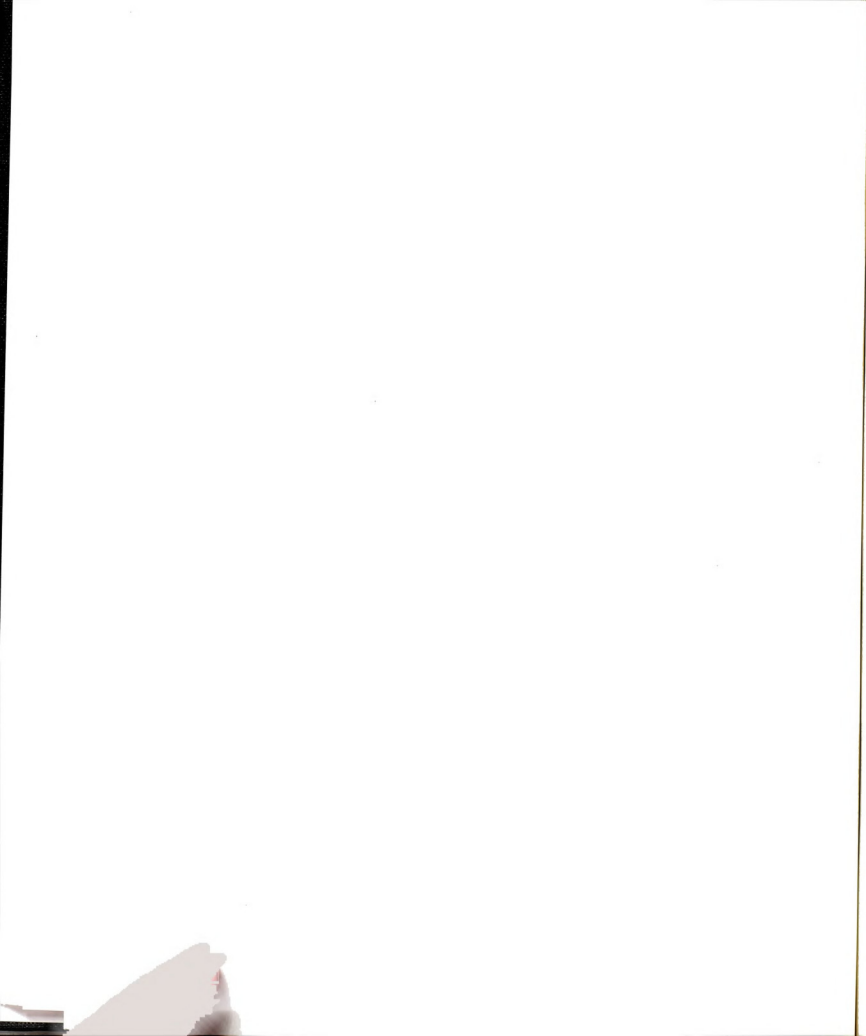
reluctance to use the materials to a willingness to participate to an enthusiastic acceptance. This was not true at Western High where procedure recycling and scaffolding were not used.

2. How Students Responded to the new Technology Curriculum?

The response of the students was examined on three levels: 1) their spoken reactions indicating attitudes, opinions, and beliefs, 2) their level of involvement and engagement, 3) and finally the nature of their interpersonal behavior. The initial spoken response of the students at both schools was varied. They did not like the Student Activity Guides that accompanied the new program – which had a lot of fill-in answers. They did like the experiments, and believed that experiments are one of the most helpful components of learning. However, they preferred demonstrations, having had difficulty following the procedures of experiments. They also expressed the opinion that the teacher was very important in helping them understand the material. They felt that the new curriculum material was harder, and were uneasy about being able to get a good grade in this unit.

The level of student involvement at Cranston High School changed during the course of the unit. The initial student reaction, however, was to engage in off-task behaviors including standing around and talking. They seemed to have little ability to follow directions and little confidence in being able to complete the work. With the intervention (scaffolding and procedure recycling), students stayed on task, completed experiments, finished concept maps and data analysis charts.

A significant change was also noted in the interpersonal behavior of the students at Cranston during the course of the unit. Before the unit started, students would work quietly at their desks – taking notes as the teacher lectured, reading text, answering questions, or writing a quiz. With the beginning of the experimental work in

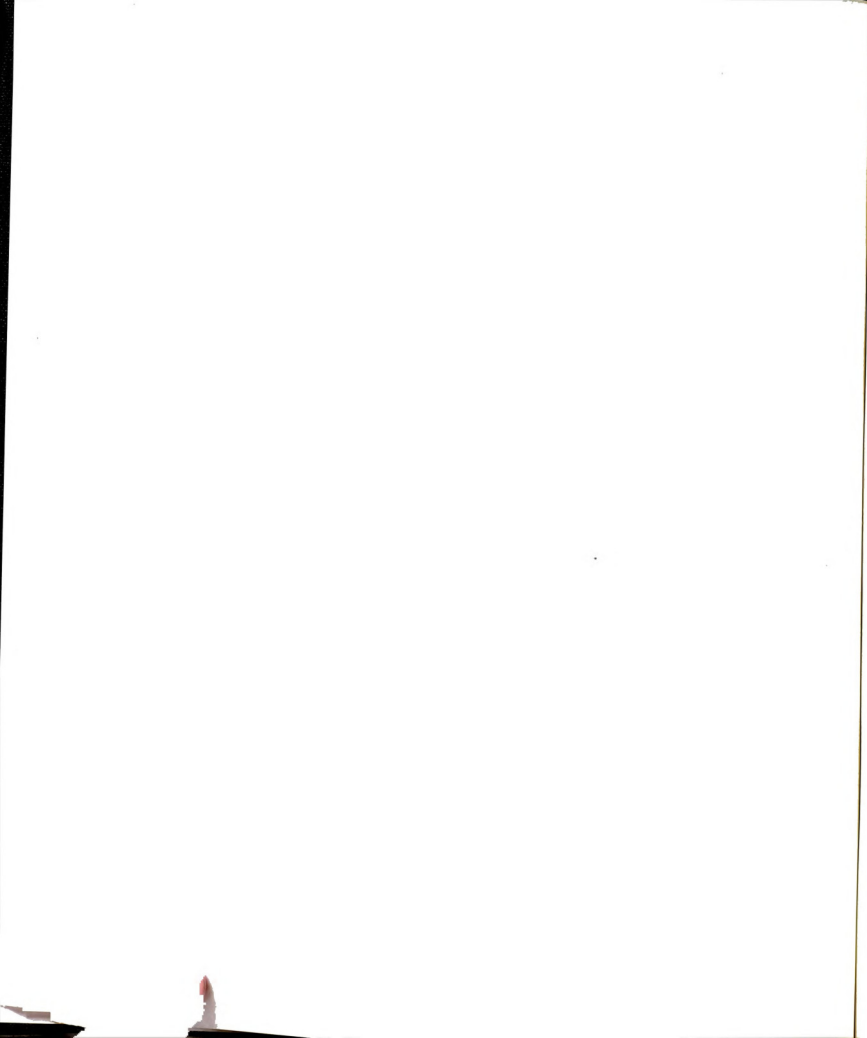


the new units, conduct deteriorated into "goofy behavior" such as placing masking tape on each others arms and then pulling it quickly off to lift a layer of hair in the process, tying each other up, and playing floor hockey. However, as students were helped to complete the work, behavior steadily improved until near the end of the unit students worked hard on doing a "good job", working to produce accurate, neat graphs and concept maps. By this time, students would bring their finished work up for me to review and admire.

Interpretation of the Data

In this section, the attempt will be made to identify the factors that contribute to the use or non-use of a new curriculum, as well as to understand the underlying logic and motivation of teachers that led them to continue with embedded traditional teaching routines and hesitate to incorporate new teaching methodology, even when research indicates enhanced learning. A complex connection appears to exist among the perceptions of students about themselves, student behavior, the teacher's experience with and perceptions about the students, the teacher's concepts about learning, the teacher's beliefs about the nature of science, and finally the mode of instruction used by teachers.

From my observations of expressions on faces of students, I believe that much of the initial inappropriate behavior was generated by an embarrassment on the part of the students in not being able to understand what to do. This opinion is supported by Blumenfeld and Meese (1988), who hold that the procedural complexity of tasks can be most difficult for students and even detract from understanding the cognitive content. The docile behavior of students observed during the three weeks before the new technology unit was introduced was in distinct contrast to the initial misbehavior during the unit introduction. This is further substantiated by the marked change in



behavior and cooperative attitude exhibited when students achieved success in completing activities after the scaffolding and procedure recycling. This strongly suggests that students negotiate with teachers to create "safety nets" to preserve their self-esteem, which Sanford (1987) describes as strategies students and teachers use to reduce the risks of embarrassment when confronted with high level cognitive tasks.

Impact of traditional instruction

Traditional instruction has had a great impact on implementation. Start with the realization that past education for the poorly motivated, low achieving science students has been fragmented in conceptual development, disconnected from their real lives, and irrelevant to the their present experience and future ambitions (Anderson, 1987a; Prawat, 1988; Gallagher, 1989a). Our observations in schools during the course of this project has substantiated a narrow objective for poorly motivated, low achieving science students. Rather than laying a foundation of understanding that prepares students for further learning and gainful employment, instruction has been geared to getting through the period, getting the credit, and graduating from high school. This has resulted in focusing on isolated bits of information (usually with oral drill & review), without the demand for cognitive engagement that prepares students to accept the responsibility for their own learning.

The student response to the lack of meaningful preparation for their lives has been one of frustration, withdrawal, misbehavior, development of a poor self-image, and in some cases outright rebellion. Additionally, research (Burow, 1978; Bradshaw, 1984; Sherris & Kahle, 1984) indicates that these students have developed a mindframe known as "other locus of control", a sense where the fate of their lives is controlled and manipulated by others, unaffected by their own effort. This in turn has created a history of experiences for teachers and a set of expectations about science

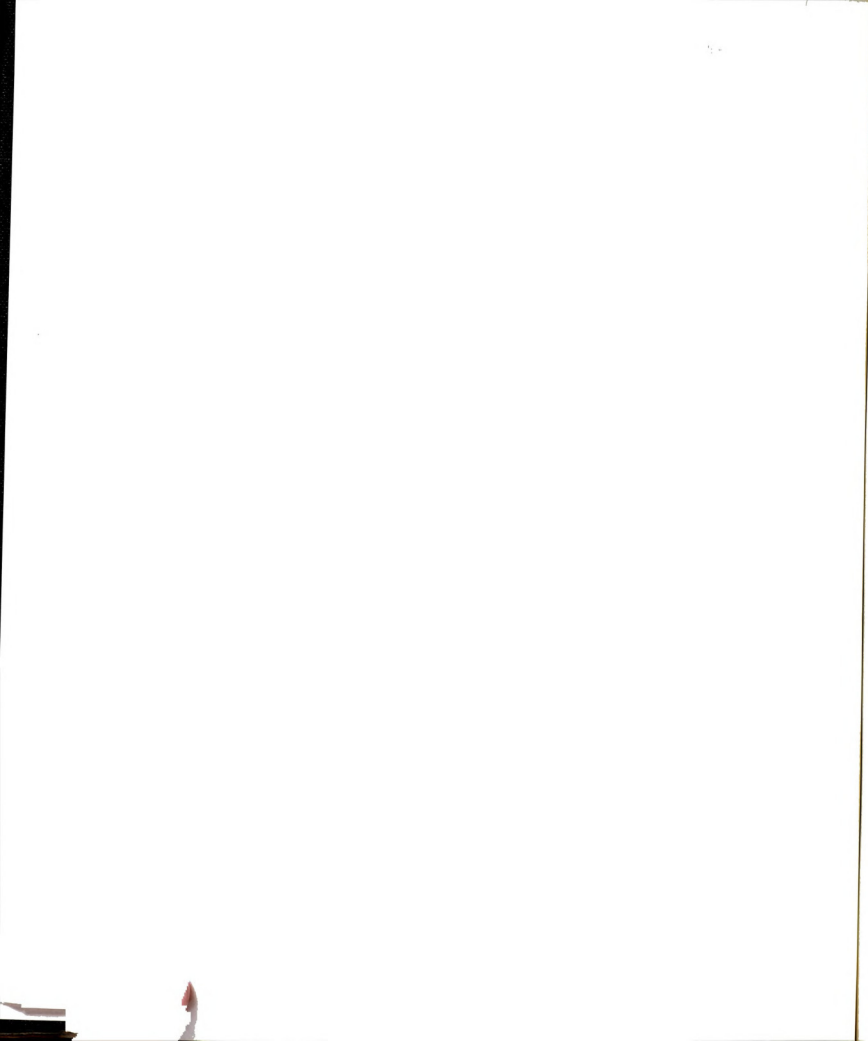
classes for the low achieving, poorly motivated students that in a large part molds the class structure even before class opens. We will look at some of these teacher beliefs in greater detail.

Impact of teacher beliefs on class structure and teaching methodology

We may wonder why teachers are so resistant to change their teaching strategies? In the last section, we focused on the teacher's existing mode of instruction and tried to establish its impact on implementation of a new curriculum. Evidence of this study suggests that both the style of teaching and structure of the classroom are in turn influenced by the teacher's beliefs and perceptions of the their students, by what is believed to be effective with this particular group of students, the teacher's view of teaching as professional actions, and by the teacher's perception of self as a teacher. Consequently, in the coming section, we will focus more on the underlying beliefs and attitudes that certainly influence the implementation of a new curriculum (Cronin-Jones, 1991).

The first area of consideration is teacher perceptions and beliefs about the students. The teachers viewed these students as having limited potential. As such, they operated on shorter term goals as simply getting them to graduate from high school. This in turn influenced their views as to the relative importance of topics, choosing areas of study tending to be more informational (applications of technology, being a good citizen, preparation as consumers), rather than operational (preparation as future producers and contributors) to our economy.

Expectations as to the amount of work required substantiate this limited perspective. While homework was required of the average and upper level classes, the almost complete absence of homework for the lower level students was again generated from both experience and attitude. The experience of these teachers is one

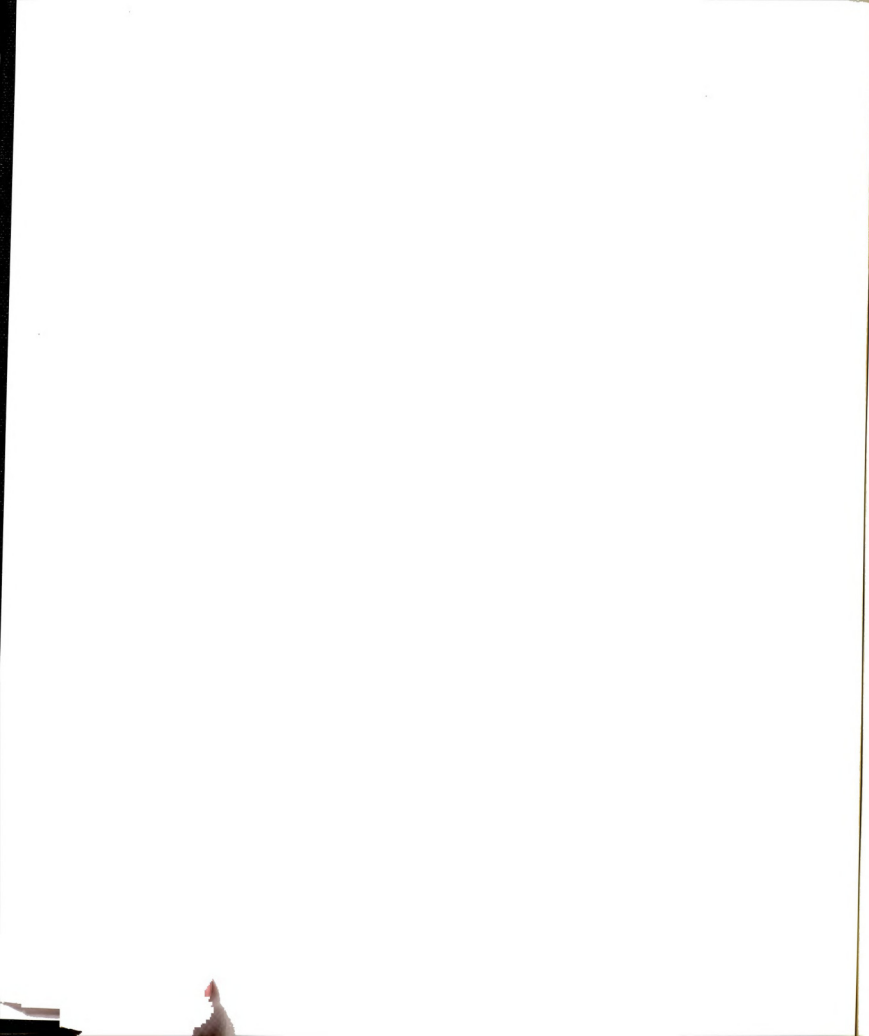


of great difficulty in requiring assigned homework with the resulting conclusion that it is not worth the hassle to demand it. Secondly, the attitude exists that these students are not going to be scholars anyway, so why take the trouble. One teacher even questioned whether these students are worth the extra expenditure of governmental funds for a project such as this (Western, p.75). This attitude is consistent with the research of Anyon (1981) in which she describes the students from the working-class schools and notes the "subtle and dramatic differences in the curriculum-in-use" (p.3) between these schools and other schools for students from middle and upper class families. She further asserts that these differences provide the basis for success in some children and deprive other children of success. I suspect that the same difference that exists between schools also exists between classes in a tracking curriculum and thus further deepen differences between children initially coming to school with educational disadvantages.

This view of students also extended to the type of work assigned. For instance, the teachers involved did not believe that lab work was profitable for these students. This attitude is generated out of a conception of students as being bored, irresponsible, and incapable of following directions (Western, p.71, 78).

Finally, the fear of losing control of the classroom is related to teachers' conceptions and beliefs. Teachers view these students as incapable of handling the more rigorous material and unable to follow the procedures of experimental science. They feel that to expect these poorly motivated, low achieving students to do "real science" would produce frustration in the students, unreasonable expectations, and generate inappropriate behavioral responses.

The second major area of beliefs contributing to the resistance of change in teaching strategies is the teacher's beliefs about teaching and learning. First of all, the



role of the teacher is seen as a provider and organizer of information. This is consistent with the absorptionist view of learning and the transmission view of teaching (Prawat, 1989). In this mode of teaching the content is specifically laid out for students and mainly taught with a procedure involving lecture, review, and practice (Western, p.77). The role of the teacher is to provide the information, drill it into the students, and continue to pile it on, hoping that some will be absorbed and not "leak out faster than the incoming flow." To make the material more "appropriate" to "these" students, the response of teachers has been to simplify the content material as much as possible. Student centered activities, especially lab work and investigative research were almost completely eliminated. Emphasis remained on content acquisition (Anderson, 1987), structured in a hierarchal progression with basic facts and skills as the primary focus (Prawat, 1989). The emphasis on terminology, with the memorizing lists of facts and writing definitions for vocabulary words reminds one of the additive view of learning (Roth, 1985).

Teachers also believe that good discipline and order in the classroom is a necessary foundation to learning. This in itself is a given. However, in the classrooms observed, both from an administrative perspective and from a management perspective of the teachers involved, discipline took a higher priority than teaching and learning, especially at Western High School. When this occurs, a climate develops within a classroom with a student perspective of "us against them (the teachers)" and a "catch me if you can" game. On the other hand, when effective teaching involves students in activities and when learning engages students cognitively in the construction of new understandings, many discipline and control problems decrease. This was observed at Cranston High School.

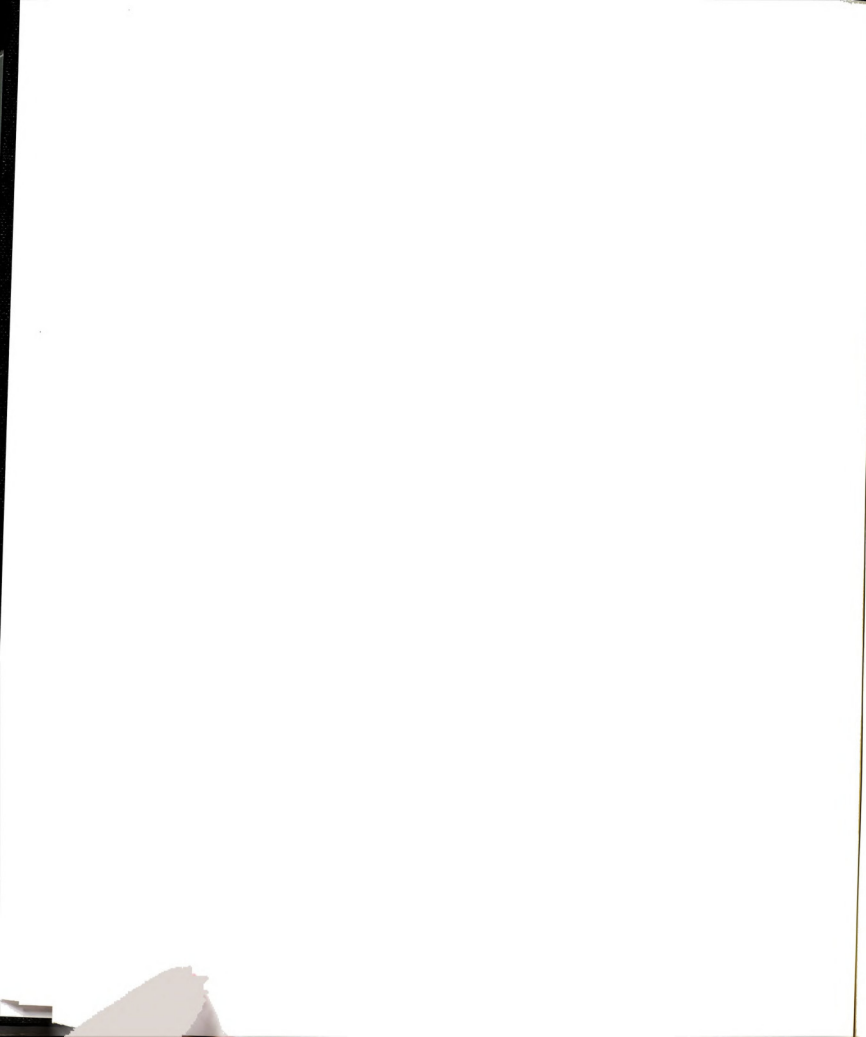
Research Question Three was stated as follows: **What factors influence teachers' and students' views and uses (or non-use) of the**

curriculum. As was noted in the last section, teacher beliefs about students are significant in determining class structure and teaching methodology. In this section, I will attempt to take the logic one step further and connect teacher beliefs into the lack of implementation, reviewing the student response to the new curriculum, the teacher response to the student response, and its subsequent impact on implementation.

While the structured routines of the textbook/lecture/seatwork approach provided for an acceptable level of quiet and order, the first experiences with the new materials was marked by a significant increase in noise level, fooling around by the students, and increasing discomfort and embarrassment to the teacher (Western, #89-90; Cranston, #96). As the new student-centered curriculum was introduced, many of the poorly motivated, low achieving science students had difficulty following directions, and would rather not attempt an activity than admit they were completely lost. These students appeared to be reluctant to add another failure to an already accumulated history of failures. Some of the off-task behavior appeared as a cover-up to mask the embarrassment of not being able to follow directions, read the text with understanding, or express themselves clearly in written form.

Teachers interpreted this student response (hesitancy and "goofing off") as an inappropriateness of the activity to the ability level of the student, and consequently refrained from using involvement type of activities with the poorly motivated, low achieving science students.

This teacher response then was one of self-preservation – using only those activities that are easily accomplished, give immediate success, and allow continuous monitoring

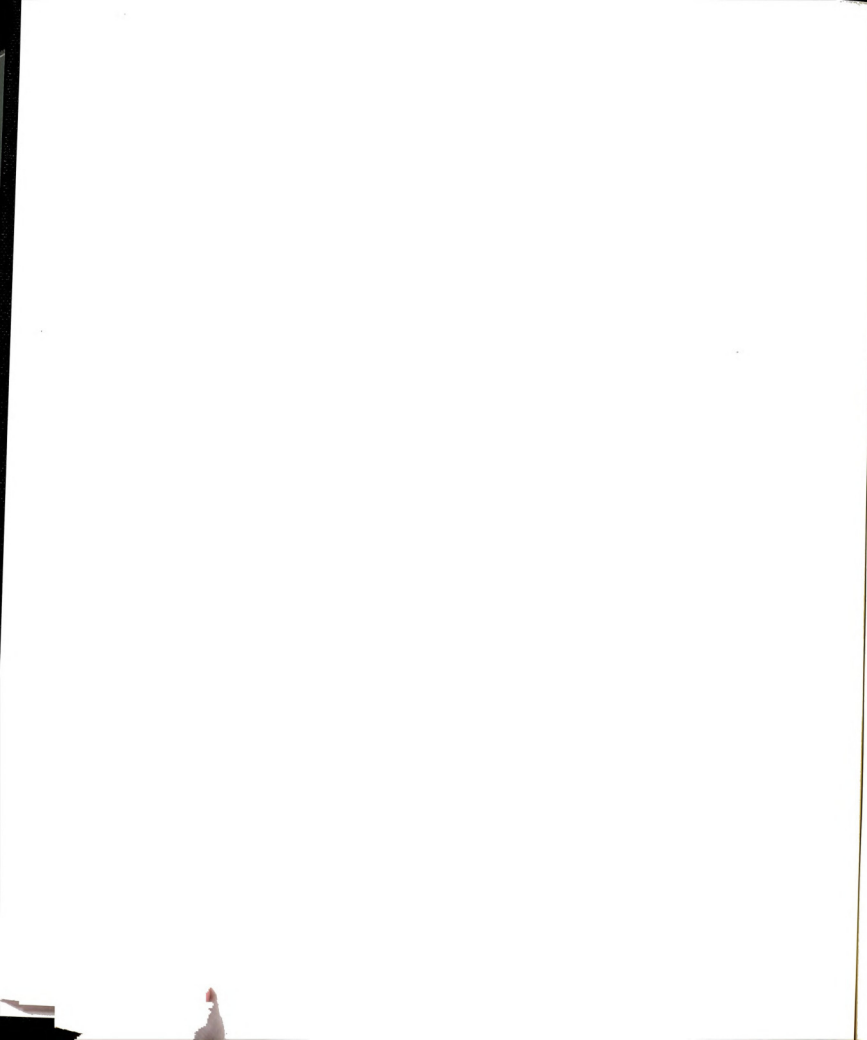


of all students. In the mind of the teachers, these procedures helped them maintain an orderly classroom. The type of activities chosen keep students in their desks and do not place materials in the hands of students that they will "fool around with" and which could be potentially dangerous. Moreover, it is believed that direct access to information (textbook and lecture), along with review and drill provide the students with a better chance of success and remove the frustration that in turn often contributes to disruptive behavior. Through their own experience in teaching, teachers have developed a repertoire of activities and management techniques that allow them to function adequately with these students.

Thus the teacher beliefs were substantiated in their minds as they attempted to cope with the deterioration of classroom behavior at the beginning of the project. These teachers were not confident that students could be trusted to act properly and learn independently.

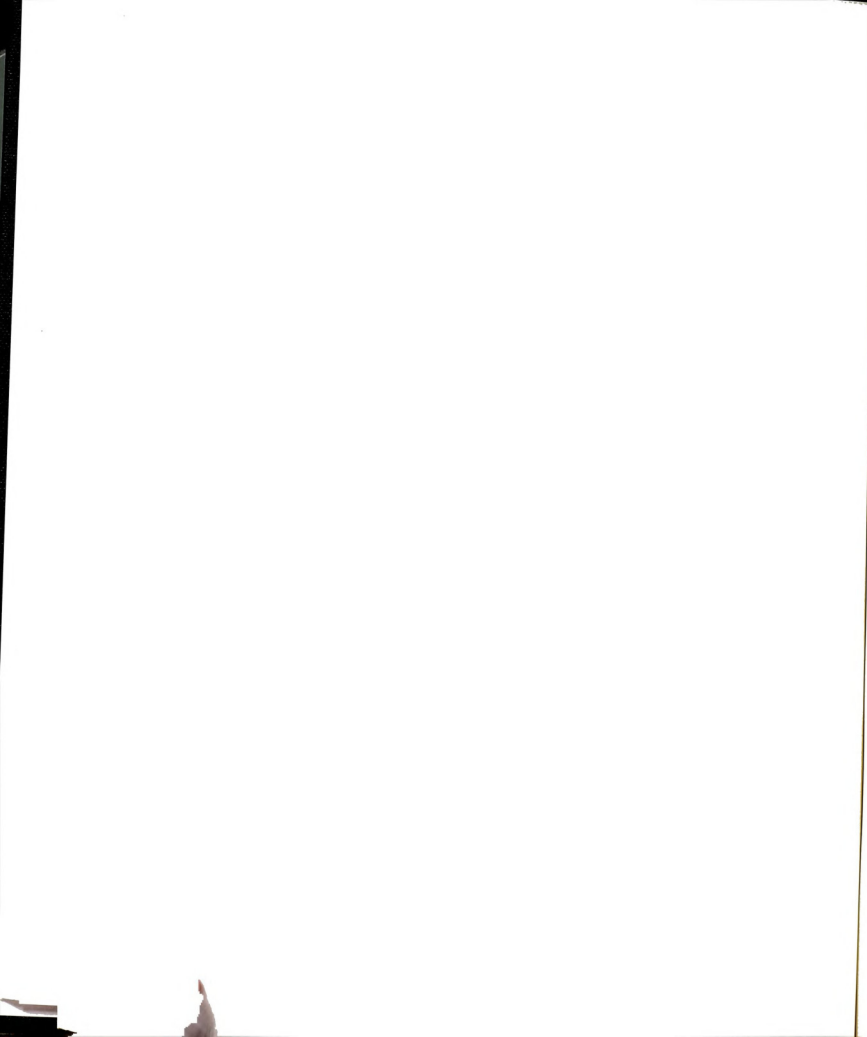
As one ponders the reluctance of teachers to use the activities in the new curriculum, evidence points to the use of management routines as mechanism for coping with difficult teaching situations. The new curriculum introduced activities that disturbed workable established routines, and so made life more difficult for the teacher by not allowing the teacher to function in the structured systematic way that had proven workable in past experience (Western, p. 37).

The elevation of class control as a primary function on the agenda of both the teacher and the administration (Cusick, 1983) led to marked differences in the teacher role between the textbook-based approach and its distinctive routines and the activity based approach of the new curriculum (Western, #77). In the textbook-based approach, activities were chosen that would facilitate classroom management and give the teacher in-class time for correcting and planning. In the new curriculum, activities



were chosen that would foster creative thinking, linking of concepts, and development of understandings. In the textbook approach, the teacher did the majority of thinking and simply functioned to transmit isolated bits of information to the students. By contrast, the new curriculum expected students to construct their own concepts through a series of activities with teacher guidance and direction. It also required the teacher to help students in contextual linking (connecting new information to local applications, to life experiences, and to prior learning). Teachers also needed to help students in conceptual linking (helping students connect facts to concepts and concepts to other concepts, developing coherent explanations for phenomena).

However, an number of other factors contributed to the deteriorating classroom management situation, including the lack of advance teacher planning, unfamiliarity with the materials, the hesitancy with the content on the part of teachers (Western #96; Cranston #56). The data support Brophy and Good (1974) in their assertion that implementation is hampered by a lack of philosophical and methodological preparation of teachers before a project begins and by constraints on teachers' time while a project is being implemented. Teachers who see lecture/review/quiz methodology as a prime mode of instruction for the poorly motivated, low achieving students often do not want to risk extended periods of alternative instruction that may contribute to a deteriorating classroom management situation. We found that the two teachers involved, to a varying degree, were not willing to put in much additional time outside of the school day to prepare for the new program. Thus the failure of initial implementation in both instances can be partly attributed to this unwillingness of teachers to take hours beyond the regular school day to become familiar with the printed materials, to take extra time gathering the materials and equipment for the activities and experiments, to take time to set up the equipment and materials before class, when they already had



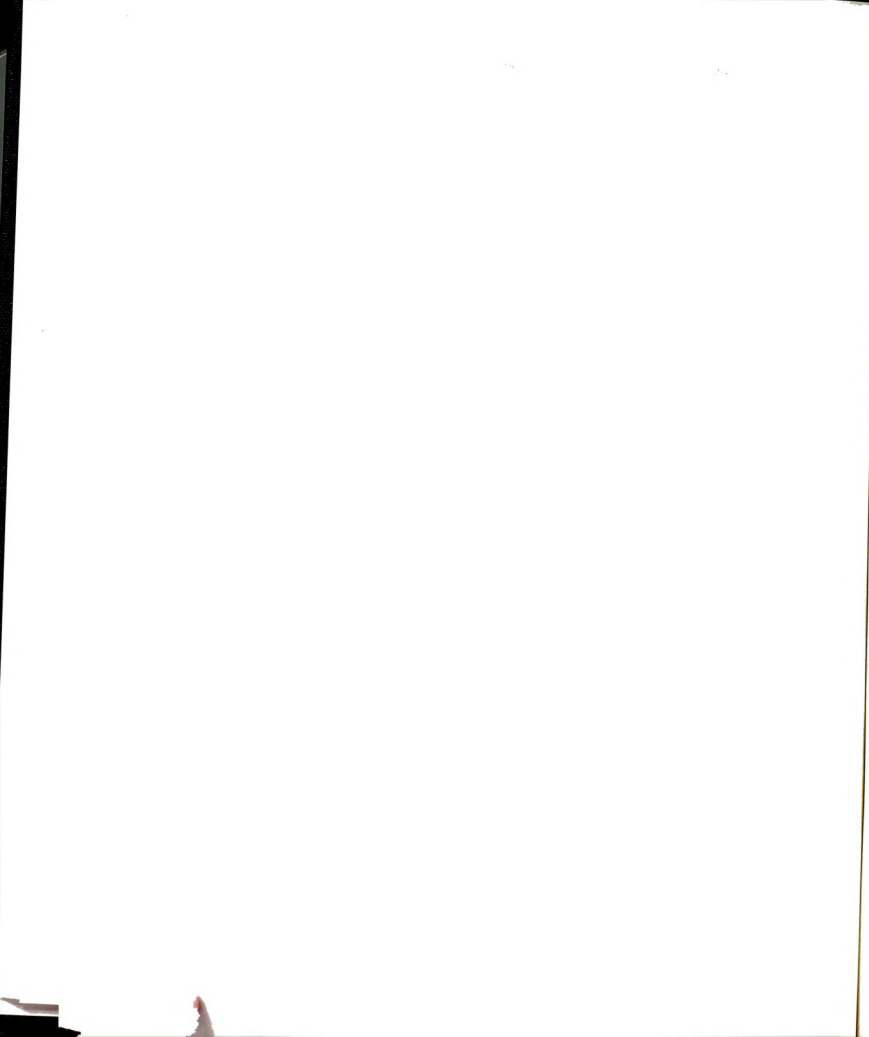
lessons prepared (from previous years) and materials in the cabinets all ready to go. This factor played a lesser part at Cranston High School and a larger part at Western High School.

In spite of the agreement to trial test the new technology curriculum as written in the textbook, these teachers modified this curriculum by choosing the topics they were most familiar with and choosing the activities they felt most appropriate for these particular students (Brophy and Good, 1974). In summary, the data show great differences between the intended and implemented curriculum. The project materials were not used as intended, but were adapted and modified to fit the beliefs of teachers, consistent with their experience as to what actually works with "these students." In conclusion, it was apparent that the beliefs held by teachers about the students and the attitude teachers have toward a particular learning situation are consistent with the nature of their teaching, and the nature of teaching in turn influences the implementation of a new program.

However, as will be seen in the next section, this study also demonstrates that if involvement type activities can be modeled for the teachers and students and if they are given support in the new form of teaching and learning so that they can experience success, incorporation of these type of activities in the design of new programs will be greatly increased, which leads us to Research Question #4, originally stated as follows:

What strategies can be used to change teacher behavior from the traditional teaching approaches to student-centered activities as suggested in the new technology curriculum?

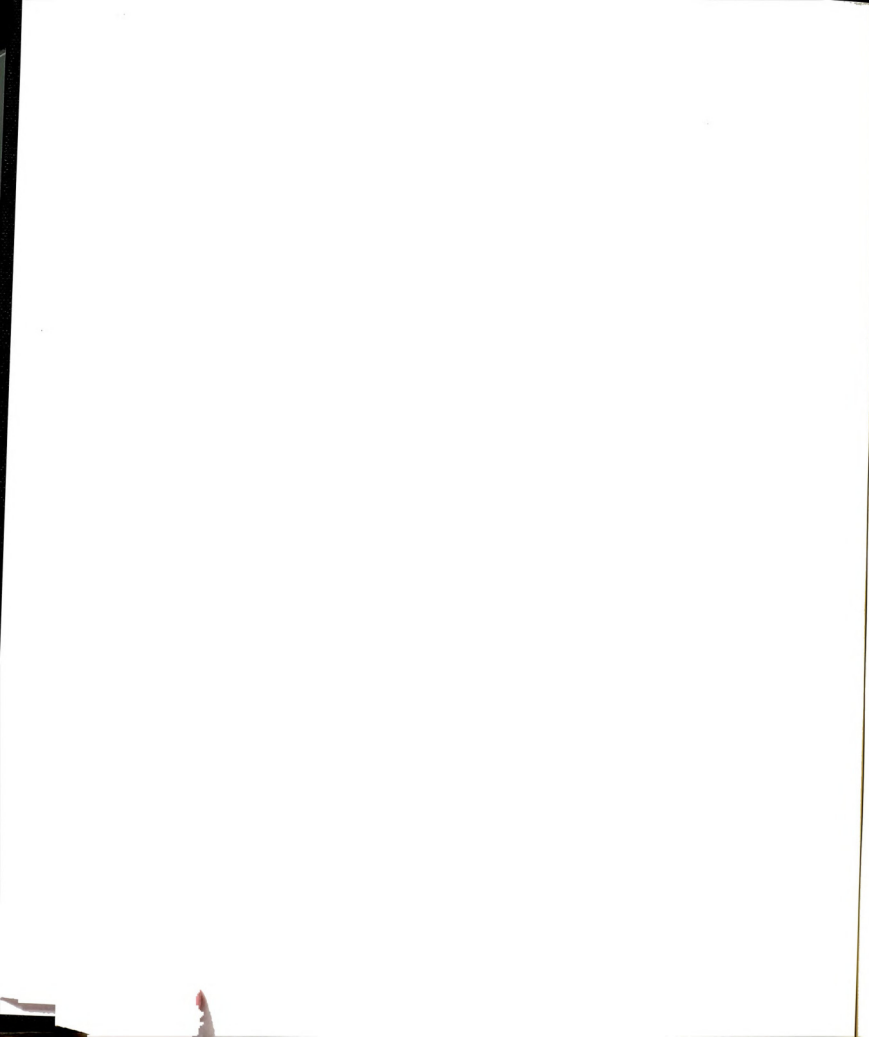
Scaffolding and procedure recycling were found to be effective in enhancing learning for low achieving students, thus increasing the level of implementation of the



new program.

Scaffolding is a means of helping students construct procedural knowledge and help teachers develop pedagogical knowledge. Three phases of the scaffolding model were used in this study: modeling, coaching, and fading. The modeling phase visually demonstrated procedures that are sometimes incomprehensible for these students from the written page. For example, the formation of the axis and plotting of the graph were demonstrated. The coaching phase allows students to work when they are able, but intervenes when they become confused or stymied with the directions. Coaching provides immediate feedback which increases intrinsic motivation (Butler & Nisan, 1986; Corno & Rohrkemper, 1985; Ryan, Connell, & Deci, 1985). This was accomplished by the teacher and researcher circulating among students during work time, offering suggestions, giving hints, and even working through the procedures with them the first time. The fading phase provides opportunity for students to proceed on their own and in small groups, helping reestablish their own dignity and pride in their work (Anderson (1987a; Collins, Brown, & Newman, 1987).

Procedure recycling provides the mechanism for students to stick with a set of procedures long enough to gain competency. It allows repetition without imposing a feeling of being treated like a "dumb" person. Moreover, procedure recycling allows students to apply scientific investigation to new situations and utilize a degree of creativity in designing their own experiments. This in turn allows these students to become involved in genuine long-term research with an air of respectability. Above all, procedure recycling permits an increasing degree of success and builds confidence in the students. In the unit weather, procedure recycling was used with the solar heaters. Three different experiments were completed with essentially the same equipment. For the first experiment (with and without a glass cover), the teacher did



the experiment with the students step by step. For the second experiment (different colors), the students were able to complete most of the procedural steps on their own. The third experiment (measuring heat absorbed by land and water), the students not only were able to complete the experiment on their own, but were also involved in the design of the experiment. This involvement progression moved the students from detailed demonstration and step by step directions to a more self-sufficient position of applying the same procedures and techniques to a new situation.

Connections With Existing Literature

Both existing literature and data collected during this study will be considered in developing an explanation of the events observed and the difference in implementation at the two high schools involved.

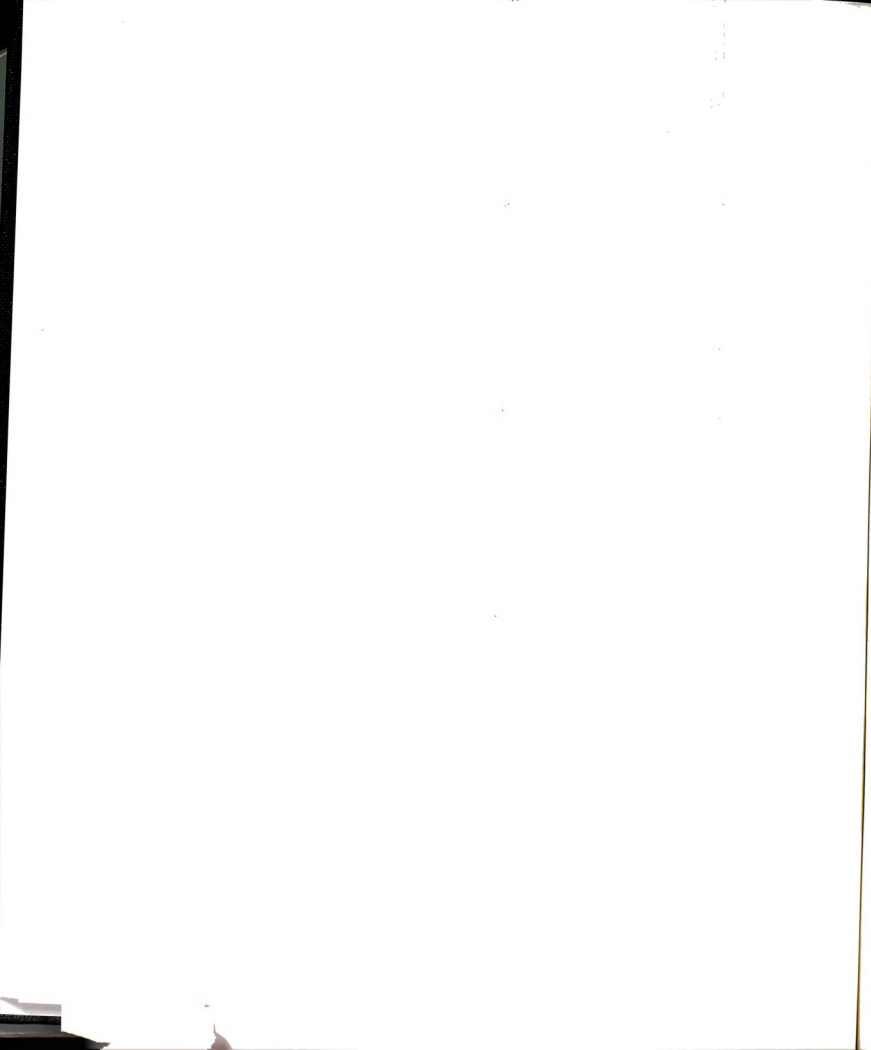
One difficulty however, is that little significant research has been completed on the learning of the poorly motivated, low achieving, high school science students and little data is available on the effectiveness of prior programs for this target population. However, existing data that are available, do substantiate the proposed interpretation of events.

Implementation of previous curricula and/or programs for the poorly motivated, low achieving science students has been meager at best (Corno & Snow, 1986; Clark & Peterson, 1991; Cronin-Jones, 1991). The intended and implemented curricula were far from identical (Barnes, 1982; Smith & Anderson, 1984; Cronin-Jones, 1991). Programs that included student involvement demanded a higher need for overt teacher management and control (Doyle, 1986), and almost all programs for the poorly motivated, low achieving science students, except *Investigations in Science* by Dolmotz and Wong, have been discarded.

In our search for an explanation as to the lack of change in science education and the failure to implement new teaching strategies for this group of students, various researchers have pointed to the link between teacher beliefs (about students and learning) and actual classroom teaching. Clark & Peterson (1991) citing research by Elliot (1976), Olson (1981), and Munby (1983) assert that "when implementing a significant curricular, organizational, or instructional change ... teachers' belief systems can be ignored only at the innovators' peril" (p.291).

Past education for this group of students has been characterized by the transmission view of teaching and absorptionist view of learning (Lockhead, 1985; Doyle, 1986; Cohen, 1988; Prawat, 1989). This view is in accord with the "additive" view of learning and places emphasis on content acquisition (Anderson, 1987a). Moreover, textbooks treat too many topics and treat them superficially (Tyson-Bernstein, 1988), resulting in science being taught as facts, rules, and definitions, but not producing understanding of related concepts (Anderson, 1987a). The result has been the accumulation of ideas and facts in isolation as students do not naturally develop the ability to link these ideas into coherent understanding (Roth, 1985).

Discovery learning, hailed in the 1960's to 1970's as the path to "scientific literacy" (Karplus, 1964), also failed to substantially change science education for low achieving students. First of all, discovery learning gave the wrong idea of scientific knowledge construction, ignoring the importance of previous knowledge (Smith & Anderson, 1984; Gil-Perez & Carroscosa, 1990). Secondly, most of these materials were not used as intended. Most teachers assumed that students would develop conceptions on their own (Roth, 1984; Smith & Anderson, 1984) and the acquisition of "process skills" would equate to cognitive engagement. The role of the teacher was

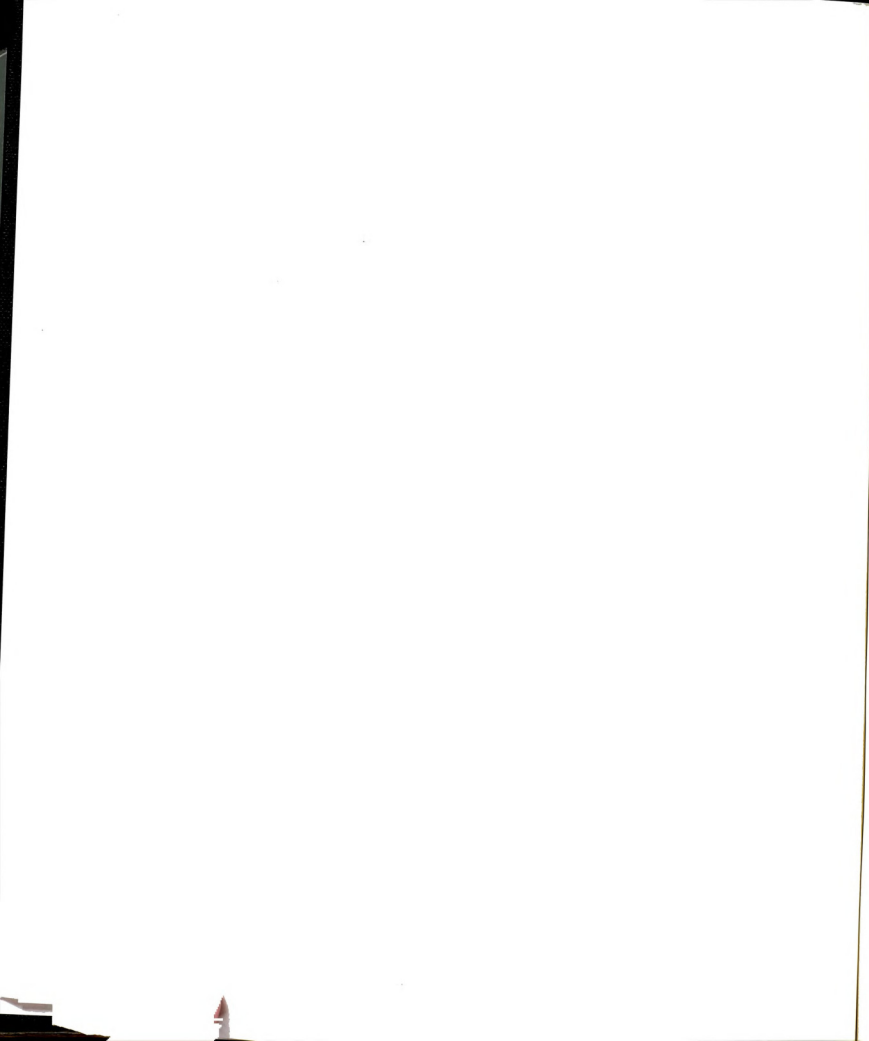


diminished to that of an organizer of materials and a manager of learning activities. The Elementary Science Study slogan of the day was often stated as; Give the kids the "hands-on" materials and let them "mess about." The role of the teacher in helping students understand what was going on and developing valid science concepts was often neglected. Left on their own, students developed incorrect ideas or simply accumulated a large number of observations with no coherent organization to help them make sense of the material. These teacher modifications never allowed the strengths of these programs to be utilized. Consequently, student understandings did not improve and in some cases fell. In the minds of teachers, the inappropriateness of the "discovery method" for these students confirmed existing beliefs teachers held about these students, and the new programs were viewed as a lot of extra work without enhancing achievement.

Many of the new programs originally marketed as allowing students to work at their own level and their own pace (thus assumed to be appropriate for the poorly motivated, low achieving students) were discarded and science instruction for these students reverted to the text-book, teacher directed mode.

Basis for a Change in Teaching Approach

The constructivist view of learning sees cognitive development as a process developed over time and not simply material transferred from the teacher to the student (Resnick, 1988; Prawat, 1989; Cronin-Jones, 1991). It involves construction of new understandings, developing descriptions and explanations, going beyond the mere accumulation of facts (Anderson, 1987b). This view of learning demands an active involvement of students in the learning process, challenging existing conceptions, presenting students with scientific questions, and developing procedures for finding answers, (Kuhn, 1970, Toulmin, 1961; Mayr, 1982; Yager & Pinick, 1983).



The construction of new understanding necessarily must take into account the prior knowledge of the student, create linkages to past and present experiences, and relevancy to future potential (Wittrock, 1986; Smith & Anderson, 1984; Rosaen, 1987; Gil-perez & Carrosscosa, 1990). Learning also involves "restructuring of conceptions or frameworks that learners already have" (Driver & Ball, 1986).

Initial construction of ideas for the poorly motivated, low achieving science students is largely dependent on the ability to develop concrete visualizations of abstract ideas (Dale, 1969) and "abundant sensory experiences with the external world (Saunders, 1992). This is in agreement with the "generative learning" model (Wittrock, 1981).

Construction of new ideas is in part a social experience (Vygotsky, 1987), in which procedural knowledge is developed for the student, and contextual and conceptual linkages forged in the process of communicative interaction. This almost necessitates small group activity where students can cooperatively develop plans, collect and discuss data, and determine meaning from the results. The construction of knowledge and skills will be facilitated more by the active social involvement of students in activities than by drilling selected and disconnected facts and terms (Driver and Oldham, 1986). More recent research on cooperative learning has shown that all learning needs to be structured in some way, even the activities where students interact with one another. This is demonstrated by the "cognitive apprenticeship" model developed at Michigan State University by Anderson and associates (Anderson, Belt, Gamalski, & Greminger, 1987). Teachers using this model take an active role in guiding students in the cooperative process. Teachers use modeling to first teach students how to describe, predict, and explain phenomena, then coaching to give

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"guided assistance to students in their attempts, and finally fading as students gain competence" (Lonning, 1993).

Having summarized the data collected and reviewed relevant literature, we will take another look at the assertions developed during the course of this study to note how well they are substantiated.

Summary of Assertions Relevant to Question Number One:

Assertion #1 – Teachers adopt a transmission model of teaching and an absorptionist model of learning, in which the teacher supplies knowledge to the students (mostly orally), and the students receive this knowledge, mostly auditorially. This assertion was supported with data from both schools involved in this study. I believe this mode of teaching stems from two sources; 1) the traditional view of teaching and learning, and, 2) teacher's former experience and beliefs about the capability of these students. For instance, **teachers have observed that the poorly motivated, low achieving students have difficulty following instructions for extended activities given by textual materials** (assertion #2). Support for this assertion was verbally expressed by teachers from both classrooms, noting how students are often confused with procedural sequences in experiments and activities. They have also noted how students do not naturally connect various facts into coherent explanations. The response of teachers has been to organize **instruction for these students into highly teacher-directed routines rather than student oriented learning activities** (assertion #3) Observations in both classrooms confirmed this assertion and field notes detailed the repeating pattern of classroom routines. **In order to help these students find success, teachers clearly indicate exactly what they are to learn, drill the material in review sessions, and test for the same content** (assertion #4). Data from both high schools strongly supported this assertion.

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(assertion #5). Observations in these contrasting classrooms showed that the type of activities for students in lower level classes are far less demanding than for average and advanced classes. Lecture, whole class drill sessions, and individual seat work characterize most of the class time for low achieving students. Common classroom activities such as small group work, individual research projects, lab work, and investigative projects are seldom seen in the classes for the poorly motivated students. Regular and advanced science classes have a greater variety of activities, while in classes for below average students, routines are limited and repetitive and chosen to maximize control. Little attention is given to understanding and the use of knowledge or to the development of useful skills.

Expectations for lower level students are different than for average and upper level students (assertion #6). Data again strongly supported this assertion. Homework was seldom assigned to lower level students and most activities did not require students to use knowledge in a creative way. The teacher virtually gave the content of the upcoming test to students in lecture and review sessions. Lower level students were allowed to use their notes during tests and quizzes. Moreover, teacher expectations regarding the maturity and behavior of these students are vastly different. Teachers were reluctant to give investigative materials to the poorly motivated students, with the expectation that they will just "fool around" anyway. Some teachers felt the students "don't care and won't work," and the minimum basic content will have to be drilled into them so they can pass. Consequently, as shown by the fieldnotes, **much of the material was covered in breadth rather than in depth. Much material was "mentioned" rather than explained** (assertion #7). This lack of student involvement and understanding contributed to low student interest. In addition,

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collected class materials showed that **most of the tested outcomes resided in the area of content-factual recall** (assertion #8), with little demand for explanation or linking of concepts.

Goals regarding the present education and expectations regarding the future potential of students in lower level science classes are far lower than for students in other science classes (assertion #9). Stated goals by teachers for the low achieving students most often were to pass the test, pass the course, and graduate from high school. Teachers for the average to above average classes worked more in preparing students to continue education in a post-secondary setting. This assertion was supported in both schools, but not as strongly as other assertions.

Established classroom routines, before intervention, were chosen out of a concern for management and control rather than to enhance learning. Data showed this assertion to be more strongly supported at Western High, but less true at Cranston High.

A mode of teaching that is "successful" in the management of these students may be counterproductive in developing the skills they most need to function in society and on a job (assertion #11). This research study does not have enough evidence to fully support the linkage suggested in this assertion, but does suggest a strong relationship. Therefore, this assertion should be a key question for future research. It must also be noted that the converse may also be true. Developing needed skills without building understanding places limitations on students as to their future opportunities and potential.

Summary of Assertions Relevant to Question Number Two:

Before the intervention, **students viewed the new curriculum with trepidation. The uncertainty of not having "correct" answers readily available**

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generated a hesitancy and added to an established fear of failure (assertion #1).

The students responded to this uncertainty with misbehavior uncharacteristic of the proceeding three weeks with the traditional textbook/lecture mode of instruction. This assertion was supported with data from both high schools observed.

Students view science as having little relevance to their personal lives, scant practical application to their immediate future, and as detached from the real world (assertion #2). This assertion gave mixed results, which may have been skewed by the nature of the unit taught. Students at Western High expressed little relevance between the content taught and their immediate lives. The students at Cranston High expressed more relevance than expected. However, weather interpretation is set before the students daily on the evening news and the application to daily life is more readily apparent than other areas of science.

Science teachers viewed the new science curriculum developed out-of-house as unworkable for the real classroom (assertion #3). Both teacher actions and statements support this assertion. Teachers were reluctant to use the new curriculum activities, especially those that require small group activities, student movement from place to place, or working with materials and equipment (assertion #4). Data show the teachers' response to the new curriculum was two-fold. First, the new curriculum materials were adapted and modified to be more consistent with the teacher's present mode of instruction by using the topics and content of the new curriculum but retaining their own instructional and management strategies (assertion 5). The second teacher response was to use the new activities and strategies if the researcher was present and worked directly with the teacher and the students (assertion #6), but to completely drop the materials in the absence of the researcher (assertion #7). In the classroom without

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intervention, the teacher completely returned to the familiar routines and old textbook within three weeks after the new technology unit started. Strong support for assertions #5, 6, and 7 came from both schools involved in this study.

Summary of Assertions Relevant to Question Number Three:

The data from both high schools clearly indicated that **teachers' beliefs about students and their former experiences in teaching these students impact their methods of dealing with these students** (assertion #1). First of all, both **teachers viewed these students as having limited potential** (assertion 2). This position is confirmed in the minds of teachers as they noted how **students rely on them to organize and furnish them with information to be covered in the next test** (assertion #3). Consequently, one of the major student and teacher goals of education was to pass the next test.

Observation and conversations recorded in the data confirmed **that teachers are not confident students can be trusted to act properly and learn independently** (assertion #4). When a new curriculum asked students to use activities that require them to work in small groups, use materials, or follow sequential procedures, teachers were hesitant to even try a mode of teaching that could cause embarrassment for both students and teacher. Viewing student involvement activities as inappropriate for "these students", **teachers were unwilling to put in extra time and effort needed to make the new curriculum a success** (assertion #5). Thus, **teachers' failure to implement new science curricula for the poorly motivated, low achieving science students can be partly attributed to a concern about management and control, and partly to the teachers' beliefs regarding teaching and learning** (assertion #6). This last assertion is indirectly supported as a conclusion

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logically derived from the data supporting related assertions.

Summary of Assertions Relevant to Question Number Four:

Just because good, new science curriculum materials are developed for poorly motivated, low achieving science students, the present potential of these materials actually being integrated into the classrooms in the intended manner is very small without intervention on the part of the developers (assertion #1). This assertion was supported with data from both Western and Cranston High School.

The scaffolding model (using modeling, coaching, and fading) can be successful in demonstrating to teachers the potential of a new science curriculum by helping students use new learning strategies and gain success in following sequential procedures and completing activities (assertion #2). The potential of student involvement in helping students construct understandings and develop skills was demonstrated to teachers, supported with data from Cranston High School (after intervention). When the teachers implemented the curriculum as intended, students' attitudes, classroom behavior, self-confidence, and pride in their own work improved substantially.

IMPLICATIONS AND RECOMMENDATIONS FOR THE FUTURE

Integration of instructional improvement and curriculum design.

Curriculum research and development of new curricula are often justified as a contribution to the improvement of instruction. However, the assumption that instructional improvement will result from developing a new curriculum is not warranted. As was shown in this study, improving instruction must deal with a much wider realm of issues than simply providing new materials. This may mean changing teachers' beliefs about students, and must include techniques of refocusing instruction on learning instead of management. As the documentation illustrates, teachers have

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worked out various classroom strategies and routines that in themselves are successful in managing a classroom and keeping the students orderly and in control. While this mode of teaching is "successful" in management, it may be counterproductive in the developing of the very skills that these students most need to function in society and on the job. Thus, curriculum development must be more closely tied to total instructional improvement as various components of the instructional system are interlinked and impact each other. The teachers' perceptions and beliefs about the students determine the activities and content they choose. Individual teachers' skills and knowledge limits the content presented and the types of activities used. The availability or inaccessibility of good materials determines what is practical for teachers to even attempt in their classrooms. The training, time, and support provided by the administration will give incentive for change or may discourage innovative practices if management and control is given a higher priority over learning. Finally, the type of assessment will set priorities on an overall system basis. It is becoming more evident that many factors are networked and the solution to upgrading instruction for low achieving students is not as simple as producing a new curriculum. Also, when teachers engage poorly motivated, low achieving science students in activities that include hands-on experiences coupled with interpretive actions that allow students to make sense of their experiences in a way that are meaningful to them, positive changes occur in behavior, attitude, self-concept and motivation. Contrary to popular beliefs of many science teachers, this kind of teaching "works" with poorly motivated, low achieving high school students.

The results of this paper indicate the need for further research in this area. The two factors that contributed the most to the difference in teacher response toward implementing this new technology program at the two high schools were: 1) limited,

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repetitive, and highly directive classroom routines structured primarily for management and control of students, and 2) the impact of scaffolding with procedure recycling. It is recognized that there was a difference in the management routines of Mrs. Strauss' classroom at Western and Mr. Lindeman's classroom at Cranston. Further investigation is needed to determine if the positive response to the intervention resulted primarily from the procedural recycling and scaffolding or from the difference between the two classrooms. A question that may be asked includes: Can scaffolding, properly used, overcome the limited routines that are structured primarily for class control. If scaffolding is used in the student teacher training of teacher education, can the tendency to develop intensely structured, substantively weak classrooms be avoided?

Recommendations for future curriculum design and development:

1. Teachers will need to be involved much earlier in the curriculum development process. The data suggest that the four "critical practices of adaptability" outlined by Little (1982) should be given close attention by future curriculum developers:

- a) Shared design and preparation of the new materials by both teachers and developers.
- b) Mutual observation – the developers observe the teachers using the new materials and the teachers observe the developers demonstrating how to use the new materials. If the materials are not workable for the developers, the teachers attempting to use them in an actual classroom will also not likely find them workable.
- c) Critique – As materials are demonstrated by the developers and/or implementors, the teachers critique the lessons. By the same token, as the

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teachers then follow up with using the lessons, the developers critique their techniques.

d) Shared participation in instructional improvement.

Little (1982) goes on to say that "these four types of practices so clearly distinguish the more successful schools, the more adaptable schools, that we have termed them the 'critical practices of adaptability'" (P. 332).

Gage (1979) also agrees that curriculum research should involve teachers more directly – observing what they do with the curriculum as it is being developed.

2. Looking at the results after working with this project, Gallagher(1989b) recommends a change in the activity structure rather than a change in the topic structure for the these students. This is in direct contrast to IIS by Harry Wong, who attempts to keep interest of students by changing the topics very quickly and staying with a subject for only a period or two. However, we believe this project has demonstrated that low achieving students can deal with the same topics as the higher achieving, more motivated students. Even the poorly motivated, low achieving students must deal more in depth, covering a topic for a longer period of time to develop a multifaceted understanding and a working knowledge of the information. This is in the spirit of "less is better" as proposed by Project 2061 (Rutherford and Ahlgren, 1989). The impact of this mode of teaching needs further investigation. Do short term lessons with new topics for each lesson virtually eliminate any long range project? Can genuine research in which equipment is used and data collected be accomplished in isolated lessons? It would seem that if actual data are to be analyzed and interpreted, the activities need to run long enough for adequate data collection, which may take from more than one to several weeks.

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Program Implementation

Successful implementation of a new curriculum may well depend on shared participation of a wider representation of the educational establishment (Mojkowski, 1991; Cuban, 1984). The decisions needed to provide the time, materials, training, and motivation often go beyond the classroom teachers and require the support of principals, department chairs, superintendents, and in some cases even other teachers. It is recognized however, that the "teachers individual autonomy is bounded by school-wide professional agreements forged by the professionals and guided by the school's vision and purpose" (Mojkowski, 1991, p. 15). This means that obtaining additional time for an individual teacher in a trial program may mean selling the methodology and philosophical basis to more than the participating teacher. It will be the superintendent, the principal, and the department chairperson who will be most likely to work out additional time and provide the materials and equipment for a new program to function adequately.

More effective teachers need to be assigned to classes of poorly motivated, low achieving students. They need to be convinced that these students can benefit from participatory science in which they are involved in using knowledge to solving problems. Evidence points to the necessity of providing teachers implementing a new program more preliminary training especially on the purpose and methodology of the new program, as well as more time during the first teaching of the material to use in materials preparation. These teachers need additional time to prepare materials and training in how to model and coach students into actively using knowledge as well as accumulating facts.

The unwillingness of experienced teachers to put in additional time outside of class suggests that implementation of new programs may be more successful with new

teachers who still need to become familiar with content as printed and still need to gather supportive materials for teaching. For experienced teachers, special training will be needed to familiarize teachers with the materials and then demonstrate to them in actual classrooms that these new pedagogical approaches do work with these students and will enhance their learning.

Teacher training will need to be theoretical as far as improvement of instruction, but methodologically program specific. Cronin-Jones (1991) holds that for curriculum implementation to be successful teachers need more in-depth exposure to the rationale and theoretical perspectives underlying the content of science. While many teacher educators now teach students to develop their own materials, the impracticality of developing a whole course for a beginning teacher needs to be recognized. Thus, teacher training needs to involve more than philosophy and instruction, but include an introduction to the philosophy and techniques of specific new programs, and possibly involvement in the development of materials and their use with children as they are being implemented. For this to really happen, school districts should require special training of all teachers who work with low achieving students.

The findings of this paper also have implications for teacher education, both pre-service and in-service. Teachers often teach in a manner in which they have been taught, often disregarding the information provided to them in methods classes. This research suggests that teacher preparation will need to change. Subject matter preparation in science must use lecture method less and help prospective teachers gain a deeper, more meaningful understanding of scientific ideas. Education in pedagogy must change to prepare teachers to teach all children, not just the bright and motivated. Student involvement activities will have to be modeled in real classroom situations and teachers will need coaching in developing experience and confidence in

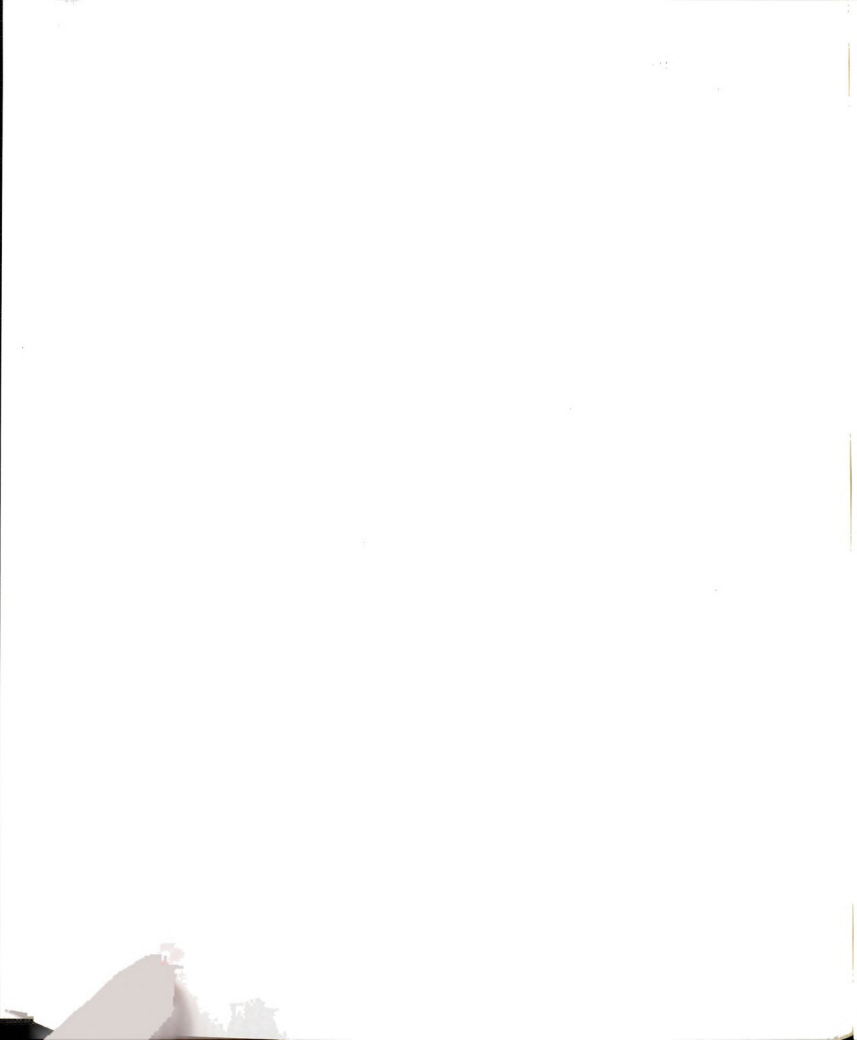
using student involvement activities with the low-achieving students.

Last of all, the scaffolding model can be used to successfully move the teacher and students into a working relationship with the materials. The implementor cannot simply be an observer and a suggestion box. Most likely the implementor will need to demonstrate the methodology to the teacher and students in a real classroom. He will have to model procedures and then circulate in the room to help the students in their first attempts to complete various activities and experiments. As students gain facility and confidence in completing activities, the implementor can then fade out and allow students to work on their own. This strategy has the advantage of training both the teacher and the students simultaneously. By seeing that the materials can work with students, the teacher is then willing to change both the methodology of teaching and some of the underlying beliefs about students.

As one of the developers of this new technology curriculum, I am convinced that many of the assumptions in the original design are valid for this population of students, and contributed to the acceptance of the unit by both the teacher and students at Cranston High School. It is interesting to note that a number of the same design components incorporated in this project are also recommended by Sizer (1990), who asserts that for modeling to be successful (using teacher as a coach), it will require:

- a) longer periods with larger blocks of time
- b) student centered learning
- c) fewer topics and more depth.

It is the belief of this researcher that building some of these components into a design and then using a scaffolding approach to begin the new curriculum, while focusing on total instructional improvement, an increased measure of success can be realized with poorly motivated, low achieving science students.



APPENDICES



APPENDIX A – PROJECT DOCUMENTS

<u>Document</u>	<u>Title</u>
1.	Research Overview
2.	Participation Agreement
3.	Parent Consent Form
4.	Teacher Feedback Form A
5.	Teacher Feedback Form B
6.	Student Feedback Form
7.	Revision Feedback

APPENDIX A - Document 1RESEARCH OVERVIEWResearch Purpose

1. Provide feedback for rewriting the trial editions into final editions.
2. Provide research data to substantiate the assumptions made when writing the technology units.

Requirements of Teacher

1. Teach a technology unit and provide written and oral feedback:
 - a) Lesson evaluation sheets
 - b) Oral reaction in a discussion setting
 - c) Administration of pre- and post-tests
 - d) Scheduling of students for individual interviews by researcher.
- 2) Incorporate conceptual and contextual linkages into teaching

University Support

1. Provision of all printed materials.
2. Financial support to purchase needed equipment (\$300 per school).
3. Consultation support by researcher, graduate assistants, workshops, etc.
5. Financial support for after school hours (\$15.00/hr)

Scheduling

Starting Date:

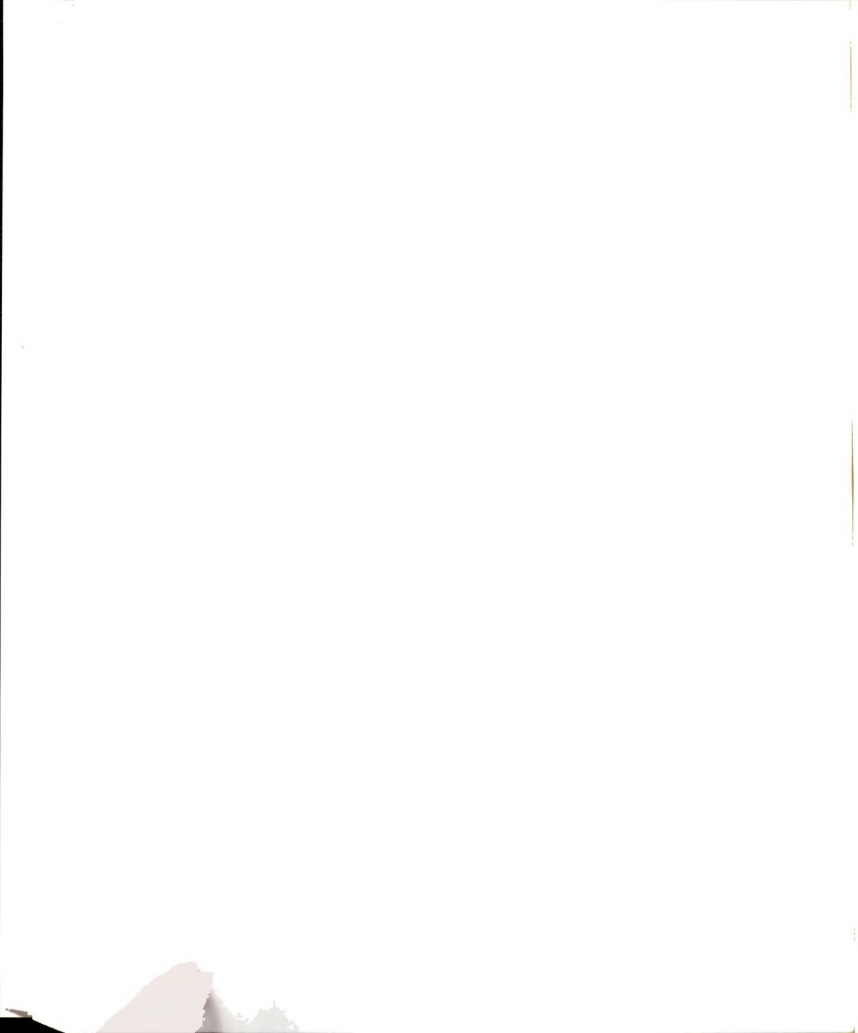
Preliminary Work -

Students for case study
Preliminary interviews
Pre-tests

Starting time for Weather Unit -

Research Assistant - Odette Lawrence - Class observations

Figure 7-8: Research Overview



APPENDIX A - Document 2

April 19th, 1989

RESEARCH PARTICIPATION AGREEMENT - TEACHER INVOLVEMENT:

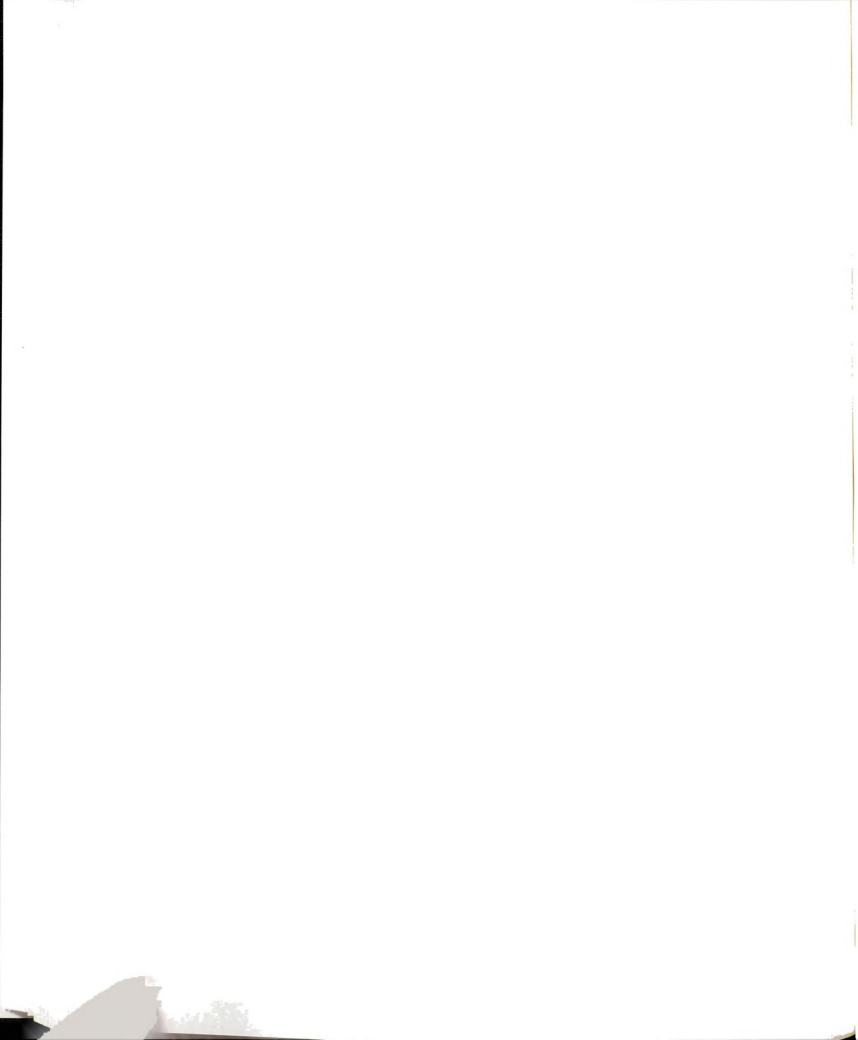
I have agreed to participate in the new Technology Curriculum Development Project during the 1989 school year. I also understand that my name and the names of my students will remain confidential, that the information collected in my classroom will be reported in a nonidentifiable way, and that I may withdraw my participation in the study at any time.

Signature

Name printed

Address

Figure 7-9: Participation Agreement



APPENDIX A - DOCUMENT 3

April 19th, 1989

Dear Parent:

The Lansing School District, in cooperation with Michigan State University and two other Michigan school districts, has participated in the development and writing of a new technology curriculum. These new materials were especially written to show how science is relevant to our modern technological society, and to help prepare our students to live and work in this period of rapid change.

Your child's science teacher will be using a trial edition of these new materials in her classroom. The intent of this state funded project is to develop materials that are of high interest and effective in teaching our young people. Thus it is vitally important that the writing team have valid feedback so that necessary revisions can be made before the final edition is published.

The study will involve a researcher observing lessons in the classroom, interviewing the teacher and students, and also collecting samples of student work. To help obtain an accurate record of both student and teacher thinking regarding the new materials, some of the interviews will be recorded on audio tape. The new unit will last approximately six weeks. This study has been approved by the principal of your school and by representatives of the Lansing School District.

Please note that the purpose and nature of the study will be explained to the students, and the information each furnishes will be voluntary. Every effort will be made to guarantee confidentiality and disguise the identity of students at all times. Participation in this project will have no effect on the student's evaluation or grades. Each student is free to withdraw any time, for any reason. We hope you will allow your child to participate. If you agree, please sign the attached form and return it to your child's teacher. If you have any questions, please call me at 355-9871 during the evening, or contact your school principal.

Sincerely,

Robert L. Liske
Member of Development Team

CONSENT FORM

My son/daughter -----has permission to participate in the curriculum research being conducted in his/her science classroom this year. I understand that my child's identity will remain confidential, that participation will not affect his/her grades, and that I may choose to withhold my child from participation in the interviews or withhold his work from the study at any time.

Date: _____

Signature of parent or guardian

Figure 7-10: Parent Consent Form

APPENDIX A - Document 4**FEEDBACK FROM TRIAL TESTING FOR REVISION**Introduction

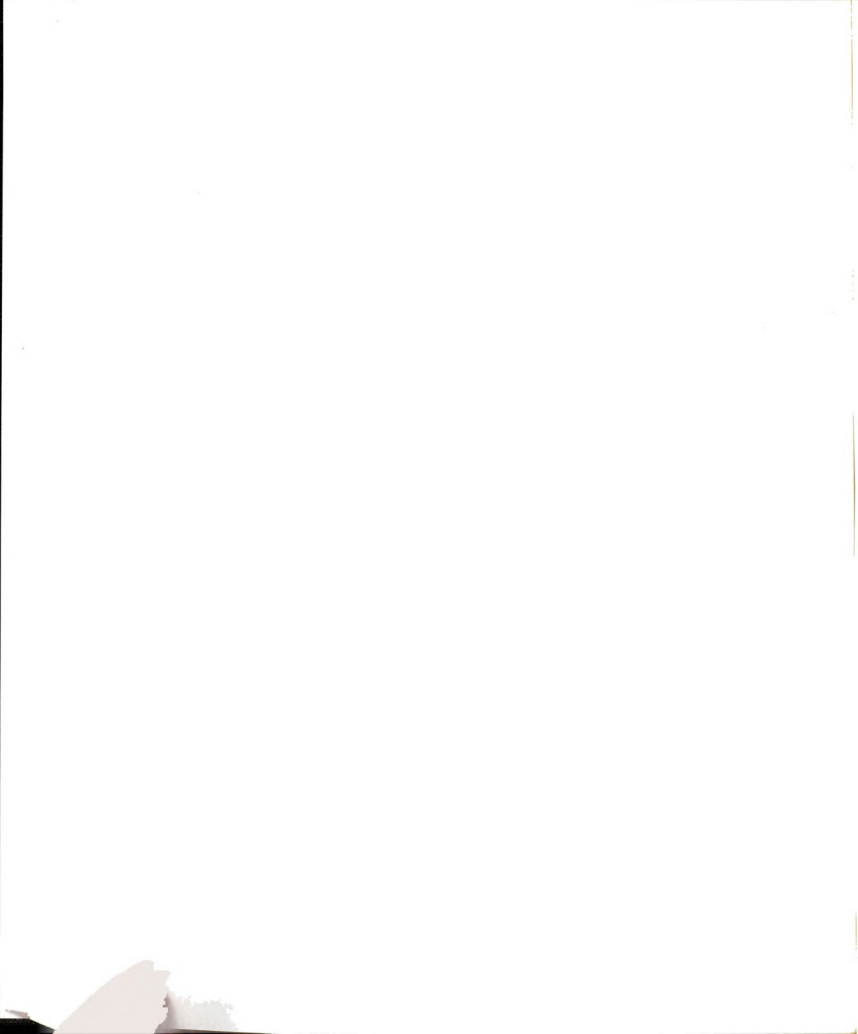
The intent is not to provide a canned, teacher-proof set of materials. Teacher creativity, personalization, and extension is both welcomed and in many cases necessary.

HOWEVER, in the trial testing phase we ask that the teachers use the materials as is to give the necessary feedback that will allow us to deal with the inherent problems of the material.

Providing valuable feedback

1. Editing - Look for spelling errors, typos, punctuation, etc.
2. Clarification - (blank expressions, lack of action)
 - a) Of directions
 - b) Of diagrams
 - c) Of concepts - Does the activity generate the concept? (cars)
 - Is the text clear?
3. Sequencing
 - a) Information given before the question??
 - b) Information not given, but assumed
4. Format problems - (page break, text & diagram)
5. Student Perceptions & Writer Assumptions
 - Common understanding of words (model, lamination)
5. Practicality of activities
 - a) Does the activity actually work? (lamination)
 - b) Will the materials be such a hassle to get that the teachers will most likely omit the activity?
6. Subjective Input
 - a) Which activities did you like?
 - b) Which activities & lessons were able to generate interest and excitement among the students?
 - c) What didn't work? What flopped?
7. Suggestions beyond material given?
 - a) Alternate or better activities
 - b) Personal adaptation
 - c) Extension activities

Figure 7-11: Teacher Feedback Form A



APPENDIX A Document 5

MSU High School Science Program
Demonstration/Trial Teachers Feedback Form

Teacher's Name _____

Unit _____

Lesson Number _____

Utilization: ☐ yes ☐ no In the space below, give three purposes of objectives for teaching the lesson to your students. If you did not teach it, give your rationale for omitting it.

General Feedback - Describe your overall reaction to the lesson.

_____ This lesson (1) is O.K. as is, (2) needs some revision, (3) needs major overhaul, (4) is unnecessary

Specific Feedback - Give specific problems you had and suggestions for changes for each part

a. Student Text Pages

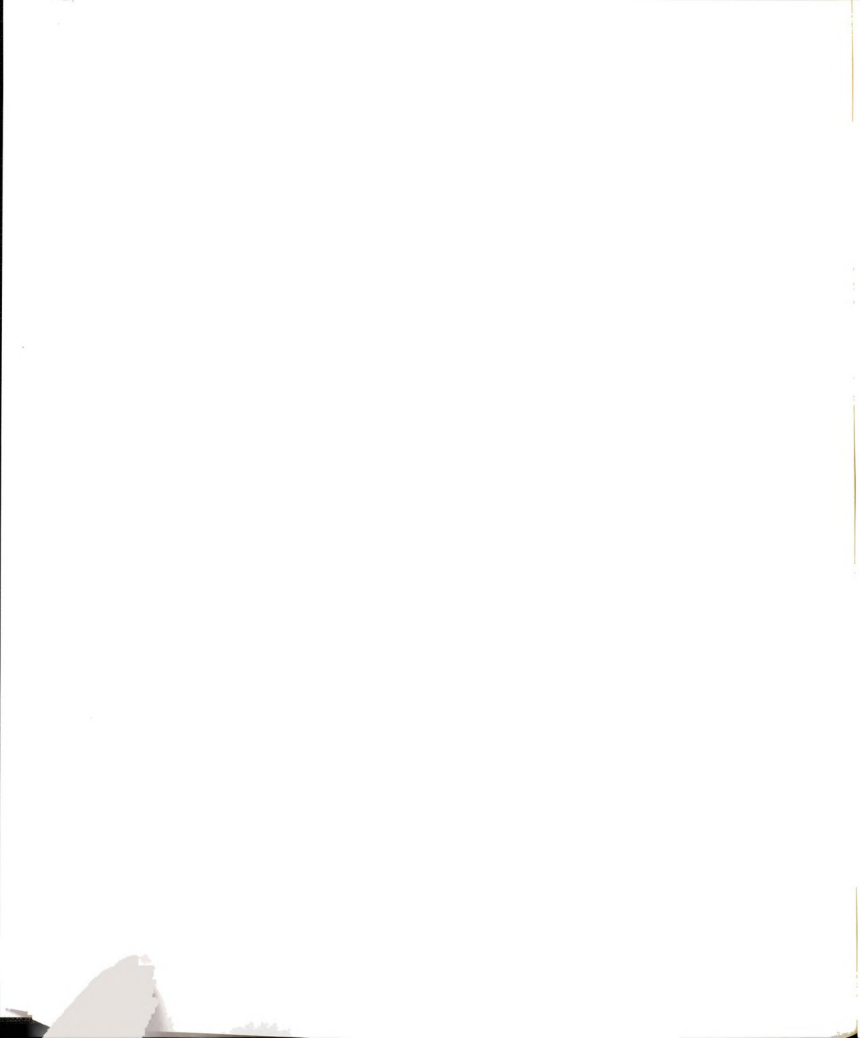
b. Student Activity Guide Pages

c. Teachers Guide

check if appropriate

☐ I have more ideas about this lesson and wish to tell you about them.

Figure 7-12: Teacher Feedback Form B



APPENDIX A Document 6WHAT DO YOU THINK?

PLEASE COMPLETE THE FOLLOWING FORM TO HELP US REVISE THE PROJECT MATERIALS. SIMPLY UNDERLINE THE ANSWER THAT SEEMS TO FIT BEST FOR YOU.

IF THE ANSWERS GIVEN DO NOT FIT WITH WHAT YOU WANT TO SAY, WRITE SOMETHING IN THE LINE BELOW THE QUESTION.

1. How did you like the new materials?

- a) boring b) OK c) interesting d) great
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2. Which part was most interesting to you?

3. Which part was least interesting to you?

4. In comparision to the regular textbook, how difficult were these materials for you.

- a) very easy b) easy c) about the same d) harder
e) very hard
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-

5. When you read the directions for the activities and experiments, you felt:

- a) totally lost b) confused c) sometimes confused
d) could usually follow e) easy to follow
-
-

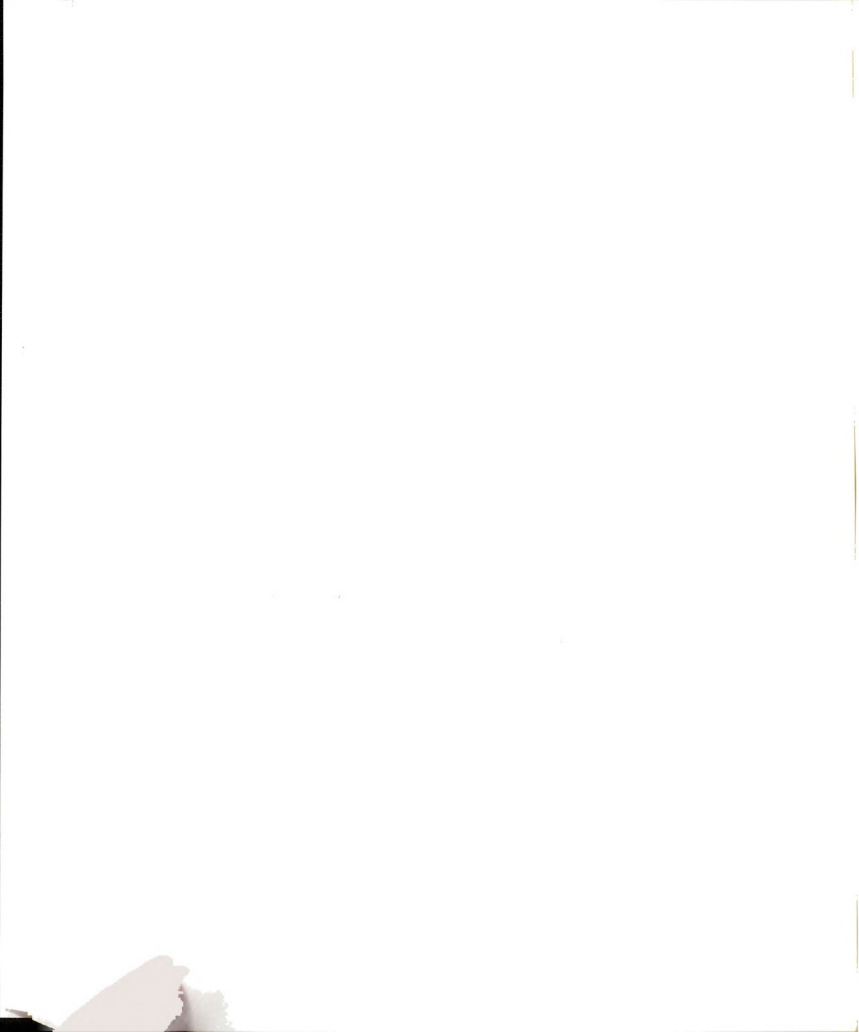
6. Are these materials important for you to study?

- a) not at all b) somewhat c) will be in the future
d) very important
-
-

7. Do the written materials give you enough informtion?

- a) too little b) about right c) not enough
-
-

Figure 7-13: Student Feedback Form



APPENDIX A Document 7

Science & Technology
 Science Units for the High School
Revision Comments

Two Questions: 1) What did we learn about the materials?
 2) What did we learn about teaching these students?

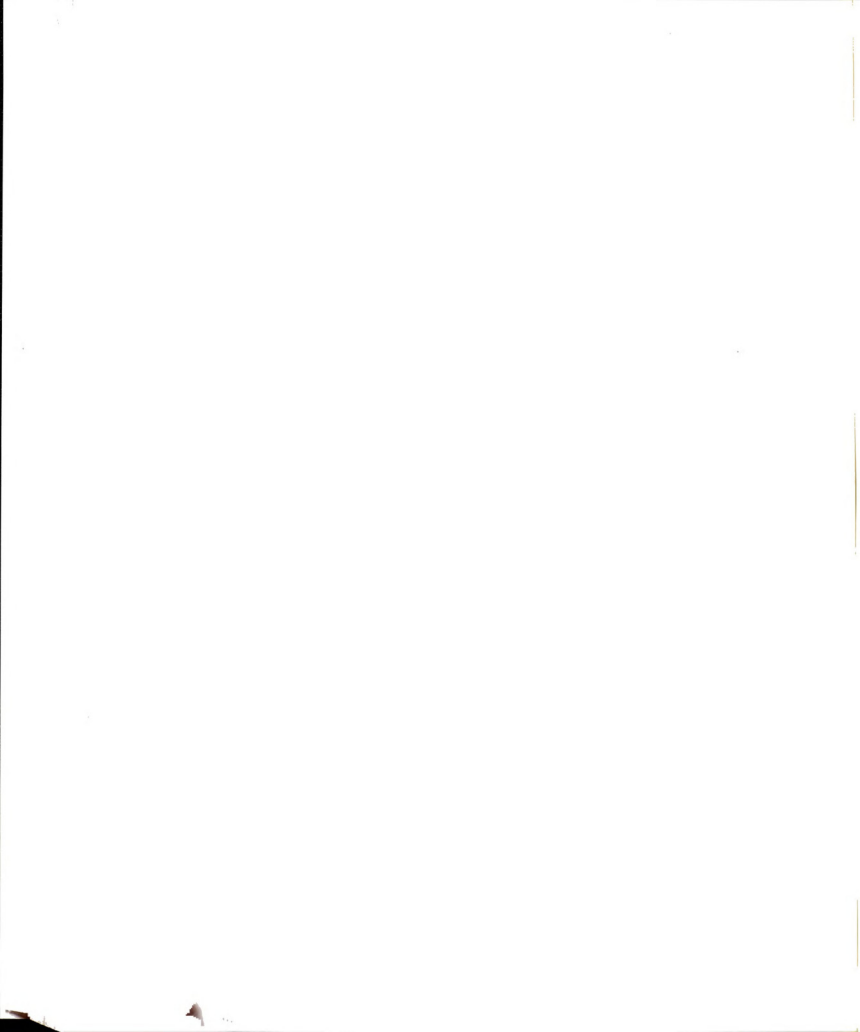
1) WHAT DID WE LEARN ABOUT REVISION OF THESE MATERIALS?

- a) Each lesson must have enough substance to support both the students and the teacher.
- b) Concepts must be taught earlier in the unit to enable students to work with them.
- c) Good data interpretation requires the collection of enough data.
- d) The materials are still only part of the instruction.
- e) Longer range projects help to give science a sense of continuity and relevance.

2. WHAT DID WE LEARN ABOUT TEACHING THESE STUDENTS?

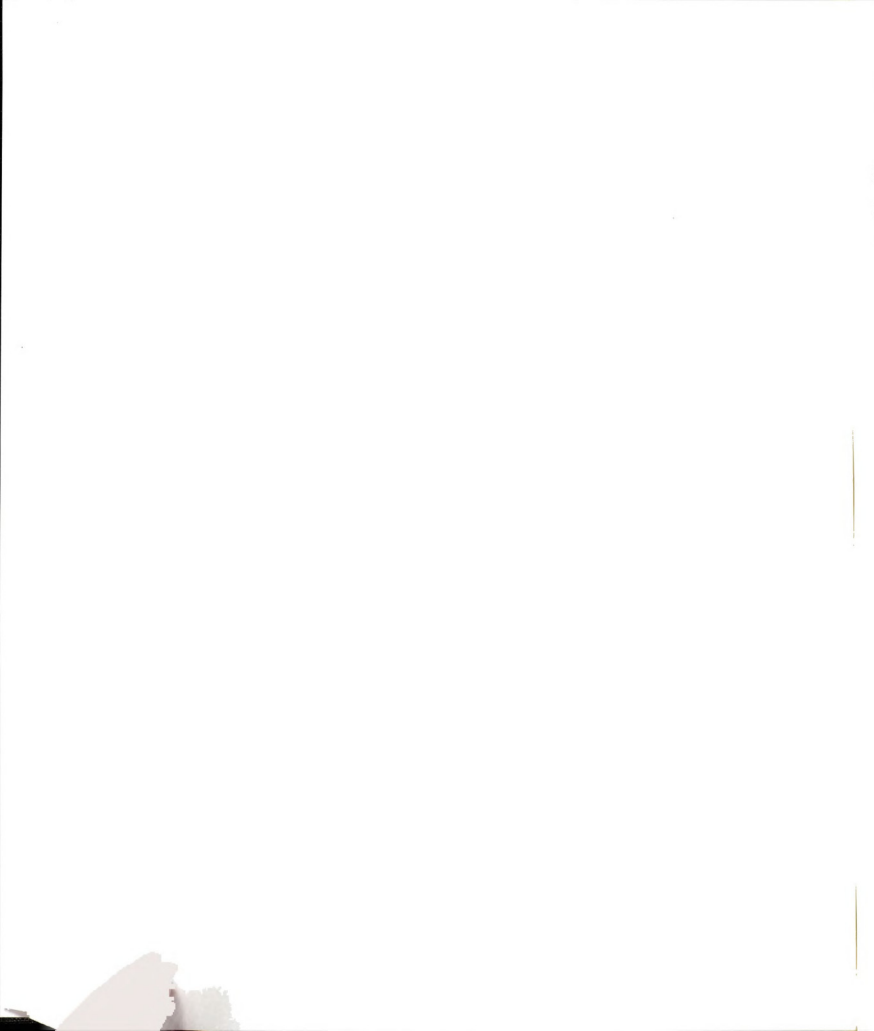
- a) Students will make a real fuss (fooling around) if they do not know how to do an activity.
- b) As they are carefully taught to do various activities, these students can be successful in completing linking activities - graphing, concept mapping, etc.
- c) When achieving this success, these students will settle down in small group and participatory activities.
- d) When activities visually construct and correlate concepts, these students can make sense of comprehensive ideas.
- e) Observation and description are something the students can do easily at the beginning of a unit. Explanation often has to be supplied by the teacher.
- f) Learning the language of science is often harder than learning the science itself. We as teachers need to teach the language of science. These students can and will learn some comprehensive science.

Figure 7-14: Revision Feedback



APPENDIX B – DOCUMENTS FOR WESTERN HIGH SCHOOL

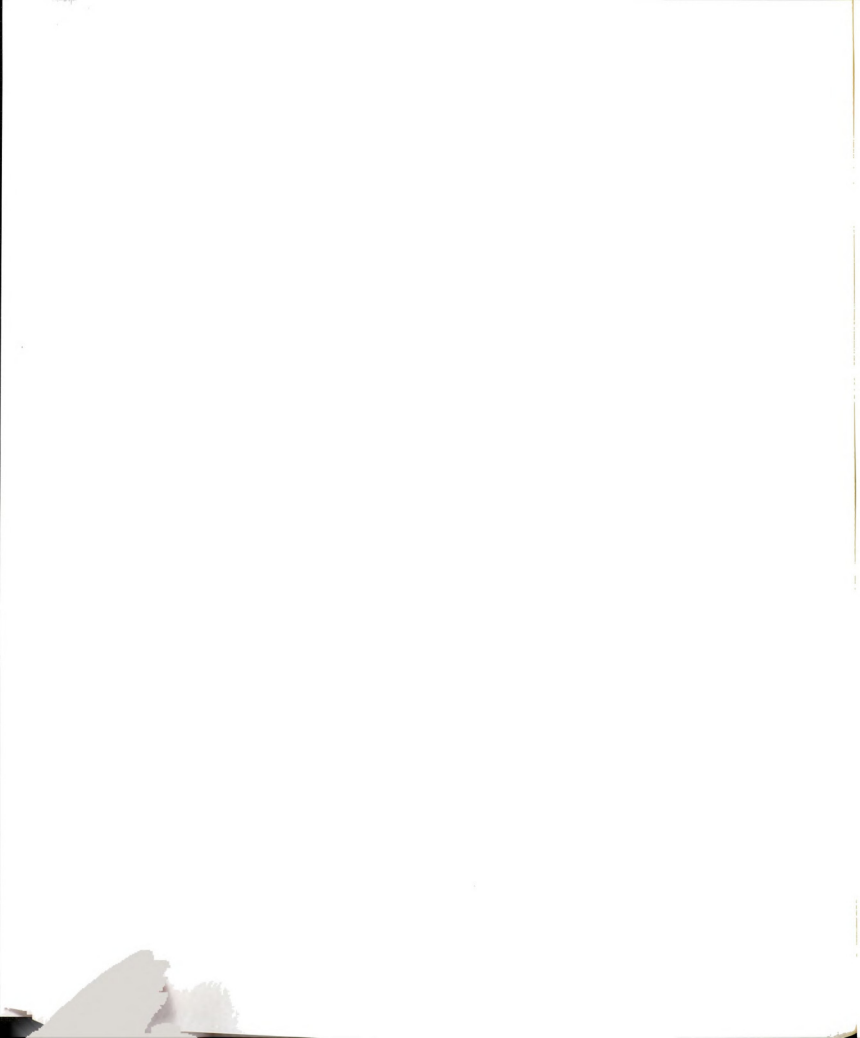
<u>Document</u>	<u>Title</u>
1.	Documents Collected at Western High School
2.	Research Log – By Class Period
3.	Research Log – By Time Allocated
4.	Lesson Completion – Unit Wheels
5.	Analysis of Activity Type
6.	Analysis of Activity Completion



APPENDIX-B-Document 1

<u>DOCUMENTS FOR ETHNOGRAPHY at WESTERN HIGH SCHOOL</u>			
<u>TYPE OF DATA</u>	<u>COLLECTION SETTING</u>	<u>SUBJECTS</u>	<u>DATES</u>
<u>Observations</u>	classroom	teacher & students	1/22-3/25
	alt. classroom	teacher & students	3/25
	IPS		
	chem		
	physics		
	school	students, staff	1/22-3/25
	neighborhood		1/22
<u>Interviews</u>			
Informal	classroom	students	3/22-3/25
		teacher	1/22-2/25
	hallway	principal	1/22-3/25
	luncheon	teachers	2/12
Formal (untaped)	classroom	teacher	3/12
Formal (taped)	classroom	teacher	3/16, 3/18, 3/23
	prep room	students	3/25, 3/27
<u>Printed School Materials</u>			
Curriculum guide	school office		1/22
Student Handbook			
Teacher Handbook			
Faculty directory			
School Schedule			
School Map			
Seating Chart	classroom	teacher	2/10
<u>Class Materials</u>			
Tests	classroom	teacher	2/12, 3/6, 3/23
Review Sheets	classroom	teacher	2/19, 3/20
T. Notes		teacher	3/5
Worksheet	classroom	teach & stud	3/25
<u>Survey Forms</u>			
Evaluation	classroom	pupils	3/10, 4/16
Project notes	classroom	teacher	3/2-3/25

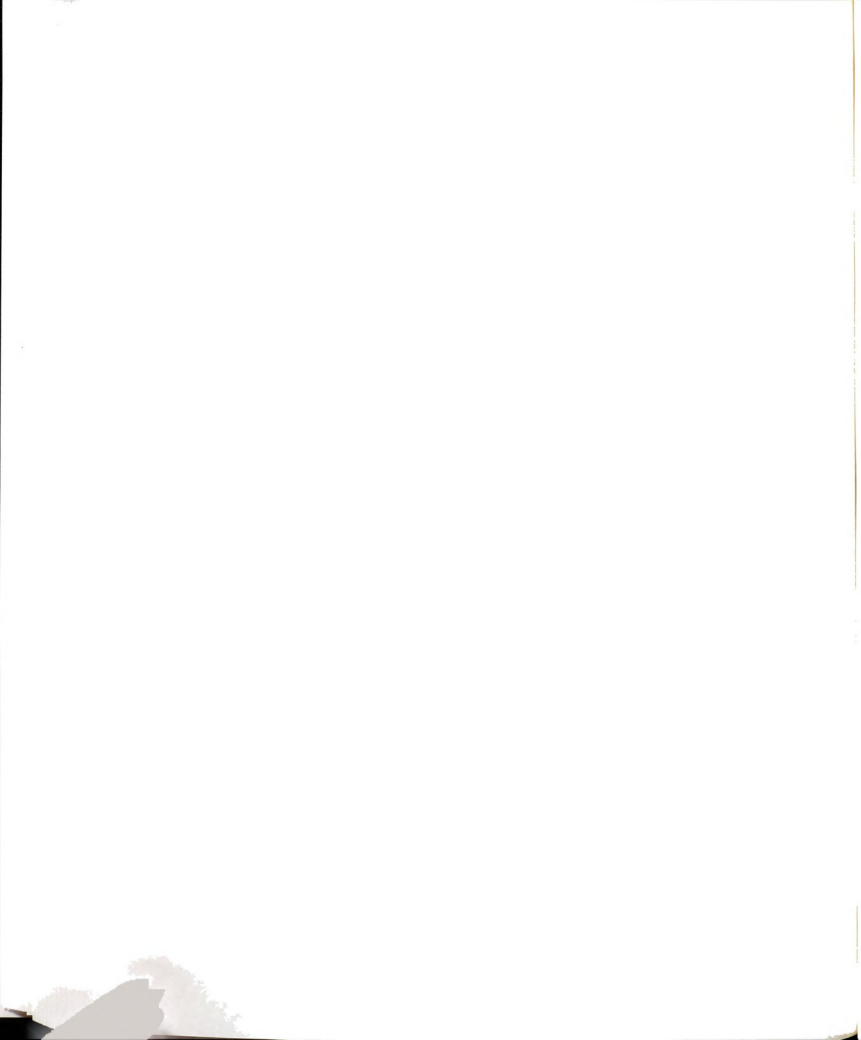
Figure 7-15: Documents Collected at Western H.S.



APPENDIX B - Document 2RESEARCH LOG AT WESTERN HIGH - BY CLASS PERIOD

Jan. 13,87		Permission from Principal and Dept. of Eval. Teacher agreement obtained		
<u>DATE</u>	<u>PERIOD</u>	<u>RECORDS</u>	<u>PROGRAM</u>	<u>CLASS TOPIC</u>
87/1/22	6	1-17	IIS	First day in school
87/1/29	6	18-27	IIS	Movie
87/2/6	6-7	28-42	IIS	Lesson Progression
87/2/10			clearance to Dr. Campbell	
87/2/12	7	43-52	IIS	papers to Dr. Bredick
87/2/19	6	53-60	IIS	Density Lab (Fac. Soc.)
87/2/20	6	61-66	IIS	Graphing (1st discussion)
87/2/26	6-7	67-74	IIS	Graphing Review
87/2/27	6-7	75-83	IIS	Review sheets
87/3/2	6	84-93	Project	permission granted, sheets distrib.
87/3/4	6-7	94-105	Project	Project introduced
87/3/5	6	106-109	Project abort	Building scale
7/3/6	7	110-115	Project	Using scales, lever!!
87/3/10	6	116-123	Project	(hole) Notes-wheel/axle
87/3/12	6	124-131	First T Interview	Test & Wheel/axle act.
87/3/16	6	132-136	Project	Unit 2 - read & outline
87/3/18	6	137-140	ISS	First T Interview - notes only
87/3/20	6	141-146	Second T Interview	Bicycle gears/tilt)
87/3/23	6	147-159	Third T Interview	Chp.26
87/3/25	2	160-161	IIS	on tape
87/3/27	3	162-164	IIS	Chp. 26
87/4/16	6	165-169	IIS	Review Sheet
87/5/20	7	170-173	Third T Interview	Quiz & Routine
	4	174-179	IPS	on tape
	6	180-182	Physics	Nuclear Energy- Lect.&Wksh
	7	183-186	Chemistry	Review
	8	187-188	S Interview with Rose	Review Sheets
	9	189	S interview with Jean	
	10	190	S interview with Paul	
	11	191	Jean & Paul present to class	
	12	192-195	IIS	Review Sheet - Chp. 24
	13	196	S Interview with Len	
	14	197	S interview with Isiah	
	15	198	S interview with Dianna	
	16	199	IIS	Chp. 14 questions
	17		Project	Planning meeting

Table 7-10: Research Log - By Class Period



APPENDIX B - Document 3

RESEARCH LOG AT WESTERN HIGH SCHOOL
OBSERVATION SCHEDULE & TIME ALLOCATION

<u>DAY</u>	<u>DATE</u>	<u>PROG</u>	<u>PRD</u>	<u>UNIT</u>	<u>EVENT</u>	<u>NOTES RECORDS</u>	<u>TIME SPENT ON PROJECT</u>
*THU	1/22	IIS	6	p.15	Quiz,vocab,read,outline,quest. 1st day	1-17	0%
Fri	1/23						
Mon	1/26						
Tue	1/27						
Wed	1/28						
*THU	1/29	IIS	6		Quiz,Movie,Report,Discussion	18-27	0%
Fri	1/30						
Mon	2/2						
Tue	2/3						
Wed	2/4						
Thur	2/5	*IS			Metric lab - meter sticks, grad. cyl,		0%
*FRI	2/6	IIS	6-7	Ch.6	Quiz,Outl.,Vocab.Quest,Notebk,tardy,grades	28-42	0%
Mon	2/9						
Tue	2/10						
Wed	2/11						
*THU	2/12	IIS	7	Ch.7	Demo,Lab density,Quiz, Interview,Fac.Soc	43-52	0%
Fri	2/13						
Mon	2/16			Ch.8			
Tue	2/17						
Wed	2/18			Ch.8	Line graphs		
*THU	2/19	IIS	6	Ch.9	Bar grph, WkSh, Chp.8 Review, 1st TLP	53-60	0%
*FRI	2/20	IIS	6	Ch.9	Grph-Review Sht, Ol cor, TLP, Worktime	61-66	0%
Mon	2/23			Ch.8-9	Test		
Tue	2/24						
Wed	2/25				"notes off board" Collected workbooks		
*THU	2/26	IIS	6-7	Ch10	Review shts, Notes, worktime, Proj.Intro.	67-74	0%
*FRI	2/27	IIS	6-7		Test (quiz) End of mark.prd.	75-83	0%

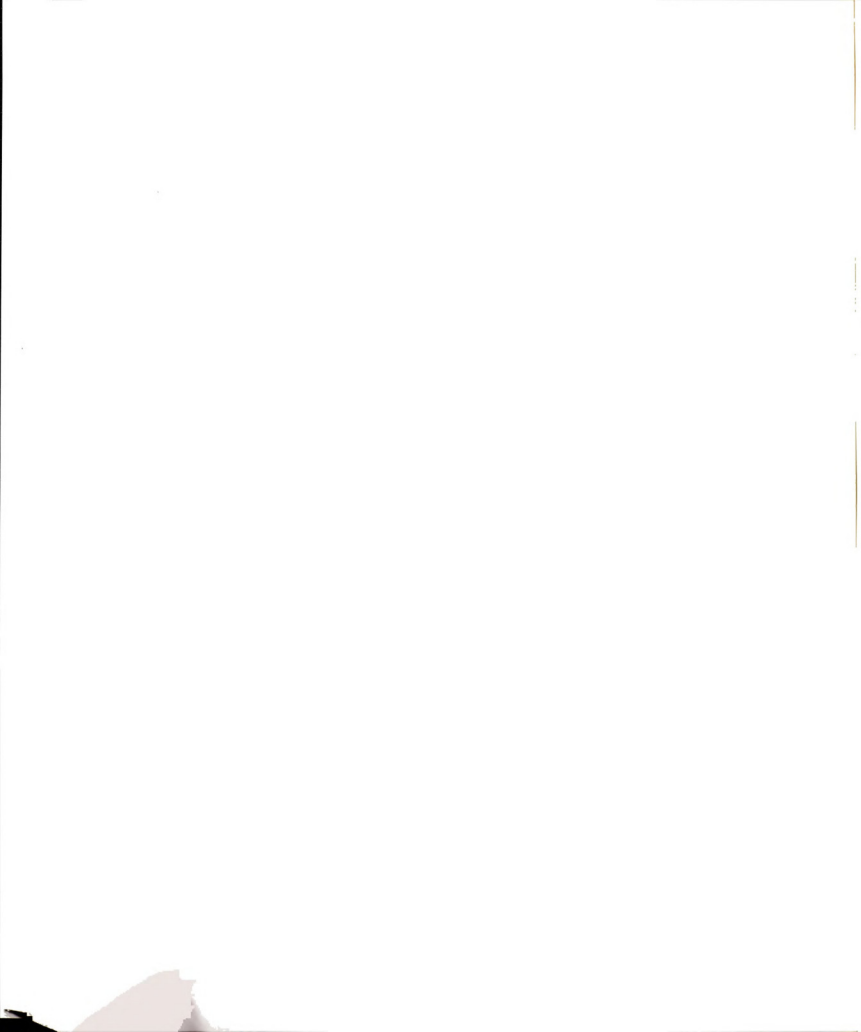
* Indicates days the researcher was actually present at school

Table 7-11: Research Log - By Time Allocation

Research Log at Western - Time Allocation (continued)

DAY	DATE	PROG.	PRD	UNIT	EVENTS	NOTES RECORDS	TIME SPENT IN CLASS
*MON	3/2	PROJ	6	I	Pre-ass, read, outl, quest, Build. scale, 1st pd. 84-93	100%	100%
Tue	3/3	proj			S1 to S9		100%
*WED	3/4	PROJ	6-7		"made outl, did questions" Lynn	94-105	100%
					Using scales w/lever, outl, answ.		
*THU	3/5	PROJ	6		Pg. 5-8 a-e, and S11-S12		
*FRI	3/6	PROJ	7		Wheel&axle, Notes on bb, Prob., Rev. wh	106-109	20%
					Project aborted		
					Prac. quiz, review, Act. Wheel/axle	110-115	20%
					worksheets		
Mon	3/9	proj			Self-ass, Gen. exper, S-19 to S-20		100%
*TUE	3/10	PROJ	6	II	Read, outl. p.1-3 & 8-10 & article	116-123	30%
Wed	3/11	Int			Movie, "Moon Landing", Short period		0%
*THU	3/12	PROJ	6		Wheel & axle, Bicycle gears (tilt)	124-136	75%
				III	S-4 to S-5, Read, outl, quest. S-1 to S-9		
					First formal teacher interview		
					Parent conferences - No class		
Fri	3/13	proj					
*MON	3/16	IIS	6		Chp. 26 "same stuff", Read, outl.	137-146	20%
					Taped teacher interview		
Tue	3/17	IIS			Ques. from textbook"/Lynn, Chp. 26		20%
*WED	3/18	IIS	6		Chp. 26, Quest. bb., outl, vocab, quest. txt.	147-161	20%
					Taped teacher interview		
Thur	3/19	IIS			Notes on engines		20%
*FRI	3/20	IIS	6		Review sheets, Ol correct.	162-164	20%
*MON	3/23	IIS	6		Quiz, Read, outline	165-173	20%
Tue	3/24				?		
*WED	3/25	IPS	2		Lecture, worksheet	174-179	
		CHEM	3		Worksh, review, quiz	180-182	
		PHYS	4		Review sheet	183-191	
		IIS	6		-Three taped student interviews		20%
Thur	3/26	IIS					
*FRI	3/27	IIS	7		Chp. 24, Review sheet 1st day before vac.	192-198	20%
					Three taped student interviews		
	3/30 to 4/5				Spring vacation at WHS		
							13%
	Monday to Friday, April 6th to 10				- not present in the classroom		
Mon	4/13						
Tue	4/14						
Wed	4/15						
*Thu	4/16	IIS	6		Outline, vocabulary, questions, Chp. 14	199-203	0%
Fri	4/17						
Wed	5/6		6		In to pick up T notes. No go!		
Wed	5/20				Planning meeting at MSU for summer project, with T,s		
					Evaluation of project materials		

Table 7-11: continued



APPENDIX B Document 4

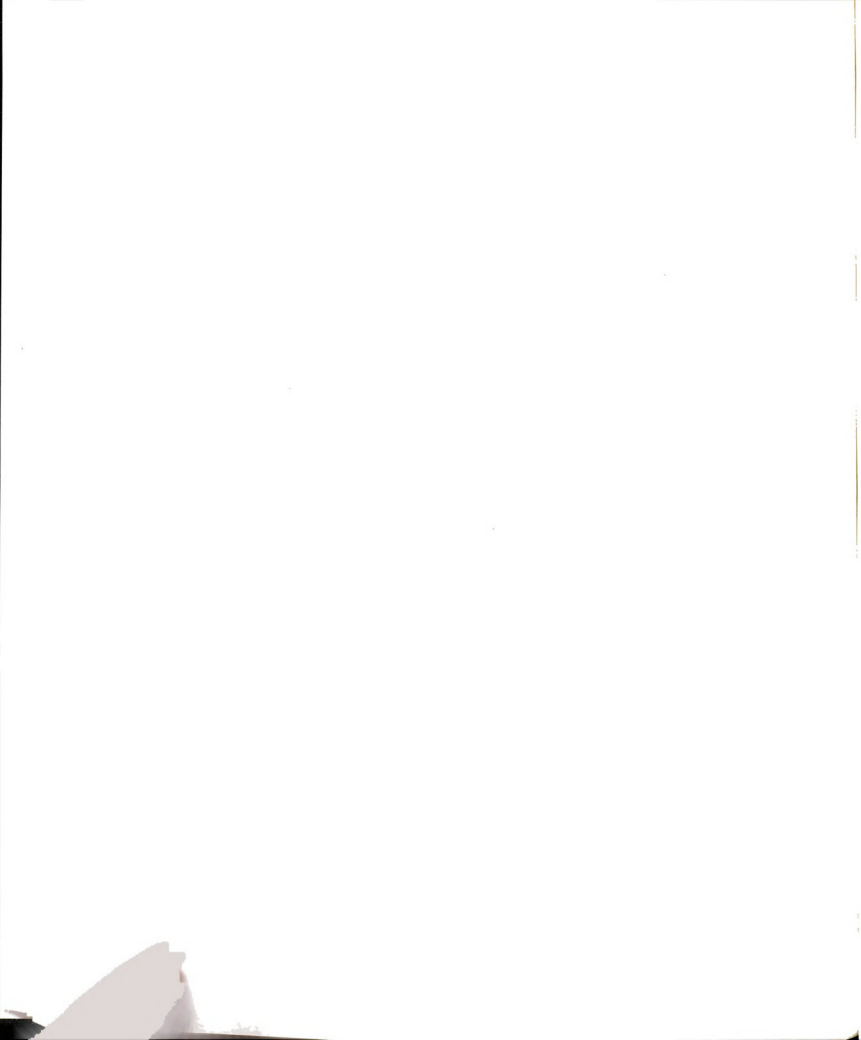
WHEELS UNIT - LESSON COMPLETION
Western High School

UNIT ONE - SIMPLE MACHINES

DAY	TITLE	ASSIGN	DATE	COMPLETE
1	Introduction - Demo Preview, S1 Where It Fits, S1 Pre-Assessment, S2 Understanding Work, S3 Exp. 1 - Measuring Forces, S9	no yes - read yes - read yes yes - read & outline yes	-- 3/2/87 3/2/87 3/2/87 3/2/87 3/2/87 3/2/87	no yes yes yes partly partly
2	Finish Exp. 1 - text and questions, S10	yes	3/3/87 and 3/4/87	yes
3	The Lever - reading S4-S5 Exp. 2 - The Lever, S11 Text & questions, S12	no yes no	-- 3/4/87 --	no yes no
4	Correct questions, S10-12 Wheel & Axle - reading S5-S6 Exp. 3 - Wheel & Axle, S13-14 Learning the Language, S18	yes yes - read & outline yes yes	3/4/87 3/4/87 3/6/87 3/9/87	yes yes partly yes
5	The Pulley - reading S7-S8 Exp. 4 - The Pulley, S15-16 * Notes on simple machines * Two review worksheets	no no (yes) (yes)	-- -- 3/5/87 3/5/87	no no (yes) (yes)
6	Self-assessment, S20 Demo: Incline Plane, T5 * Worksheet	yes no (yes)	3/9/87 -- 3/6/87	yes no yes
7	Test, T7-9 * Test - Prentice Hall	no yes	-- 3/10/87	no yes
8	Generalizing Experience	yes	3/9/87	yes

* Note: Items marked with a star (*) are not part of the Wheels unit as originally written, but are extra exercises added by the teacher.

Table 7-12: Lesson Completion - Unit Wheels



WHEELS UNIT - LESSON COMPLETION
Western High School

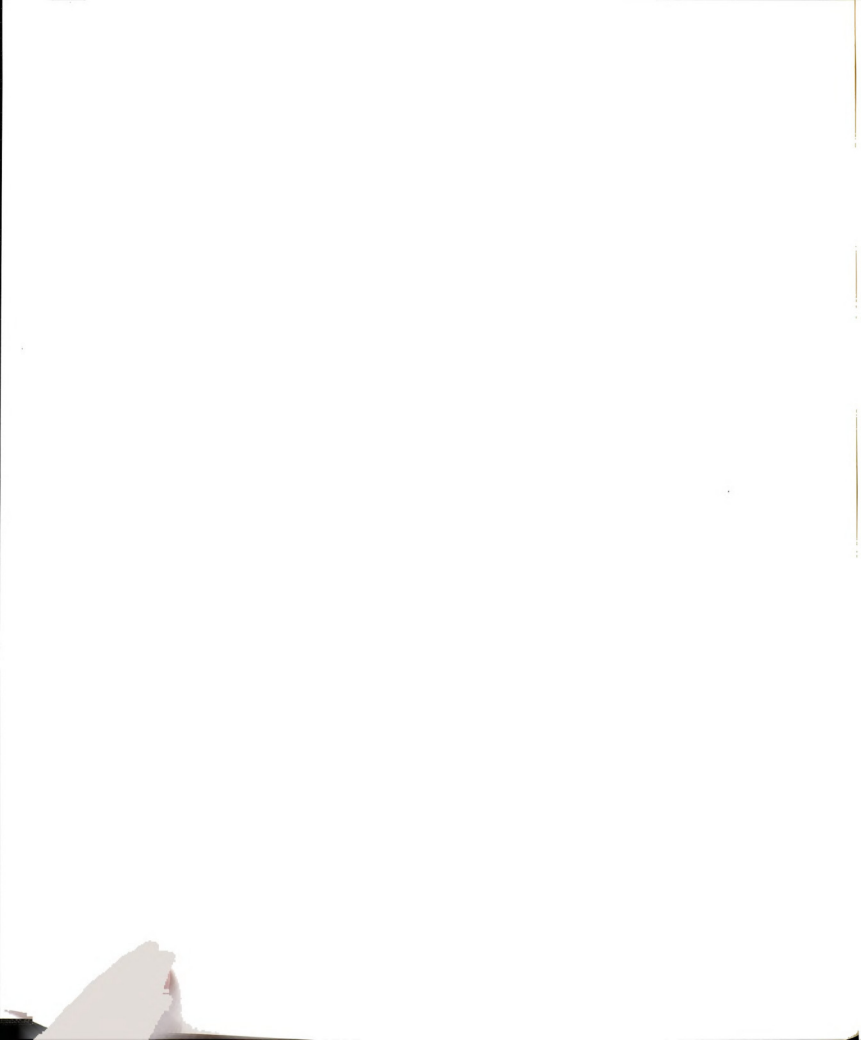
UNIT TWO - BICYCLES

DAY	TITLE	ASSIGNED	DATE	COMPLETE
1	Preview S1	yes -	3/10/87	yes
	Where It Fits S2	read &		
	Getting Started S2	outline		
	Intro Activity S3	yes	3/10/87	yes
2	Lab 1 - Bicycle Gears S4-s5	yes	3/12/87	demo
3	Lab 2- Using Gears S6-S7	Yes as extra credit		no
4	Activity 1- Friction on a Bicycle S8	no	--	no
5	Activity 2 - Riding Safely S8	yes - read & outline	3/10/87	yes
6	Rules of Road S9	yes - read & outline	3/10/87	yes
	Did You Know That S10	Yes - read & outline	3/10/87	yes
	Safety Gear S11	yes - read & outline	3/10/87	yes
7	Read "Health & Fitness" S12	yes	3/10/87	yes
	Final Test	yes	3/10/87	yes

UNIT THREE - CARS AS SYSTEMS

DAY	TITLE	ASSIGNED	DATE	COMPLETE
1	Preview S1 & T1	no	--	no
	Intro Activity T3-4	no	--	no
	Demo: Heat & Work T3	no	--	no
	Systems Application S2-4	no	--	no
2	Heat Engines S5-6	no	--	no
	Auto Engines S7-8	no	--	no
3	Experiment: Making a turbine	no	--	no
4	Car as Systems S11-14	no	--	no
	Self-Assessment S15	no	--	no
5	Quiz T6-7	no	--	no
	Correct	no	--	no

Table 7-12: continued



WHEELS UNIT - LESSON COMPLETION
Western High School

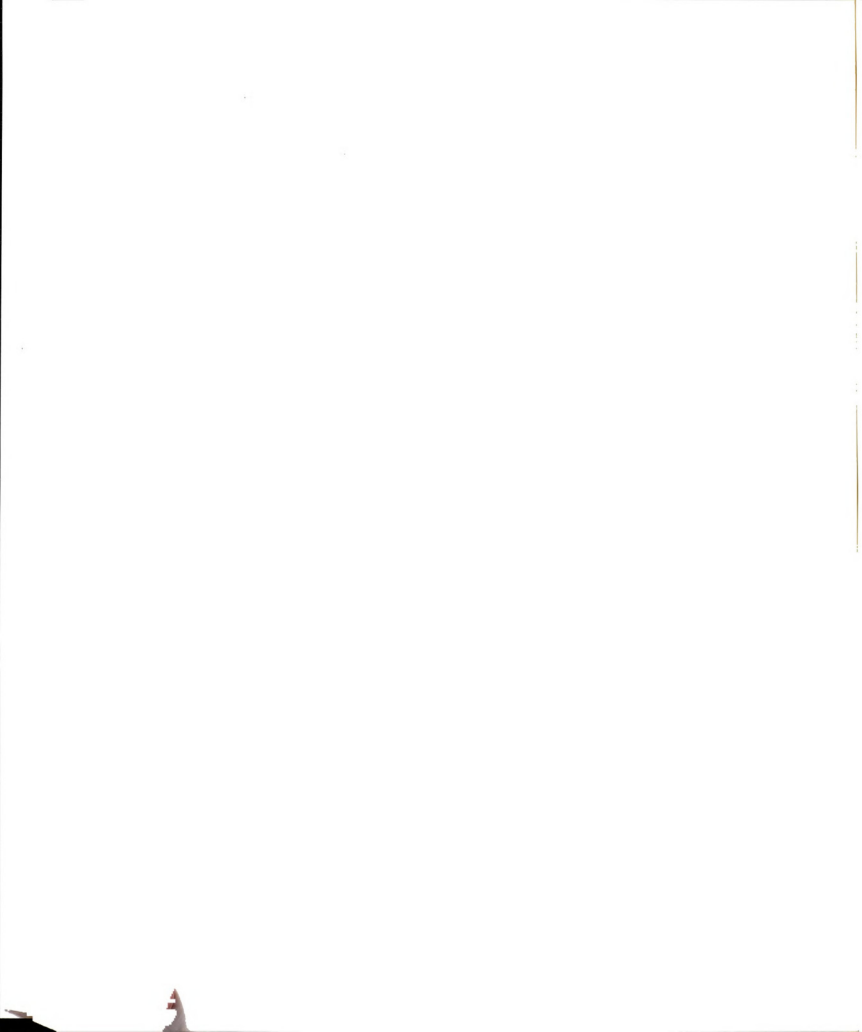
UNIT FOUR - BUYING A CAR

DAY	TITLE OF ACTIVITY	ASSIGNED	DATE	COMPLETE
1	Unit Planning	no	--	no
	Introduction & Pretest	no	--	no
	Model Development	no	--	no
	Unit Organization	no	--	no
2	Planning Research on Cars	no	--	no
	Planning a Survey	no	--	no
	Developing a Checklist	no	--	no
3	Needs, Wants, & Priorities	no	--	no
	Planning Reports	no	--	no
4-13	Individual Group Research	no	--	no
	Gathering Data	no	--	no
14	Organizing & Interpreting Data	no	--	no
	Preparing the Report	no	--	no
15	Making Visuals for Reports	no	--	no
16	Giving Oral Reports	no	--	no
17	Decision Making	no	--	no
18	Posttest	no	--	no

UNIT FIVE - PACKAGING PEOPLE (SAFETY)

DAY	TOPIC OF ACTIVITY	ASSIGNED	DATE	COMPLETE
1	Introduction & Pretest	no	--	no
2	Lab 1: Sudden Stops Hurts	no	--	no
3	Lab 2: Protecting Passengers	no	--	no
4	Activity 1: Modifications & Design	no	--	no
5	Activity 2: Seat Belts	no	--	no
6	Selftest & Review	no	--	no
7	Posttest	no	--	no

Table 7-12: continued



UNIT SIX - TECHNOLOGY AND MATERIALS

DAY	TOPIC OF ACTIVITY	ASSIGNED	DATE	COMPLETED
1	Introduction Pretest	no	--	no
		no	--	no
2	Demo 1 - Ore to Metal	no	--	no
3	Activity 1 - Testing Foil	no	--	no
4	Complete Activity 1	no	--	no
5	Demo 2 - Preparing an Alloy Activity 2 - Simple Laminate	no	--	no
		no	--	no
6	Activity 3 - Testing Materials	no	--	no
7	Finish Activity 3	no	--	no
8	Plan report	no	--	no
9	Give reports	no	--	no
10	Decision making Activity Posttest	no	--	no
		no	--	no
		no	--	no
11	Laminate activity contest	no	--	no

UNIT SIX - TECHNOLOGY AND MATERIALS

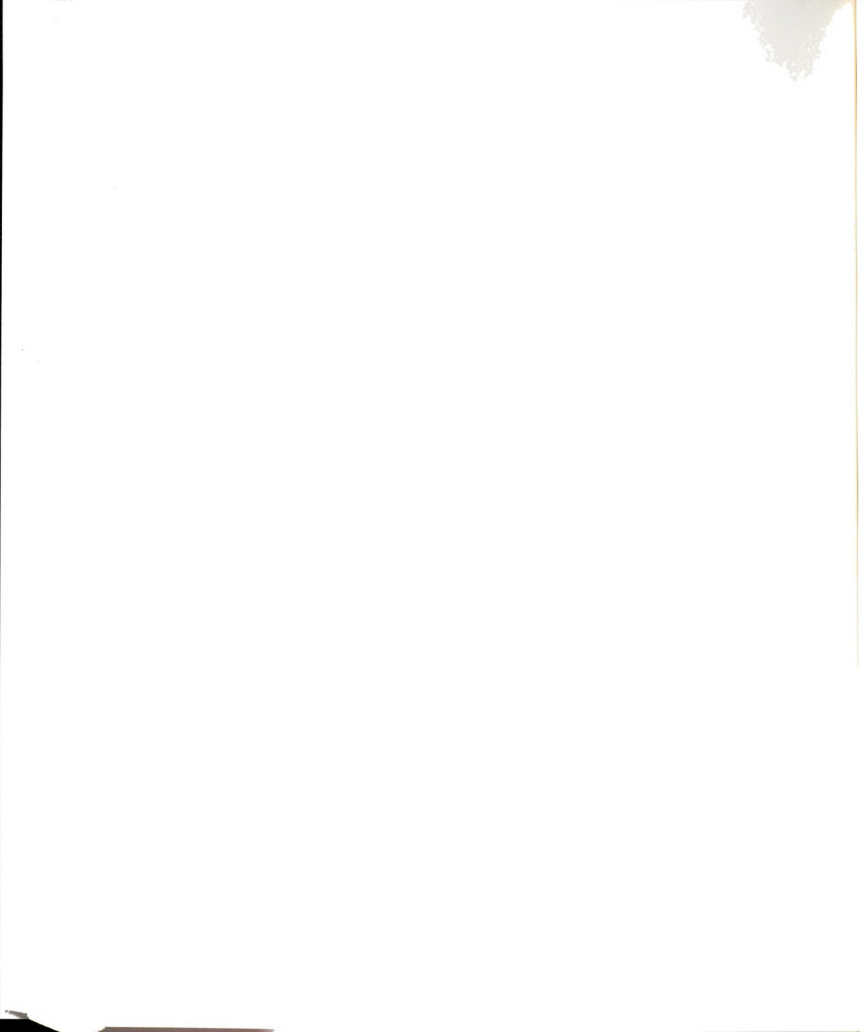
DAY	TOPIC/ACTIVITY	ASSIGNED	DATE	COMPLETED
1	Overview Preassessment Activity 1: Brainstorming	no	--	no
		no	--	no
		no	--	no
2	Activity 2: Survey	no	--	no
3	Class Histogram Design for Appeal	no	--	no
		no	--	no
4	Activity 3 & 4: Design for Economy	no	--	no
5	Activity 5: Wind Tunnel Building Designs	no	--	no
		no	--	no
6	Test & measure cars Prepare class reports	no	--	no
		no	--	no
7	Oral reports	no	--	no
8	Activity 6: Uses of Vehicles	no	--	no
9	Concluding Activity Selfassessment	no	--	no
		no	--	no

Table 7-12: continued

APPENDIX B - Document 5ANALYSIS OF ACTIVITY TYPE
Western High School

ACTIVITY NUMBER	DEMO	READING	EXPERI- MENTS	WRITTEN WORK	NOTES
1-1		/	/	/	
1-2		2/7=29%	3/7=43%	2/7=29%	
1-3		/	/	/	
1-4		/	/	/	
1-5	1/10=10%	/	/	4/10=40	/
1-6	/	2/10=20%	2/10=20%	//	1/10=10%
1-7		1/5=20%		/	
1-8				//	
2-1		/		4/5=80%	
2-2	/			1/3=30%	
2-3	1/3=30%		/	/	
2-4			1/3=30%	/	
2-5		/		2/3=66%	
2-6		1/3=33%		/	
2-7				/	

Table 7-13: Analysis of Activity Type

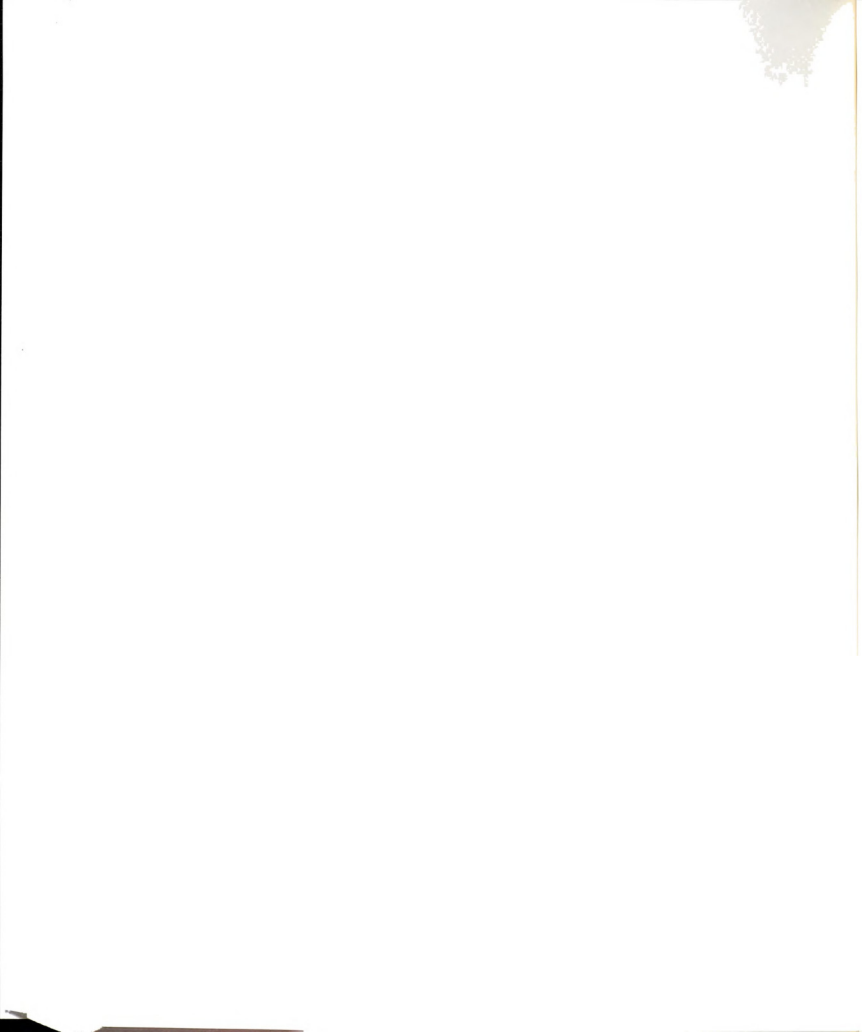


APPENDIX B - Document 6

ACTIVITY COMPLETION SUMMARY - WHEELS UNIT
Western High School

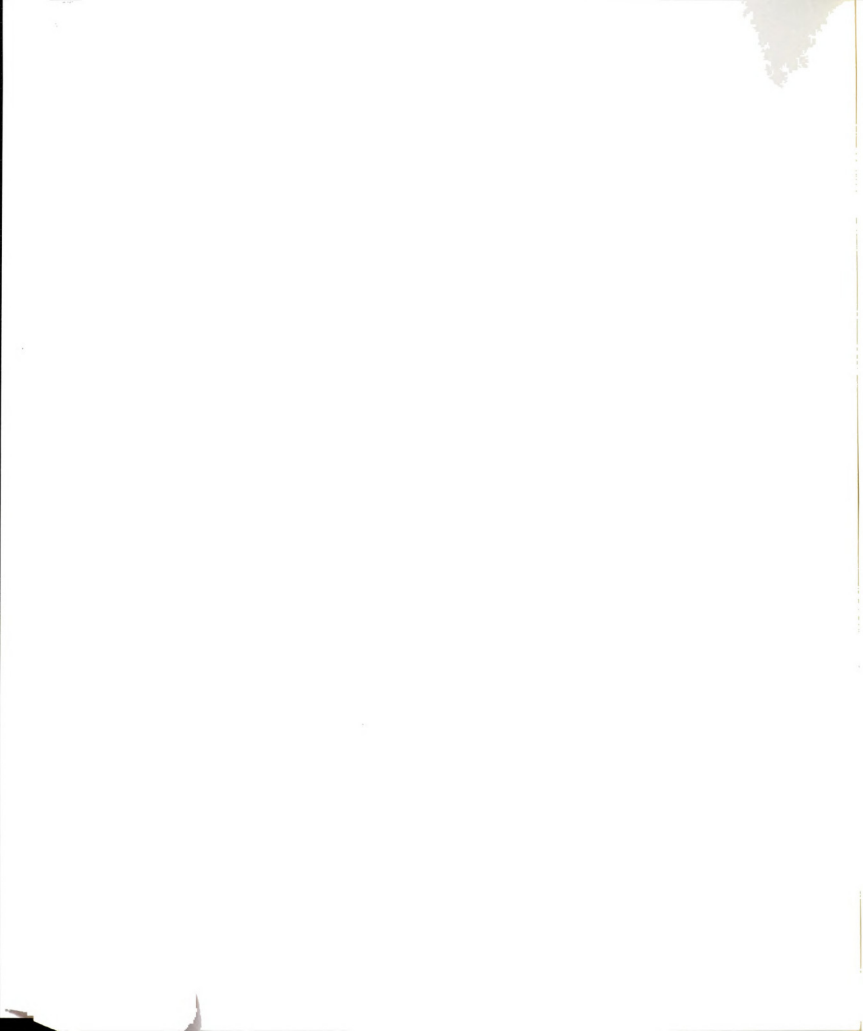
3 DAY SEGMT	LESSON	NUMBER OF ACTIVITIES	ACTIVITIES COMPLETED	CALCULATIONS OF PER CENT
1	1-1	6	4	$6/10 = 60\%$
	1-2	1	1	
	1-3	3	1	
2	1-4	4	3.5	$4.5/8 = 56\%$
	1-5	2	0	
	1-6	2	1	
3	1-7	1	0	$3/4 = 75\%$
	1-8	1	1	
	2-1	2	2	
4	2-2	1	.5	$.5 \div 3 = 17\%$
	2-3	1	0	
	2-4	1	0	
5	2-5	1	0	$5/6 = 83\%$
	2-6	3	3	
	2-7	2	2	
6	3-1	4	0	$0/4 = 0\%$
	3-2	2	0	
	3-3	1	0	
7	3-4	2	0	$0/7 = 0\%$
	3-5	2	0	
	4-1	3	0	

Table 7-14: Analysis of Activity Completion



APPENDIX C – DOCUMENTS FOR CRANSTON HIGH SCHOOL

<u>Document</u>	<u>Title</u>
1.	Documents Collected at Cranston High School
2.	Activity Completion Log
3.	Activity Completion Summary
4.	Research Log – By Time Allocation
5.	Three Day Segment Summary
6.	Analysis of Time by Activity Type: Weather Unit
7.	Activity Type Summary – Raw Scores & Per Cent
8.	Protocols: Interview, Time Analysis
9.	Interview Questions
10.	Pretest Tabulations
11.	Posttest Tabulations



APPENDIX C - Document 1

DOCUMENTS COLLECTED AT CRANSTON HIGH SCHOOL

1. Field Notes
 - a) By researcher
 - b) By research assistant
2. Pretests:
 - a) On weather
 - b) On beliefs and attitudes
3. Posttests
 - a) On weather
 - b) On beliefs and attitudes
4. Graphs of Weather Record
 - a) December
 - b) January
 - c) February & March
5. Concept Maps
 - a) Weather Factors
 - b) What Makes the Wind Blow
6. Interview Records (based on notes & audiotapes)
 - a) At the beginning of the project
 - b) At the end of the project
7. Interpretive Summaries on Data Base
8. Revision Comments From Teacher
9. Teacher Participation Agreement
10. Parent Permission Forms

Figure 7-16: Documents Collected at Cranston H.S.

APPENDIX C - Document 2

WEATHER UNIT - ACTIVITY COMPLETION LOG

Cranston High School

SAG - refers to Student Activity Guide (data record & workbook)

LESSON	TITLE	ASSIGNED	DATE	COMPLETED
1	Weather Predictions	Pretest Read text SAG - yes	11/6/89 11/7 11/8	yes yes yes
2	Weather Reports (Factors)	Form groups Plan materials SAG - no	11/7 11/7 --	yes yes no
3	Weather Instruments	Read text 5-6 SAG - no	11/8 11/9	yes no
4	Planning Weather Station	modified	11/7	yes
5	Planning Weather Station: Synthesis	modified SAG - no	11/7 --	yes no
6	Collecting Weather Data	modified	cont.	partly
7	Clouds	Read text 18-20 SAG p.16-17 - yes Slides - modified	11/20 11/20 12/1	yes yes yes
8	Air Masses & Fronts	Read text 21-24 SAG - yes	11/20 12/4 & 7	yes yes
9	Making Sense of Weather Observations - No. 1	modified concept map	11/22 11/27	modified
10	Weather Map - What's On It?	Read text SAG - no	12/7 --	modified no
11	Making Weather Map	Isobar Activity Isotherm Activity Concept Map SAG - no	12/7 12/7 12/8 12/18 --	yes yes yes yes no
12	Comparing & Interpreting Weather Maps	Planned	1/11 12/13	yes
13	Local Weather Signs: Connection to Weather Data	Read Chp. 13	12/14	partly no
14	Satellites & Radiosondes	Read Chp. 14 SAG p. 29-31 - yes	12/14 12/15	yes yes
15	Radar	no	--	no
16	Making Sense of Weather Observations, No. 2	modified	12/18	modified

Table 7-15: Activity Completion Log

ACTIVITY COMPLETION LOG - Weather Unit (continued)

LESSON	TITLE	ASSIGNED	DATE	COMPLETED
17	Project Work	no	--	no
18	What is Wind?	Read 41-42 SAG p. 40-43: yes	1/23 1/25	yes yes
19	What is Air?	Activity 1 Stations SAG - yes	1/26 1/30 1/31 2/12	yes yes
20	What Does Heat do to Air?	Demo: Act.1 Demo: Act.2 Graphing	2/1 2/7	yes yes
21	Differential Heating and Wind	Read text 48-50 SAG pp.56-57 Act.1 & 2 Demo	2/4 2/6 2/6 2/12	yes yes yes yes
22	Making Sense of Weather Observations: Part 3	modified (graphing)	2/23	yes
23	More About Wind	SAG pp. 61-63 Concept Map Graphing	2/21 2/23&26 2/28 3/12	yes
24	Southwest Winds	no	--	no
25	Jet Stream	no	--	no
26	The Greenhouse Effect	no	--	no
27	Making Sense of Weather Observations: Part 4	no	--	no
28	What Causes Rain?	no	--	no
29	Evaporation	no	--	no
30	Moisture In and Out of the Air	no	--	no
31	Making Sense of Weather Observations: Part 5	no	--	no

Table 7-15: continued

APPENDIX C - Document 3

ACTIVITY COMPLETION SUMMARY - WEATHER UNIT
Cranston High School

3 DAY SEGMT	LESSON	NUMBER OF ACTIVITIES	ACTIVITIES COMPLETED	CALCULATIONS OF PER CENT
1	1	3	3	$6/8 = 75\%$
	2	3	2	
	3	2	1	
2	4	1 modified	1	$3/5 = 60\%$
	5	2	1	
	6	2	1	
3	7	2	2	$5/6 = 83\%$
	8	2	2	
	9	2	1	
4	10	2	1	$5/7 = 71\%$
	11	4	3	
	12	1	1	
5	13	2	1	$3/4 = 60\%$
	14	2	2	
	15	1	0	
6	16	2	1	$3/5 = 60\%$
	17	1	0	
	18	2	2	
7	19	2	2	$8/8 = 100\%$
	20	2	2	
	21	4	4	
8	22	2	1	$4/5 = 80\%$
	23	3	3	
	24	not present		

Table 7-16: Activity Completion Summary

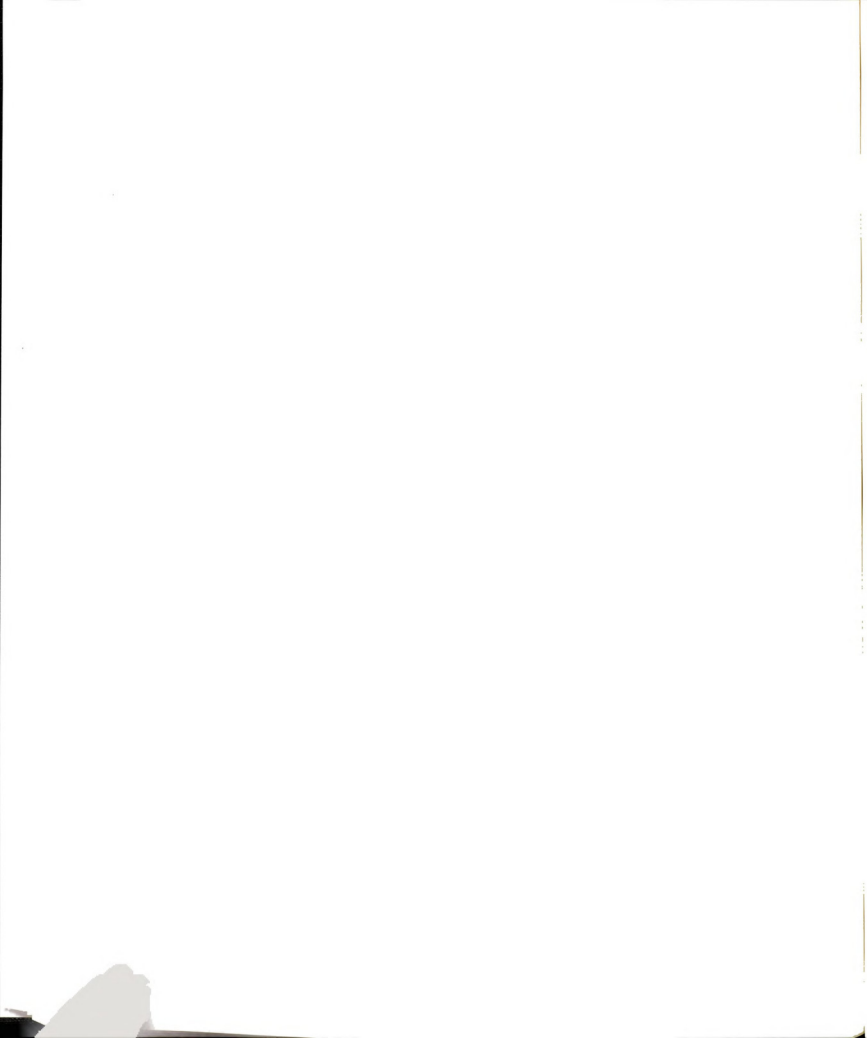
APPENDIX C Document 4RESEARCH LOG AT CRANSTON HIGH SCHOOL

<u>LOG OF OCTOBER, 1989</u>		<u>PERCENTAGE OF TIME SPENT ON PROJECT</u>
2 - Appointment with Dr. Gallagher		
3 - Appointment with Dr. Gallagher		
4 - Appointment at Cranston High with Mr. Glen Lindeman		
5 -		
6 -		
9 - Appointment with Dr. Gallagher		
10 -		
11 - Eastern High School, 1:00 PM; Gallagher, 2:00 PM		
12 -		
13 - Appointment with Dr. Gallagher		
16 -		
17 -		
18 -		
19 -		
20 - Appointment with Dr. Gallagher		
23 - Teacher Planning with Glen Lindeman, 8:15 AM		
24 -		
25 - Appointment with Dr. Gallagher		
26 - First class - Video & Worksheet "Red-tailed Hawk"		
27 - Notes and Quiz on "Red-tailed Hawk"		
30 - Notes on excretory & circulatory system. Vocabulary Quiz		
31 -		
<u>NOVEMBER, 1989</u>		
1 - Parent/teacher conferences. Cranston dismisses at noon. Appointment with Glen at 2:00 PM.		
2 - Final test in classroom on old unit. Appoint with Dr. Gallagher at 3:30		
3 -		
(4) Detroit Science Teachers Association Convention		
6 - First day with project materials.	100%	93%
7 - Demonstration of "connecting links" using clouds.	100%	
8 - Teacher presentation on overhead of climates, biology, and weather lore.	80%	
9 - Interview with Sarah. Quiz on "weather instruments"	0%	0%
10 - Interview with Tom. Appointment at Sorenson Suburban High School.	0%	
13 - Interview with Ross. Appointment with Dr. Gallagher, 3:00 PM	0%	0%
14 - RLL interviews Laura. Deana interviews Simon	0%	
15 - Flint Teacher Training Workshop. Diana interviews Brent.	0%	
16 - Interview with Scott	0%	0%
17 - Marquette Workshop. Diana at Cranston	0%	
(18) - Marquette Workshop continued.	0%	

Table 7-17: Research Log - By time Allocation

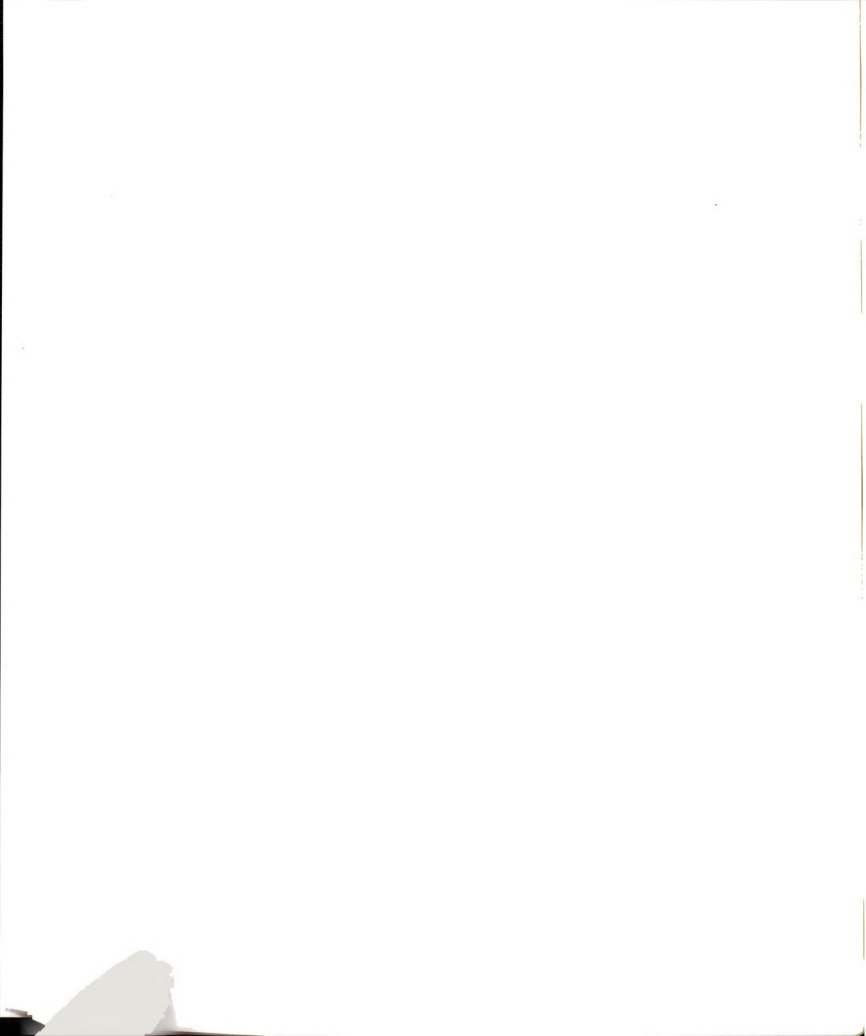
November Log (continued)		PERCENTAGE OF TIME SPENT ON PROJECT		
	20 - Journal Notes & Worksheet on "deer" Diana interviews Denise Homework: Read lesson 7, Do pages 16-17 in Activity Guide Book.	0%		
5	21 - Journal Notes on "deer" continued Researcher interviews Katie	0%	67%	
	22 - Teacher led presentation (TLP) on clouds using slides and worksheet. Researcher led presentation (RLP) on "concept mapping"	100%		
	23 - Thanksgiving break			
	24 - Thanksgiving break			
	27 - Students work on concept maps. Coaching by teacher & researcher	100%		
6	28 - Appointment with Dr. Gallagher 4:00 PM (not present in classroom)	0%	33%	
	29 - Lansing Teacher Training Workshop. Video on "squirrels"	0%		
	30 - Teacher reviews clouds Students finish concept maps	100%		
	<u>LOG OF DECEMBER, 1989</u>			
	7	1 - Quiz on "squirrels" Cloud oral review quiz with slides Detroit Teacher Training Workshop		50%
8	4 - Notes on fronts Lesson 7 SAG - Clouds Lesson 8 SAG - Air Masses & Fronts	100%		
	5 - Kalamazoo Teacher Training Workshop (video on mink)	0%		
	8	6 - Worksheet "mink" Quiz on weather words Video on freshman basketball	30%	43%
7 - TLP on "air masses"		100%		
8 - Video		0%		
9	11 - Video ... (absent from room)	0%	0%	
	12 - Video ... (absent from room)	0%		
	13 - Absent from room	0%		
10	14 - Weather quiz: Clouds, fronts, weather instruments, weather maps Video "Kodiak Bear"	50%	83%	
	15 - Balloon launch Preliminary weather record	100%		
	18 - Graphing actual weather data	100%		
11	19 - Finish graphing	100%	33%	
	20 - (Absent from room)	0%		
	21 - Review for final	0%		
	22 - Review for final	0%		

Table 7-17: continued



<u>LOG OF JANUARY, 1990</u>		<u>PERCENTAGE OF TIME SPENT ON PROJECT</u>	
12	8 - Review on leaves for final Open book quiz Complete weather record	10%	20%
	9 - Lesson 12 on weather maps	50	
	10 - Video on	0%	
13	11 - Lesson 12 continued	50%	17%
	12 - Review for final	0%	
	15 - Review for final	0%	
	16 - Review for final	0%	
	17 - Semester finals		
	18 - Semester finals		
	19 - Semester finals		
<u>II Semester Begins</u>			
14	22 - Notes on evolution	0%	9%
	23 - TLP: Demonstration of density (oil & water) Video on badger	27%	
	24 - Video on ...	0%	
15	25 - Notes on mammals Quiz on badger Demonstration of convection box, p. 43 Read 502-510. Do questions on page 517	55%	50%
	26 - Demonstration of air pressure (crushed can) Students work at stations, Activity	100%	
	29 - Teacher away (substitute)	0%	
16	30 - Lesson 19, Activity 1	64%	59%
	31 - TLP on mammals Graphing lesson	64%	
	<u>LOG OF FEBRUARY, 1990</u>		
17	1 - Charts & Graphs TLP on mammals	56%	63%
	2 - Students finish charts Lab & Activity Questions - Lesson 19 Four mammal worksheets assigned	100%	
	5 - TLP on mammals continued (organs & systems) Worksheet on mammals	0%	
18	6 - Students work on mammal worksheets TLP on greenhouse effect Graphing Lesson 21, Activity 1 and 2	90%	33%
	7 - Redo Activity 1 and 2 with materials	100%	
	8 - Video on "Wolverine"	0%	
	9 - Slides on ancient animals (paleozoic, mezozoic, cenozoic) Quiz on "Wolverine"	0%	

Table 7-17: continued



February Log (continued)PERCENTAGE OF TIME
SPENT ON PROJECT

19	12 - TLP: Experimental summaries, concepts, and review Draw heart	60%	} 40%
	13 - Students finish heart & brain drawing Demonstration on heat transmission (iron & glass) Demonstration on solar heater	60%	
	14 - Slides and quiz on fossils		
	15 - (Snow day - school not open)	0%	
	16 - (not present in class)		
20	19 - No school at Bath (President's Day)		} 82%
	20 - Weather review: Notes on greenhouse effect, convection box Fossil slides on vertebrates and invertebrates	50%	
	21 - Fossil review, questions 481 Experiment on heat absorption (land & water) Weather record	100%	
	22 - School cancelled (buses vandalized)		
	23 - Review on wind. Vocabulary words Review data on Wednesday's experiment Graphing, #20 Student Activity Guide Biology questions	100%	
21	26 - Review sheets for quizzes Student Activity Guide, Activity 3, Line Graph Video and review on "Birds of Prey"	36%	} 62%
	27 - Making concept maps	100%	
	28 - Work on concept maps	50%	
	Quiz "Birds of Prey"		
<u>LOG FOR MARCH, 1990</u>			
22	1 - (substitute teacher)	0%	} 56%
	2 - Quiz Work on concept maps	73%	
	5 - Notes Draw snake head Quiz Weather record	50%	
	6 - Posttest	100%	
	7 - Interview with Sarah		
	8 - Interview with Scott		
	9 - Interviews with Kathie and Steve		
	12 - Interview with Laura		
	13 - Interview with Brent		
	14 - Interview with Denise		
	15 - Interview with Roger		

Table 7-17: continued

APENDIX C Document 5

CLASS TIME USED ON PROJECT AT CRANSTON HIGH

THREE DAY SEGMENT	CLASS TIME IN PERCENT
=====	=====
1 :	93
2 :	0
3 :	0
4 :	0
5 :	67
6 :	33
7 :	50
8 :	43
9 :	0
10 :	83
11 :	33
12 :	20
13 :	17
14 :	9
15 :	50
16 :	59
17 :	63
18 :	33
19 :	40
20 :	82
21 :	62
22 :	56

Table 7-18: Three Day Segment Summary

APPENDIX C - Document 6

ANALYSIS OF TIME BY ACTIVITY TYPE
Cranston High School

LESSON NUMBER	DEMO	READING	EXPER DEVELOP	WRITTEN WORK	LECTURE NOTES	REVIEW QUIZ
1	/	/	/	/		/
2	1/8=13%	2/8=25%	//	1/8=13%		2/8=25%
3		/	2/8=25%			/
4			/		/	
5			/		1/4=25%	
6			3/4=75%			
7		/	/	/	/	/
8		2/10=20	1/10=10%	/	/	3/10=30
9			/	2/10=20%	2/10=20%	/
10		/	3/5=60%			/
11		1/5=20%	//			1/5=20%
12			/			
13		/	/	/	/	/
14		/	/	/	/	/
15		2/7=29%	1/7=14%	1/7=14%	2/7=29%	1/7=14%
16			/	1/3=33%		
17	1/3=33%		/	/		
18	/		1/3=33%			
19	3/15=20	1/15=7%	/	/	/	/
20	//		5/15=33%	3/15=20	2/15=13	1/15=7%
21	/	/	//	/	/	/
22			/	/		
23			//	/		
24			3/5=60	2/5=40		
	demo	read	exper	written	notes	quiz

Table 7-19: Analysis of Time by Activity: Weather Unit

APPENDIX C Document 7ANALYSIS OF ACTIVITY TYPE
Cranston High School

PERCENTAGE

THREE DAY DEMONSTRATION SEGMENT	READING	EXPER DEVELOP	WRITTEN WORK	LECTURE NOTES	REVIEW QUIZ
1	13	25	25	13	0
2	0	0	75	0	25
3	0	20	10	20	20
4	0	20	60	0	0
5	0	29	14	14	29
6	33	0	33	33	0
7	20	7	33	20	13
8	0	0	60	40	0

ANALYSIS OF ACTIVITY TYPE (by Raw Scores)
Cranston High School

THREE DAY DEMONSTRATION SEGMENT	READING	EXPERIM DEVELOP	WRITTEN WORK	LECTURE NOTES	REVIEW QUIZ
1	1	2	2	1	0
2	0	0	3	0	1
3	0	2	1	2	2
4	0	1	3	0	0
5	0	2	1	1	2
6	1	0	1	1	0
7	3	1	3	3	2
8	0	0	3	2	0

Table 7-20: Activity Type Summary-Raw Scores & Percent

APPENDIX C - Document 8aINTERVIEW PROTOCOLPART I: WEATHER UNIT

Interviews are conducted before and after teaching the unit on weather. The interviews are conducted with each student alone in a room away from the classroom. The questions are asked by the interviewer, the student answers orally, and the interviewer notes the answer in written form on the interview sheet. Each interview is taped for later verification.

A. The purpose of the interview is introduced as follows:

"We are in the process of developing some new courses and written textual material for high school science classes. We need your help to understanding two things:

1. How much students already know about weather.
2. What kind of explanations students give regarding various weather phenomena.

This interview is taped so I can later check if I accurately wrote down the ideas that you have shared with me. You will also be interviewed after this unit is over to see how much your ideas have changed."

B. Procedure:

The interviewer reads each question with the student, allows the student time to respond, and notes a summary of his answer on the interview form.

PART II: MOTIVATIONA. Opening Statement:

"In this next part, we are interested in how you think and feel about science. We will read each question together and then you are to mark your answer."

B. Procedure:

Each question is read orally, the interviewer asks the student if the question is clear, and then shows the student where and how to mark the answer.

Figure 7-17: Protocols: Interview, Time Analysis

APPENDIX C - Document 8b

TIME ANALYSIS PROTOCOL

For an activity to be classified as 100% project material, it had to include:

- a) Same purpose - such as teach students how to lay out the two axis on a graph
- b) Same topic and content - such as weather forecasting
- c) Same activity type - graphing, observing & recording data, answering questions from text
- d) Same teaching methodology - seatwork, lecture, lab investigation, discussion
- e) Same information source - such as text, teacher, video, experiment

If the activity has the same purpose, content, text, but differs in methodology and activity type, it would be rated as 60%

If an activity has the same content, but differs in purpose, activity type, methodology, and information source, it would be rated 20%

Figure 7-17: continued

APPENDIX C Document 9aINTERVIEW QUESTIONS - PERSONAL PERSPECTIVE

Name of Interviewee:

Date of Interview:

Interviewer:

SCIENCE

1. Do you like science?
2. Do you feel that what you learn in science is worthwhile
--that it will help you some day?
3. Is the material you are learning in science important?
4. Is science hard for you?
5. What part give you the most difficulty?
6. What part do you enjoy the most?
7. Do you feel that the science you are learning is
challenging or is it too easy? --- Like some students
say "babish"?

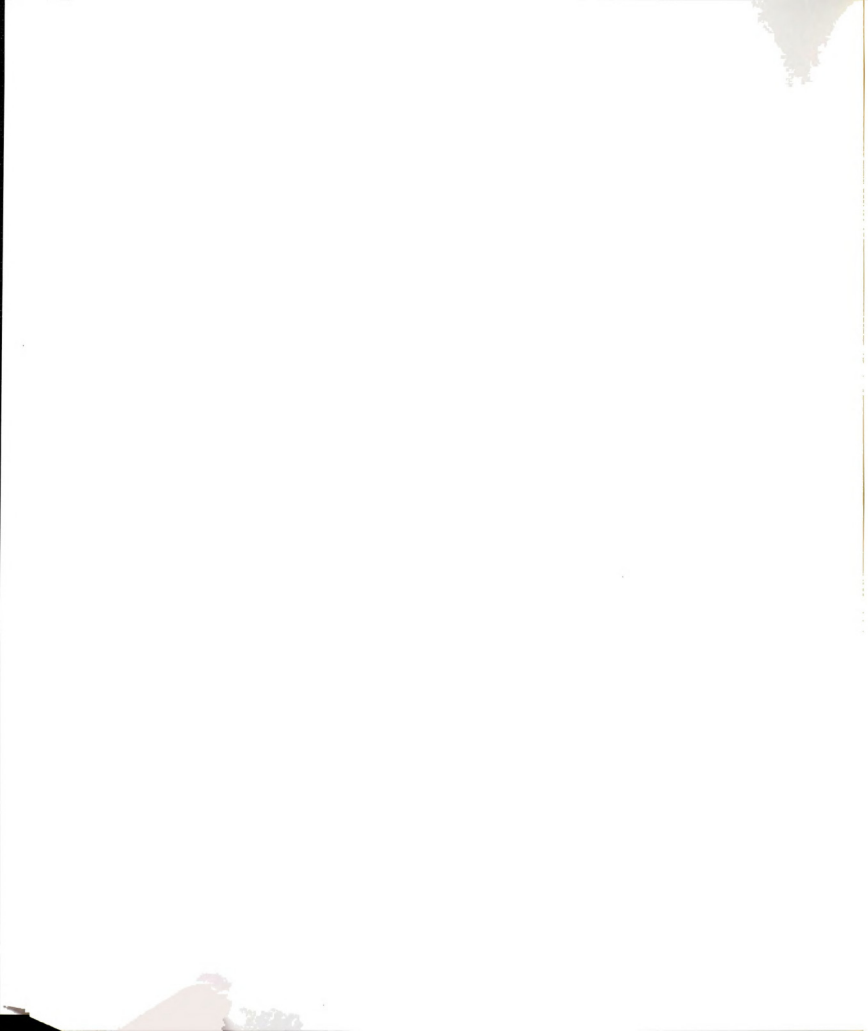
Note: This form was used at the beginning of the unit

Figure 7-18: Interview Questions

LEARNING

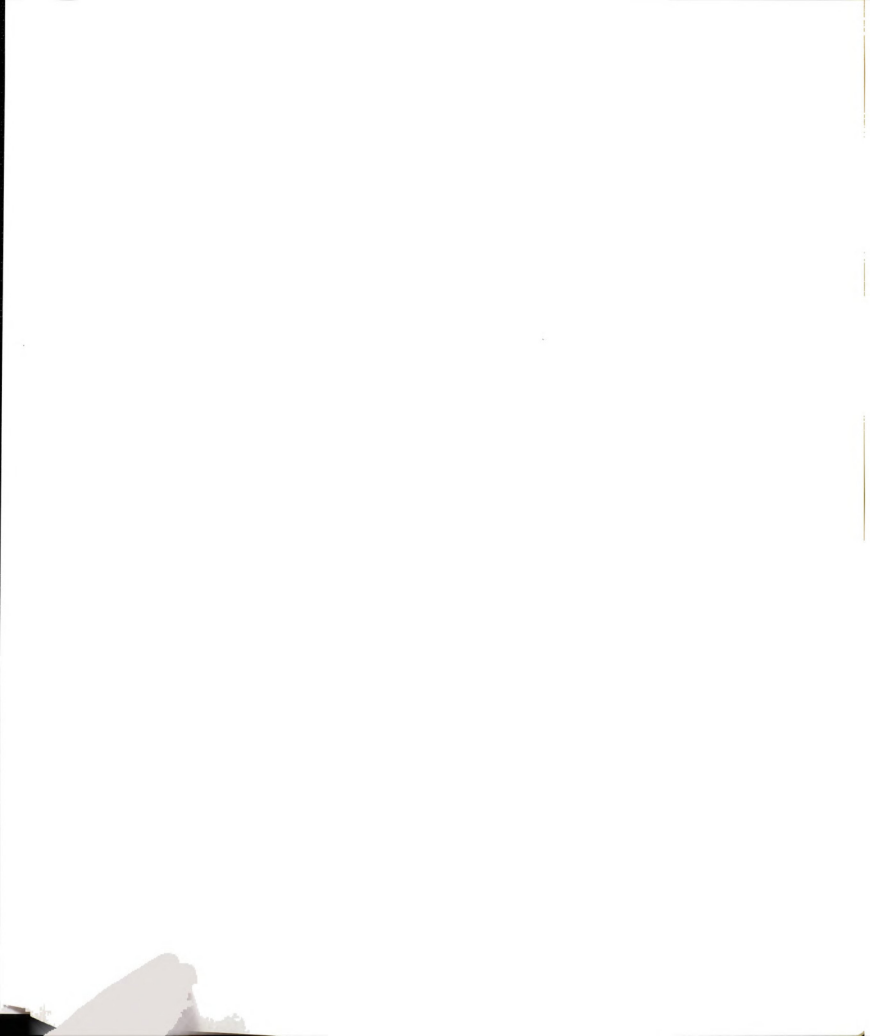
1. What makes the greatest contribution to your learning and understanding science?
2. Think of the various things the teacher does in the classroom. What teacher activities help you the most in learning
3. Why do some students do poorly in school?
4. Why do other students do so well in school?
5. Does hard work in school pay off? If you put more effort into school, will your grades get better?
6. What kind of effort do you put in? --- Average, your best, little?
7. What helps you learn the most?
8. What about a teacher makes a good teacher?
9. Who would you consider the best teacher in the school?
Why?

Figure 7-18: continued



THE STUDENT

1. How do you rate yourself as a student? Are you a good student, average student, or does learning come hard for you?
2. Have you ever received any A's on a report card?
3. Some students get A's on their report card, some get B's, and some students get an occasional F. What do you think makes the greatest contribution to success in school?
4. Will you be taking chemistry and physics in high school?
5. What math are you now taking?
6. How hard do you try? (Your best, average, little effort)
7. Have you ever tried your best and still have done poorly?
8. What do you plan to do after high school?
9. What would you like to do when you finish school?
10. How do you see your own capabilities? Do you feel you can be successful in school or do you sometimes get quite frustrated?
11. How much homework do you do each night?
12. Do you usually complete all the homework assigned?



SCHOOL

1. Do you like school?

Why?

3. What makes a person rate around this school with the other students? Who are the popular students?

3. How do you fit in at this school? Do you feel you are accepted by the other students?

By the teachers?

4. How do you think that the teachers at this school see you? What do they think of you?

5. What is the hardest part of school for you?

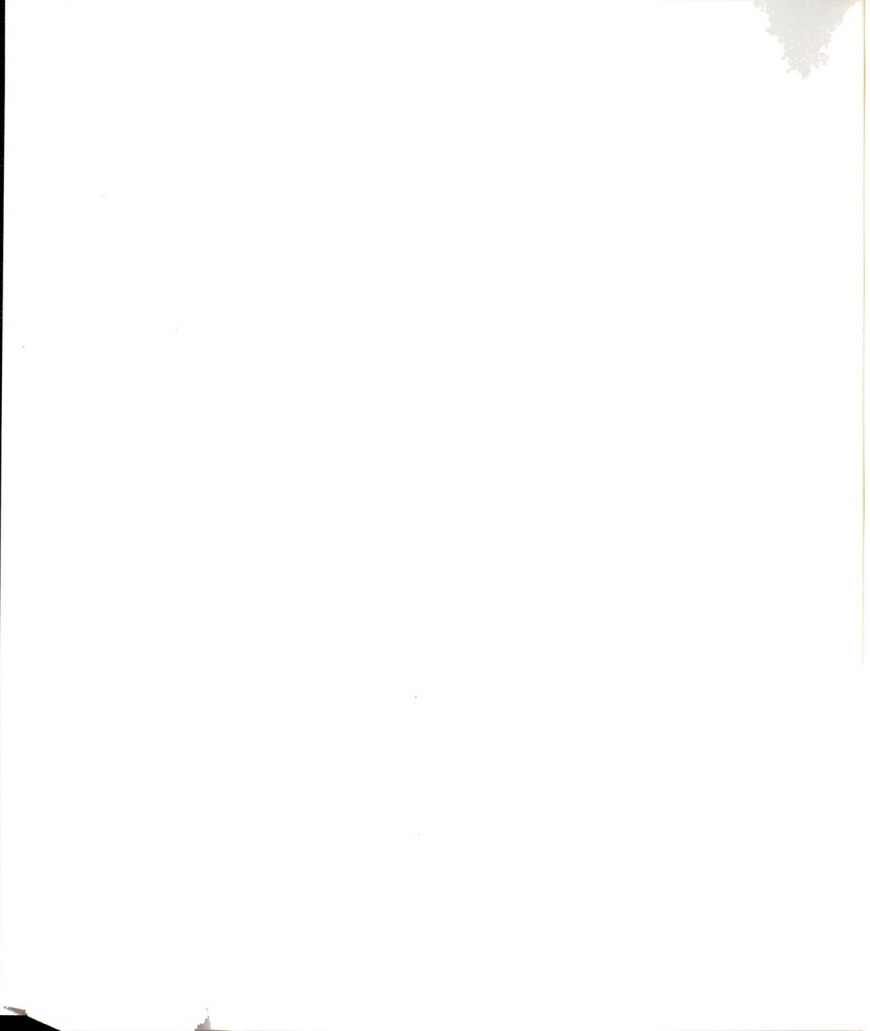
6. What part of school gives you the greatest reward, or the best feeling?

7. What is the easiest part of school for you?

8. If you look back at your school career, which were the best times?

9. What is important to students here at this high school?

10. How do most of the students view a person who really works hard at studies? Are they respected or considered sissy?



APPENDIX C Document 9bINTERVIEW QUESTIONS - PERSONAL PERSPECTIVE

Name of Interviewee:

Date of Interview:

Interviewer:

GENERAL QUESTIONS

1. How do you feel about the weather unit? Tell me what you think?

2. How was this unit different from other science you have taken in high school?

SCIENCE

1. Did you like weather unit? What especially?

2. Do you feel that what you learned in Weather was worthwhile - that it will help you some day?

How?

3. Is the material you are learned in weather important?

Like what? In what way?

4. Was weather hard for you?

Challenging?

Encouraging?

Discouraging

5. What part give you the most difficulty?

6. What part do you enjoy the most?

7. What did we do in weather that helped you understand what what going on.

LEARNING

1. What makes the greatest contribution to your learning and understanding science? Do you see anything differently now than before we did the weather unit?
2. Think of the various things we did in the weather unit. What activities helped you the most in learning
3. Have you done graphing before?
What do you think of the graphing?
4. Have you done concept maps before:
What do you think of concept maps?

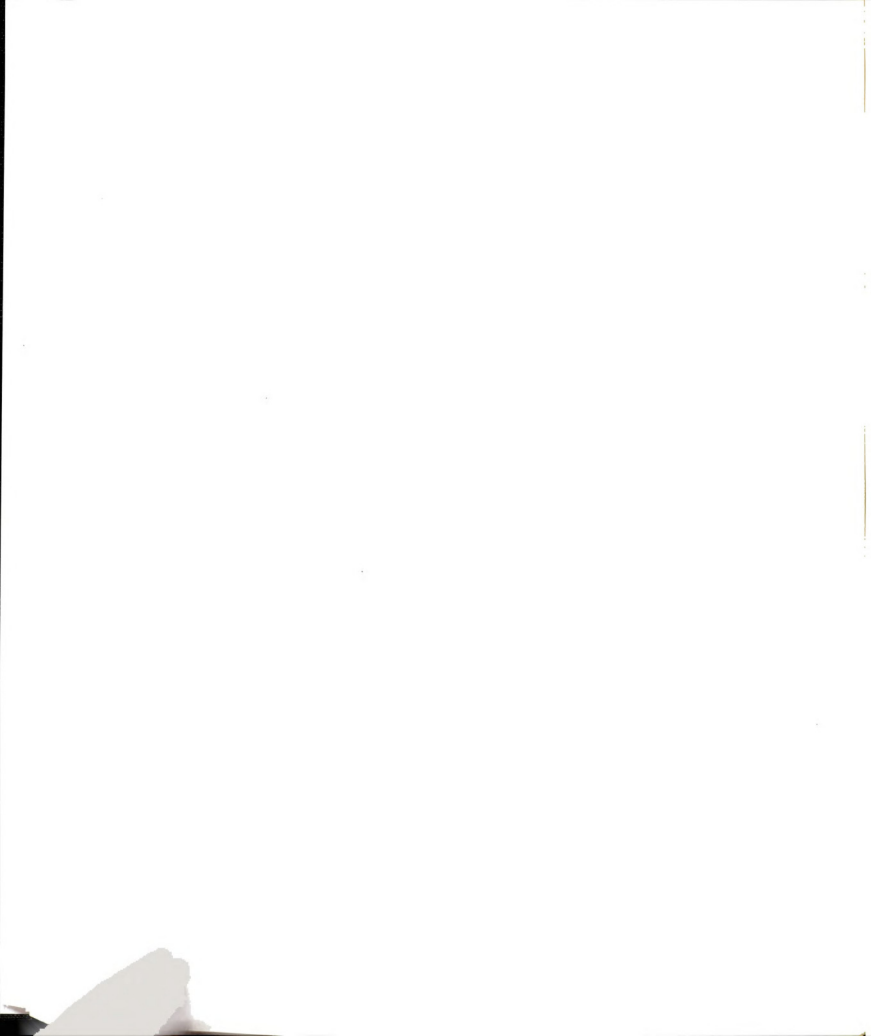
THE STUDENT

1. Do you more confident in your ability to now do science?
2. Do you now feel more confident in your ability to understand science?

FURTHER PLANNING

1. Do you have any advice for us as we write new materials for students in high school?
2. If you were a science teacher, what would you do to help your students learn?

Figure 7-18: continued



APPENDIX C Document 10a

PART TWO - SCIENCE AND ME

Pretest tabulation

1. For me science in school is ..

Scale	very hard	2	3	4	very easy
Responses	1	3	9	7	1

2. I am able to understand ----- of the material in science.

none	little	some	most	all
1	2	3	4	5
0	0	8	10	2

3. In the next grading period I expect to get a grade of ...

F	D	C	B	A
1	2	3	4	5
0	0	4	10	6

4. I find that ----- science makes sense to me.

no	little	some	most	all
1	2	3	4	5
0	1	7	12	0

5. During a science period I am usually able to complete ----- of my work.

none	little	some	most	all
1	2	3	4	5
0	1	2	8	9

6. I can do my science homework alone ----- of the time.

none	little	some	most	all
1	2	3	4	5
0	2	4	9	5

7. In school science is my ----- subject.

hardest	average	3	easiest
1	2	3	5
0	3	12	1

N = 20

Table 7-21: Pretest Tabulations

APPENDIX C Document 10b

INTERVIEW DOCUMENT NO. 2 - MOTIVATION

(Pretest Tabulation)

Directions: Finish the following sentence by marking the best position below.

PART ONE - WHAT'S THE GOOD OF IT?

1. The material we are now studying in science will be of help to me some day:

not at all		somewhat		very much
1	2	3	4	5
0	5	10	4	1

2. The material we are now studying in science is important:

not at all		somewhat		very much
1	2	3	4	5
0	1	10	6	3

3. The material we are now studying in science is useful to:

no one		a few people		most people
1	2	3	4	5
0	2	6	9	3

4. The material we are now studying in science will be used by me some day:

never		a few times		very often
1	2	3	4	5
0	7	8	4	1

5. The material we are now studying in science will be most valuable to:

everybody else		some others		Only me
1	2	3	4	5
2	4	12	2	0

N = 20

Table 7-21: continued

APPENDIX C Document 11

SCIENCE PERCEPTIONS: PART ONE - WHAT'S THE GOOD OF IT?

(Posttest Tabulation)

Directions: Finish the following sentence by marking the best position below:

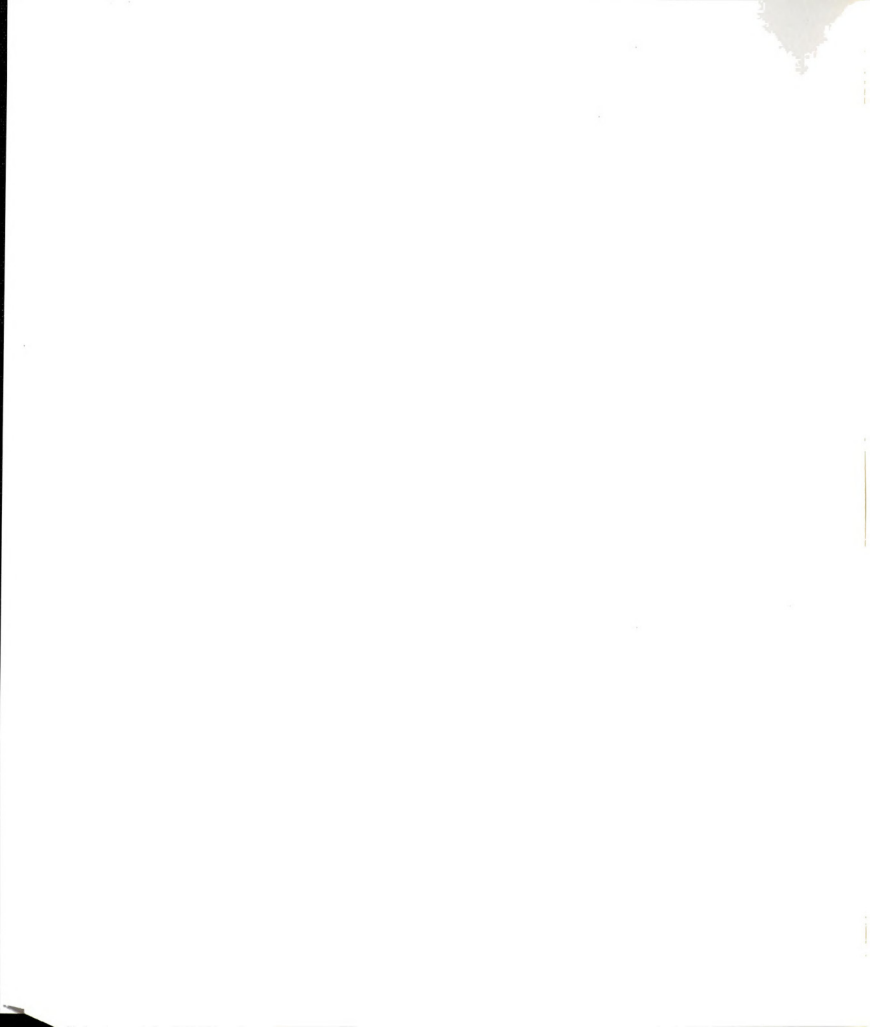
1. The study of weather will be of help to me some day:
 not at all 1 2 3 4 5
 1 2 15 7 2
2. The study of weather is important:
 not at all 1 2 3 4 5
 1 11 6 6
3. The study of weather is useful to:
 no one 1 2 3 4 5
 6 9 7
4. The study of weather will be used by me some day:
 never 1 2 3 4 5
 3 1 9 9 2
5. The study of weather will be most valuable to:
 everybody else 1 2 3 4 5
 6 10 2

PART TWO - DOES IT MAKE SENSE?

1. For me science in school is ..
 very hard 1 2 3 4 5
 13 8 2
2. I am able to understand ----- of the material in science.
 none 1 2 3 4 5
 2 15
3. Concept maps help me to understand:
 not at all 1 2 3 4 5
 1 3 6 9 4
4. I find that weather makes ----- sense to me now.
 no 1 2 3 4 5
 11 11 2
5. Graphing helps me make sense of our weather recordings:
 not at all 1 2 3 4 5
 5 12
6. How do each of these best help you understand weather? Rank them 1 to 6
- | | | | |
|---------|-------------------------|----|--|
| Ranking | 2 a) concept maps | 9 | } students marking these items #1 and #2 |
| | 3 b) class discussions | 8 | |
| | 4 c) making graphs | 7 | |
| | 6 d) reading the book | 2 | |
| | 5 e) the weather record | 3 | |
| | 1 f) doing experiments | 14 | |

7. In school science is my ----- subject.
 hardest 1 2 3 4 5
 2 10 12

Table 7-22: Posttest Tabulations



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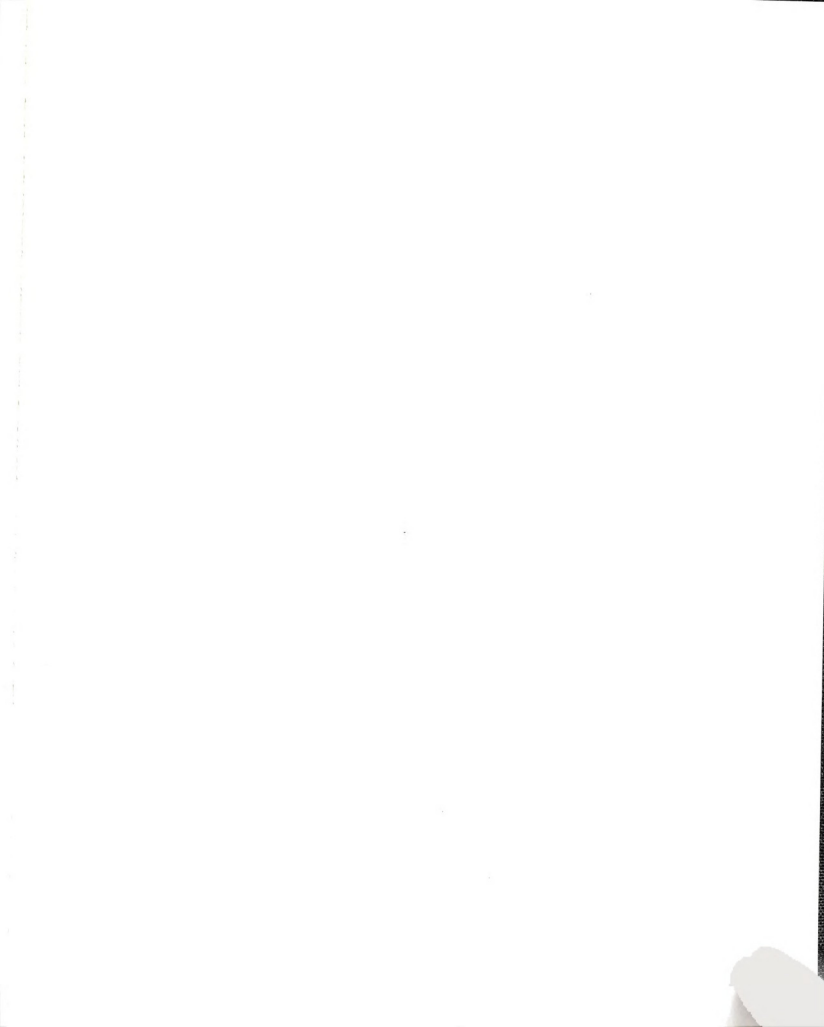
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