THE EFFECTS OF A COOPERATIVE LEARNING INSTRUCTIONAL STRATEGY ON THE ACADEMIC ACHIEVEMENT, ATTITUDES TOWARD SCIENCE CLASS AND PROCESS SKILLS OF MIDDLE SCHOOL SCIENCE STUDENTS

DISSERTATION

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By

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Stanley L. Helgeson
Advisor
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To
The Memory of Dr. Patricia E. Blesser,
and
to
Rajiv, Raghav, Mama, Papa, and Kavita
for your never ending support
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CHAPTER I
INTRODUCTION

INTRODUCTORY COMMENTS

Two heads are better than one.
The power of cooperative interaction is well known according to Johnson, Johnson and Smith (1991).

In his seminal work on successful people, Think and Grow Rich, Napoleon Hill (New York: Hawthorne, 1966) continually emphasizes that the most effective method for generating creative thinking is to have several people focus cooperatively on the same problem. Hill refers to this technique as the "mastermind method." In a more recent best seller, Seven Habits of Highly Effective People, Stephen Covey (New York: Simon and Schuster, 1989) identifies the sixth habit as developing a "synergy" or interdependent relationship between two or more people. Such a group will prove noticeably more productive than the same number of people working individually (Johnson, Johnson and Smith, 1991, Foreword).

There is an ongoing effort in education today among teachers specifically in curriculum development, to improve methods of instruction to promote the development of higher academic skills in students. This has led to the development of instructional methods that seek to have the students engaged in the active pursuit of knowledge rather than have the information presented to them orally or through demonstrations by the teacher. Pursuit of knowledge should bear some of the critical features of scientific investigation such as identification of research problems, hypothesis formation, and the
collection and interpretation of data. In general, along with inappropriate curricular materials, low motivation, low self-esteem, poor attitudes, and a competitive classroom environment can have a detrimental influence on academic achievement.

Today more and more teachers are looking to move away from traditional teacher-directed instructional methods and to evolve an instructional strategy that allows greater student participation. It is in the conservative method that teachers become the vocal components of the classroom and the students are passive listeners. One innovative instructional strategy which seems to be getting a lot of attention is cooperative learning. The proponents of this learning strategy are David Johnson and Roger Johnson (1978) and Robert E. Slavin (1983a). They defined a cooperative learning strategy as one where the goals of learning can be achieved by the students only when they work together. In science, especially where students are grouped and made to work together, the aim is to help them discover the intricacies of the subject matter together and lead them to develop inquiry oriented minds. The traditional school setting does not prepare students for work and social tasks they will face as adults. Cooperative learning can help students interact with each other, generate alternative ideas, and make inferences through discussion. In cooperative learning, students must share materials and help one another to discover knowledge together. They can thus learn the value of interdependence. Since there is a group goal to be achieved, success is dependent on both individual and cooperative success. Cooperative learning in small groups encourages students to help each other. This social interaction can exert positive effects on students' motivation to learn, on their
self esteem, and on their perception of the classroom environment.

Cooperation involves more than merely working along with other students. It involves discussions, group discoveries, helping each other, and sharing materials. Through cooperative learning students learn the value of interdependence. There is a group goal to be achieved, so either the whole group fails or succeeds. In cooperative learning, especially as characterized by inquiry oriented discussions, members of the group share their perspectives, argue their points of view, and very often modify their opinions. In cooperative learning, students work in small, mixed abilities, inter-racial, heterogeneous groups. Small groups of three to five students cooperate in achieving identified cognitive learning objectives. Through cooperative learning, students achieve the benefits of social participation. Johnson, Johnson, Holubec, and Roy (1986, *Circles of Learning: Cooperation in the Classroom*, p. 8) characterized cooperative learning by four basic elements. These are: (1) positive interdependence; (2) face to face interaction; (3) individual accountability; and (4) the appropriate use of interpersonal and small group skills. Positive interdependence is achieved through mutual goals (goal interdependence); division of labor (task interdependence); and through the sharing of materials, resources, and ultimately, rewards. For a learning situation to be cooperative, students must perceive that they are interdependent on each other. Cooperative learning also requires face to face interaction amongst students. Individual accountability is ensured by making each group member responsible for maximum achievement in his/her task. Finally, cooperative learning requires that students appropriately use their interpersonal group skills to process information and accomplish the task.
PROBLEM STATEMENT

The aim of this study is to determine whether the use of a cooperative learning instructional strategy will result in greater levels of student academic achievement (conceptual knowledge and application), process skills (procedural knowledge), and positive attitudes toward science class, as compared to a traditional instructional strategy. A secondary purpose is to determine whether there are any gender differences in the academic achievement, process skills, and attitudes towards science class.

NEED FOR THE STUDY

Johnson, Johnson and Smith (1991) relate the story told by Aesop to illustrate the benefits of working in a group:

The story is of a man who had four sons. The father loved them very much, but they troubled him greatly for they were always fighting with each other. Nothing the father said stopped their quarreling. "What can I do to show my sons how wrong it is to act this way?" the father thought. One day he called his sons to him and showed them a bundle of sticks. "Which of you, my sons, can break this bundle of sticks?" he asked them. All the boys tried in turn, but not one of them could do it. Then the father untied the bundle and gave each son a single stick. "See if you can break that," he said. Of course, they could easily do it. "My sons," the father said, "each of you alone is weak. He is as easy to injure as one of these sticks. But if you will be friends and stick together, you will be as strong as the bundle of sticks." (p.15)

The instructional system or the means by which information and skills are transmitted to the students is the critical feature of a school organization (Slavin, 1983a). All other elements of the school must ultimately be directed at making instruction as effective as possible for all students (Slavin, 1983a, p. 1).
If students are not motivated to learn, the instruction may not yield results. In the traditional instructional system teachers use some combination of lectures, assigned individual tasks, and administer individual tests. Students are rarely allowed or encouraged, to help each other in academics or even interact socially in the classroom. Because of this lack of student-student interaction, traditional task structures become less optimal for student achievement (Slavin, 1983a). In a traditional classroom students get little opportunity to participate in the learning process.

"Science and mathematics phobia is not an inherited tendency, it is created." (Dodd, 1992, p. 296). It can be created when teachers place too much emphasis on memorizing formulae and applying rules. When teachers do not realize the critical connection between students' academic performance and their feelings about the subject matter being studied or about themselves, they are inadvertently fostering the development of a science phobia (Dodd, 1992). The adoption of more personal and process oriented teaching methods can help in solving this problem as well as increasing students' self-confidence and self esteem. One way teachers can help students develop more self-confidence is by finding ways to help them experience success (Dodd, 1992). As students realize that they can learn new concepts, self-confidence increases which in turn may lead to a higher level of competence. Cooperative learning can also help remove loneliness which may prove to be another barrier to learning (Dodd, 1992).

When students believe that they are the only ones who do not understand the subject matter they may just suffer in silence rather than risk looking stupid by asking a question. Lack of confidence, anxiety and loneliness are intricately interwoven and all can affect motivation for learning (Dodd, 1992, p. 296).
Cooperative learning is a technique in which student-student interaction is facilitated and thus students can take active part in learning and participate actively in ongoing activities. Since there is interdependence among group members, it is hoped that all individuals are participating actively in the learning process. Since there is a group task to be completed, motivation to achieve could be enhanced resulting in greater student learning, better grades, and ultimately resulting in improved attitudes toward the subject matter being learnt.

DEFINITION OF TERMS

Cooperative learning is an instructional format in which students work together in small groups to achieve a particular goal or task (Hassard, 1990, p. 30). It is characterized by four elements which are student interdependence, face to face interaction, individual accountability, and the appropriate use of interpersonal and small group skills.

In this study, the cooperative learning experience included group learning along with hands-on, and inquiry enriched experiences. The students shared resources and completed their tasks in groups. The teacher in a cooperative learning classroom served more as a facilitator of learning than a mere dispenser of information. Review of subject matter encountered in the tasks involved questioning of the students and leading them to the correct answers. The grade of the students included points for group work as well as his/her score on the tests.

A traditional method of instruction refers to an instructional strategy where the teacher is the main source of information and students work individually, to complete class and home-work assignments. Here the teacher served as the
main source of information and there was minimal student-teacher and student-student interaction. Groups of four students shared the resources for the tasks, however they completed their assignments individually. The task for this group also involved inquiry and hands-on experiences.

Review of material involved lectures given by the teacher on the subject matter. The final grade of the student was his/her score on the test.

**Academic Achievement** refers to the scores obtained by the student on a teacher constructed test on the subject matter. The test was aimed more toward conceptual understanding with questions which test conceptual knowledge as well as application of those concepts, than toward mere recall of facts or a test of memorization abilities. The test emphasized theoretical and conceptual knowledge and did not include procedural knowledge.

**Attitudes toward science class** refers to the general attitude of students toward science class instruction in school. It is measured by scores obtained on an instrument specifically developed to measure such feelings.

**Process skills** refers to the scores on a test designed to measure the ability to perform activities like identifying experimental questions, identifying variables, formulating hypotheses, designing investigations, graphing data, and interpreting data. Thus, it is a test of some components of procedural knowledge.

**RATIONALE BEHIND THE USE OF COOPERATIVE LEARNING IN SCIENCE EDUCATION**

Research on cooperative learning strategies has been done from two major theoretical perspectives - developmental and motivational (Slavin,
1987a). Slavin says that the developmental perspective assumes that the interaction between students during cooperative learning increases maturity of theoretical concepts or skills. The developmental theory is developed from Vygotsky and Piaget's theory. The motivational theory is derived from the work of Lewin, Deutsch, Atkinson, and Skinner.

According to Vygotsky (1978), cooperative activity amongst children promotes growth because children of similar ages are likely to be operating on one another's proximate zone of development, modeling in the cooperative group behavior is more advanced than that performed as individuals. Vygotsky (1978) defined the zone of proximate development as the distance between the actual developmental level determined by independent problem solving and the level of potential development determined through problem solving under an adult's guidance. Piaget (1926) was of the view that social knowledge about language, morality, and values is learned mostly through interaction with others. He said that peer interaction is also important in logical mathematical thought, in dis-equilibrating the child’s egocentric conceptualization, and providing feedback to the child about the validity of the logical construction.

On the basis of this theory, Slavin (1987a) says that most Piagetians like Murray (1982) and Wadsworth (1984) have called for an increase in cooperation amongst students in schools. Student interaction during learning tasks can lead to improved student achievement. Cooperative learning helps students to learn from each other. While discussing with each other cognitive conflicts may arise which lead to development of reasoning skills and a higher quality of understanding of the subject.
The motivational perspectives concentrate more on the reward or goal structures under which a group operates. Deutsch (1962) identified three goal structures: cooperative, competitive, and individualistic. According to motivationalists (e.g., Johnson, Maruyama, Johnson, Nelson, & Skon, 1981; Slavin, 1983b) in the cooperative goal structure, the group member's attainment of individual goals is dependent on the success of the group as a whole. Therefore, group members learn to help their group mates and do whatever helps the group to succeed.

According to Slavin (1981), cooperative learning strategies vary in principal aspects of classroom organization, task structure, and reward structure. In cooperative learning, cooperative task structures are used in which students have to and/or are encouraged to work together. In some methods of cooperative learning each group member has a sub-task belonging to the task of the whole group, in others all students work together towards a group task. While any cooperative learning method uses cooperative tasks, the reward structure can vary. Rewards may be given to students on the basis of the group performance or group rewards may be given on the basis of the sum of individual learning performance. From the developmental perspectives cooperative learning is effective on student academic achievement because of the use of cooperative task structure, but from the motivational perspective cooperative learning emphasizes cooperative reward structure as a necessary element of cooperative learning. Therefore, according to Slavin (1987) cooperative learning improves achievement scores because the cooperative reward structure creates peer norms and sanctions supporting individual efforts.
The intention of all science teachers should be to ensure that students learn the concepts of science, not through memorizing but in a meaningful manner. Meaningful learning, according to Klausmeir, Ghatala, and Frayer (1974), promotes the usability of the concept. Students, after the class, should be able to (1) generalize what they learned to new situations; (2) recognize new concepts in a taxonomy as supra-ordinate, coordinates, and sub-ordinates; and (3) recognize cause and effect correlational probability and axiomatic relationships among concepts and solve problems involving the concept. All these characteristics apply to meaningful learning.

Deutsch (1962) felt that, since a goal inter-dependence exists within a group in a cooperative setting, psychological consequences of cooperation are substitutability, positive catharsis, and inducibility, meaning that instruction through cooperative learning can help shape student’s beliefs or behaviors, by helping them to see that their beliefs are reasonable and their behaviors justified.

LEARNING THEORY PERSPECTIVES

Cooperative learning refers to instructional methods where students are encouraged to work in groups on academic tasks, with a common goal. Group rewards and peer interactions are two constituents of cooperative learning. Cooperative learning strategies vary two principal aspects of the classroom organization: task structure and reward structure (Slavin 1977, 1980, 1983b). In a cooperative task structure, students are required to or encouraged to work with one another. These cooperative tasks can vary considerably in the degree to which they use the cooperative reward structure. The rewards may be
individual or group. In methods developed by Johnson and Johnson, students agree on common answers and are rewarded on the basis of the quality of group work. In Student Teams Achievement Divisions (STAD) (Johnson & Johnson, 1978) students study academic materials together, followed by teacher instruction and are then quizzed individually. The two elements that make cooperative learning effective are group rewards and individual accountability. Group rewards provide an incentive to the cooperating group to encourage and help the group members to do whatever helps the group to succeed. Individual accountability is achieved by calculating group scores based on the sum of the individual test scores. It ensures the participation of all group members in the task.

Taking into account the fact that cooperative learning is effective if a successful task is rewarded, it means that the reward acts as a stimulus to the pupil to lead to learning. Such a programmed strategy would then follow B. F. Skinner’s ideas (Goodlad & Hirst, 1989).

From a constructivist perspective all meanings are humanly constructed. In cooperative learning, the constructive process is a dialectical process among the group members. Individuals construct ideas themselves and are influenced by the meanings of ideas constructed by others. These meanings are organized into bodies of knowledge. The meanings which are finally formulated may be constrained by the physical and social environments of the individual. When this happens, the constructions or meanings are modified slightly to accommodate the constraint. This is what Piaget calls the process of accommodation.

The material studied in class through actual interaction can be much
more than words printed in a textbook. As seen in Belenky, Clinchy, Goldberger, and Tarule (1981), learners' abilities to learn depend in part on their views of themselves as people capable of making sense of the world and on the extent to which they perceive themselves to be connected to the content being learned and to the teacher. Reinforcing traditional ways of teaching may not lead to increased learning by the students. Piaget's and other constructivists' views of learning emphasize bringing out connections in learning such that scientific knowledge is actively constructed rather than being a mere presentation of facts. Raven (1974) gave recommendations for designing instructions to promote the acquisition of logical operations. He said that for this to occur instructional strategies must incorporate the active engagement of the student in using logical operations in the construction of rules and concepts. In this researcher's view, this is what happens in cooperative learning.

Cooperative learning, like the theory of constructivism, rests on two principles (Wheatley, 1991). First, knowledge is not passively received but actively built by the individual. Second, the function of cognition is adaptive and serves "the organization of the experiential world and not the discovery of ontological reality" (Wheatley, 1991, p. 10). From a constructivist point of view knowledge originates in the learner's activity. "To know is to act," or to know is to understand in a certain manner which can be shared by others who join with you to form a community of understanding (David W. Johnson, 1987, p. 206). When learners reflect on actions their knowledge becomes more powerful. That is why Piaget says that the process of reflective abstraction is the basis of learning. Knowledge viewed from a constructivist perspective is a
learner's activity. Constructivism considers science to be the activity of constructing relationships and patterns. This construction can be greatly enhanced by social interaction. In cooperative learning students are engaged in a collective effort for good performance. Learners assume the role of explorers and inventors. The classroom is a learning place, a place where there is active discussion taking place. The teachers are facilitators of learning rather than sources of information. It is through social interaction that students can be encouraged toward Bruner's (1961) discovery learning. Cooperative learning strategies ensure that students discover and design learning procedures themselves. Such an instructional strategy encourages the natural instinct in students to construct meanings. Students come to realize that they are capable of problem solving. Thus, students are motivated to focus on learning for learning alone. They become more task oriented as opposed to grade oriented. Cooperative learning may also be structured to involve the three phases of the learning cycle, i.e., exploration, invention, and discovery. Thus cooperative learning encourages the scientific inquiry process as well as both concrete and formal concept formation and subsequent application.

Thus, there is no doubt that even though children make sense of ideas themselves, socialization is a major factor for cognitive growth (Piaget & Inhelder, 1969). Participation in small group problem solving can stimulate cognitive disequilibrium such that a marked change in problem solving strategies of those children can be noticed after some time. Doise and Mugny (1984) showed that children working in pairs or groups produced more adequate solutions than when they were working alone. Thus it makes sense for children to work together. When children work together they are
stimulated by challenges to their ideas and thus recognize the need to reorganize and reconceptualize. Learning occurs best in the social context of the classroom and is heavily influenced by interactions among peers. Knowledge is constructed through these interactions and an exchange of ideas which can lead to the development of shared meanings.

**NATURE OF SCIENCE AND COOPERATIVE LEARNING**

Recent educational reports like *Science for All Americans* (Rutherford & Ahlgren, 1989), *Nation at Risk* (National Commission on Excellence for Education, 1983), *Educating Americans for the Twenty First Century* (National Science Board Commission on Pre-college Education in Mathematics, Science and Technology, 1983), have all advocated that children should understand the nature of science. But what is the nature of science? On one side *Science for all Americans* (Rutherford and Ahlgren, 1989) and *Science Objectives* (National Assessment of Educational Progress, 1990) propose a view of science that revolves around the methodology or process of science, i.e. it is from observations that scientists build theories. *Science Objectives* (National Assessment of Educational Progress, 1990) emphasizes scientific processes like classifying, inferring, interpreting data, formulating hypothesis, and designing experiments. This is the empiricist's philosophy (Collins, 1989). In *Science and Technology Education for Elementary Years* (National Center for Improving Science Education, 1989), the nature of science revolves around the theoretical and explanatory aspect of science. *Science for ages 5-16* (Department of Education and Science and the Welsh Office, 1988) does not define science by its methods but by the historical scientific endeavor. This means that one has
to recognize that ideas and theories will be changed when they come to be regarded as inadequate in a given context.

Science is a complex activity. As such science inevitably reflects social values and viewpoints (Rutherford & Ahlgren, 1989, p. 29). Whichever philosophy is followed, science is in fact knowledge that is constructed by humans to describe, understand, explain, predict, and control natural phenomena. Science can be viewed as having three components (Collins, 1989, p. 131), the structural, the procedural, and the human. The structural or theoretical component and the process or procedural component overlap each other. The third component which is a human or social component overlaps both the structural and procedural components. The theoretical component is the knowledge base which includes facts, concepts, relationships, principles, theories, phenomena, and models. Facts are empirical statements that describe observable events. Concepts are formed by creating relationships or providing meaning from information received by sensory input. Concepts may be empirical, i.e., formed from observations, or they may be abstract, i.e. formed from imagination for the purpose of prediction and explanation. The process component of science includes measuring, classifying, critical thinking, problem solving, and other inquiry related skills (Collins, 1989). But basic to both these components is the human or social component. Science is not a solitary enterprise. Because scientific knowledge is a human construct, it is tentative. Ideally, science should not be broken up into its components. However, these components must be recognized especially in the classroom environment. Learning should be structured so as to capture the complex dynamic and human characteristics of science. Science learning should involve
all three components. A balanced approach to teaching science should provide students with opportunities to develop skills as well as construct and evaluate their own knowledge. Fig. 1 shows the three components of science in the form of three circles. The three circles are not separate. What is significant here is that both the conceptual and procedural components of science have in common a social element. Thus it follows that because the social element is integral to the nature of science, cooperative learning could be a logical way of teaching science.
Fig. 1: The Components of Science. (Adapted from "Components of Scientific Understanding", Angelo Collins, 1989, p. 135)
PERSPECTIVES ON ATTITUDES IN SCIENCE EDUCATION

Science as a successful enterprise needs the good disposition of its learners toward it. The development of favorable attitudes toward science should be one of the major aims for science teachers. Students attitudes can be affected by, among other things, strategies employed in teaching and learning the subject. One of these strategies can be change in the method of instruction. Learning outcomes can be in the cognitive, affective, and psychomotor domains of learning (Bloom, 1956; Krathwohl, Masia & Bloom, 1964; Simpson, 1966, in Bemis & Schroeder, 1969). Components of the affective domain include attitudes and interest. The work of Walberg (1969) has demonstrated that the classroom environment is a predictor of both affective and learning outcomes. They say that cognitive aspects of the learning environment are better predictors of cognitive outcomes and affective aspects are better predictors of affective outcomes. The classroom is the basic structure of the educational system. It is the place where interactions among the students, teachers, peers, and curriculum take place. It is also the place where learning takes place. These interactions create an environment that affects attitudes in students.

In science education today the term attitude has ambiguity. Blosser (1984) says the definition or construct of attitude related to science is vague and inconsistent. Several definitions of the term have been given. Oskamp (1977) called attitude an intervening variable which is not observable in itself but helps to explain or mediate the relationship between certain observable stimulus events and certain behavioral responses. Gardner (1976) thinks that attitude can serve as a predictor of subject choice of the future. Sorenson and
Voelker (1972) feel that attitude in science is important because it helps the student to understand the relation between science and society. Lawrenz (1975) identified increased achievement and improvement in students' attitudes as two desirable consequences of science education. Olairewaju (1988) says that Oskamp, Gardener, and Sorenson and Voelker consider attitude to be a process while Lawrenz places attitude in the position of an end product.

Defining what is meant by attitudes toward science is the main cause of discrepancies in attitude research in science education. Fishbein and Ajzen (1975) defined attitude as a learned disposition to respond consistently favorably or unfavorably toward an attitude object. Shrigley (1983) says, in the beginning, attitude was considered to be the readiness to respond. Then it was defined as a motor readiness or vigilance. Fleming (1967) credited Darwin with first associating emotion with attitude. But here emotion was integrated into the concept of motor behavior and the role of mental readiness was ignored.

Rom Harre in *The Social Construction of Emotion* (1986) has also linked attitude to emotion. He says that emotion is a "response suffered by a passive participant in some emotive event and is itself part of the social strategies by which emotions and emotional declarations are used by people in certain interactions" (Harre, 1986, p. 5). He goes on to say that the dominant contribution to this emotional state comes from the social world by way of its linguistic practices and moral judgments. Attitudes in the emotional theory are derived from two theories which define attitudes to be an emotion-state or an emotion-act.

The proponents of the naturalistic theory endorse the view that different
emotions share the same natural cognitions. They define attitudes to be an emotional state encompassing all social and cognitive knowledge. "Sociocultural variables in this theory have only a peripheral influence, for example, in controlling the intensity of the response or the manner in which it is displayed" (Harre, 1986, p. 39). The beliefs, evaluations, and attitudes involved in the emotion are cognitive and depend upon the person's knowledge and his/her capacity to judge and compare. Emotions in this theory are dependent on cognitions. Harre (1986, p. 42) says that, because emotions are constituted by particular conjunctions of attitudes, they are complex phenomena. This characterization of emotion as attitudinal and cognition dependent is crucial to the constructionist principle of emotions as socioculturally acquired responses. Thus, elements constitutive of the emotion are capable of being acquired by the person, and go beyond being a matter of perception followed by sensation. In the case of emotions, factors like behavior and attitudes are ontologically constitutive of an emotion feeling (Harre, 1986, p. 47). Harre (1986) gives the example that the feeling of "joy" is not ontologically distinct but constituted by those thoughts which provide the particular content of the attitudes to which "joy" is conceptually related and the term "feeling" refers to those attitudes which are constitutive of feeling joyful. The term "feel" is used for occurrent emotions, or to express uncertainty as to whether we should be in a particular emotion state or simply to give a performatory role to the expression. Constructionists unite the two concepts discussed above and explain emotions as culturally constituted responses which are simultaneously experiential and performatory. Thus, according to constructionists, attitudes are emotion acts (Harre, 1986). They differ from
naturalists in regarding emotions not as natural responses stimulated by natural situations but as socioculturally determined patterns of experience and expression which are acquired and expressed in certain social situations (Harre, 1986).

In conclusion, attitudes are learned and information acquisition is central to attitudinal change. Attitudes involve the process of cognition. It is cognitive dissonance that leads to attitudinal change. Attitudes find their source in that knowledge that helps in the better understanding of the phenomena involved. Attitudes explain the tendency of the individual to behave in a certain manner in response to a certain event. Thus attitude predicts behavior. Fishbein and Ajzen (1975) suggest a probabilistic relationship between science attitude and behavior, instead of a one to one relationship. Attitudes are affected by the social influence of others. Asch (1966) suggests that attitudes serve to interpret current events in our lives. The concept of attitude gives the personality an anxiety and readiness to respond. In fact as far back as 1939, Goldstein defined anxiety as the loss of attitudinal capacity. However, the characteristic most unique to the concept of attitude is the fact that it is evaluative. Because of its evaluative component, the preferential posture or the tendency to be for or against a particular object, event, or person can be measured (Shrigley, 1983). The evaluative component differentiates attitude from belief which has only a cognitive element. Attitudes involve emotions, are acquired by the process of learning and are therefore cognitive, but their manifestation is evaluative. As described earlier, attitudes are psychological reactions that are constructed as environmental or social reactions.
Attitude has two determinants: first is the affective component or the evaluation toward performing a behavior and, second, a subjective norm which is the social influence of others on our behavior (Shrigley, 1983). Since social influence is thus central to the definition of attitude, the conceptual validity of attitude scales would be enhanced if they included statements testing social influence.

Attitude for this study is defined as "the affect for or against a psychological object" (Thurstone, 1931, p. 261; Fishbein, 1967a; Fishbein, 1967b; Mueller, 1986).

This is a unidimensional concept of attitude as opposed to the multidimensional viewpoint promoted by many psychologists that includes the components of beliefs and behavioral intentions as well as affect. Fishbein (1967a; 1967b) argues in favor of the unidimensional construct. In his view, beliefs and behavioral intentions are determinants of attitude. Furthermore attitude studies can be made more productive by viewing attitude as an affect and by considering the other two components to be related to attitude (Germann, 1988, p. 693).

Because attitude is a complex construct and influenced by many variables this study attempted to restrict itself to the measurement of a general attitude toward science as a subject area.

A graphical representation of the ideas presented in the preceding pages is given in Fig. 2. The essential components of cooperative learning are depicted in the petals of a flower. The center represents the different outcomes of cooperative learning. The stalk which holds the flower contains the motivational and affective components involved in cooperative learning. Thus based on the different ideas discussed in the preceding pages it can be premised that interdependence structured amongst students can determine
how much and how well they interact with each other which in turn can largely determine their motivation to achieve, their attitudes, and ultimately the instructional outcomes.

Fig. 2: A Graphical Representation of the Factors Involved in Cooperative Learning
RESEARCH QUESTIONS

Much of the research has been conducted to show how cooperative learning contributes to student achievement at the elementary level. Also, cooperative learning has been shown to improve self esteem and inter-racial relations (Slavin 1980). If cooperative learning does in fact result in greater student involvement with the subject matter, then it would be useful to know whether its use answers the following questions.

1. Does the academic achievement of middle school science students in cooperative learning classrooms (as defined in the definition of terms), differ from those in traditional learning classrooms?

2. Does the academic achievement of middle school science students in cooperative learning classrooms differ for females and male students?

3. Do the attitudes toward science class of middle school science students in cooperative learning classrooms (as defined in the definition of terms) differ from those in traditional learning classrooms?

4. Is there any difference in the attitudes toward science class of middle school science students at the end of the study, in cooperative learning classrooms for female and male students?

5. Do the process skills of middle school science students in cooperative learning classroom (as defined in the definition of terms) differ from those in traditional learning classrooms?

6. Is there any difference in the process skills of middle school science students at the end of the study, in cooperative learning classrooms for female and male students?

7. Are the outcomes of cooperative learning (achievement, attitudes toward
science class, and process skills), for middle school science students, related to the time of day (morning or afternoon)?

RESEARCH HYPOTHESES

1. For achievement, attitudes toward science class, and process skills of middle school science students, the treatment (cooperative learning and traditional learning), will have a greater effect on the morning classes than the afternoon classes and these effects will be greater for female students than the male students.

2. For achievement, attitudes toward science class, and process skills of middle school science students, the treatment will have a greater effect on female students than on male students.

3. For achievement, attitudes toward science class, and process skills of middle school science students, the treatment will have greater effect on the morning classes than the afternoon classes.

4. For achievement, attitudes toward science class, and process skills of middle school science students, the male students will do better than the female students in the morning classes than in the afternoon classes.

5. For achievement, attitudes toward science class, and process skills of middle school science students, the students using cooperative learning methods will do better than those using traditional methods.
CHAPTER II
REVIEW OF RELATED LITERATURE

INTRODUCTION

The review of literature focuses on the research and practical application of all aspects of the various teaching strategies that come under the rubric cooperative learning. It also includes to some extent key research on the issues of cooperation vs. competition in the classroom, and the development and organization of some cooperative learning strategies. For the purpose of this document, the literature reviewed was restricted to the subject areas of mathematics and science. Selection of journal articles and papers was done from searches obtained from the ERIC database (1964-1994). In addition to these, some books on cooperative learning were valuable resources of information.

COOPERATIVE LEARNING METHODS

Most of the research on practical cooperative learning techniques has focused on the following major models.

Teams-Games -Tournaments (TGT)
Student Team Achievement Divisions (STAD)
Team Assisted Individualization (TAI)
Jigsaw
Jigsaw ll

Group Investigative Method
Learning Together

Teams-Games-Tournaments (TGT)

The proponents of this model are DeVries and Slavin (1978). For this the students are grouped in two, four, or five member teams. In these teams the students are assigned according to a procedure that maximizes heterogeneity in ability levels, sex, and race. The primary function of the team is to prepare its members for the tournament. Following an initial cooperative class preparation by the teacher, the students work and study together to prepare themselves for the tournament. After a team practice session the students play academic games with other members whose past academic performance in cooperative learning has been similar to theirs. Thus, students play academic games to show their individual mastery of the subject matter. These games are played in weekly tournaments. The competition takes place at tournament tables of three students. Students playing each game are competing as representatives of their teams and the score of each student is added to an overall team score. Because students are assigned to homogeneous tournament groups, each student has an equal chance of contributing a maximum score to his/her team. While team assignments always remain the same, tournament assignments are changed for every tournament according to a system that maintains an equality of past performance at each group. The highest scorer at each table is moved to the next higher table for the next tournament, and the low scorer at each table is moved to the next lower table.
This equal competition makes it possible for students of all levels of past performance to contribute maximum points to their teams if they do their best. Team scores are figured at the end of the tournament.

**Student Team Achievement Divisions (STAD)**

Slavin (1977) proposed this method which uses four to five member groups similar to those used in TGT, but instead of games there are fifteen minute quizzes which students take after studying in groups. The teams are made up of high, average, and low performing students of heterogeneous backgrounds. Each week the teacher introduces new material in a lecture or discussion. The students then meet in groups to work together and master a set of worksheets on the material. They may work problems one at a time in pairs, take turns quizzing each other, or discuss the problems in a group. The students are then given worksheets to help them learn the concepts. Team members are told not to end group activity until each of their teammates has understood the material. Following team practice, students take quizzes on the subject matter. The score the student contributes to his/her team is based on the degree to which it represents an improvement over the student's own past average. The teams with the highest scores are recognized in a weekly class newsletter.

**Team Assisted Individualization (TAI)**

Slavin, Leavey, and Madden (1982) proposed a cooperative learning method which is a combination of team learning and individualized instruction applied to the teaching of mathematics. In TAI, the students are
also assigned to four or five member heterogeneous teams. After being placed in the appropriate teams after a diagnostic test, each student works through a set of programmed mathematics units at his or her own pace. Students follow a regular sequence of activities to prepare them to master the skills and take a checkout to see if they have mastered the skill and then, finally, take a test. Students test scores and the number of tests they can complete in a week go into a team score and team members receive certificates for exceeding preset team standards. Because of this preset standard, any number of teams can receive certificates. All skill sheets and checkouts are scored by teammates and all tests are scored by student monitors. In TAI the teacher is able to work with individuals and small groups on problems. TAI is unique because it uses individualized rather than a class paced instruction. It was developed mainly to allow for classes which are made up of heterogeneous groups with students requiring material to be presented to them at their own levels.

**Jigsaw**

Aronson, Blaney, Stephan, Sikes, and Snapp (1978) is the proponent of this method. Each student is assigned to a five or six member group and is given a section of academic material the whole group will be studying. The students study their sections with the members from other teams who have the same sections. Then they return to their teams and teach their sections to the other team members. Finally, all team members are quizzed on the entire unit. The quiz score contributes to individual grades and team scores. In the jigsaw there are no group rewards and an individual's performance contributes directly to the performance of other group members. However, because each
member's positive behavior contributes to the rewards of other group members, it constitutes cooperative learning.

**Jigsaw II**

Slavin (1980) modified Aronson et al. (1978) model of the Jigsaw and named it Jigsaw II. In this the students read the same material but focus on separate topics. The students from different teams who have the same topics meet to discuss their topic and then return to teach it to their team mates. Finally, the students take a quiz on the materials and these quiz scores are used to form the individual and team scores.

**Group Investigative Method**

Sharan and Sharan (1987) developed this method where students select sub topics within a general area selected by the teacher and then organize themselves into small groups of two to six members. These groups further subdivide their topic into individual tasks to be performed by group members in preparation for a group presentation to the whole class. The students in the small groups take substantial responsibility for deciding what they will learn, how they will organize themselves to learn it, and how they will present it to the whole class. The group presentation is then evaluated by the other students and by the teacher. Thus small group teaching is high in student autonomy and involves a high degree of task interdependence.

**Learning Together**

This method was developed by Johnson and Johnson (1975). Here
students are assigned to small groups and instructed to work together on academic tasks and hand in a single assignment as a group. The group as a whole is given praise and recognition.

OUTCOMES OF COOPERATIVE LEARNING:

ACADEMIC ACHIEVEMENT

A large number of studies have been conducted to study the effect of cooperative learning on the academic achievement of students. According to Slavin (1983a), cooperative learning methods that use group rewards and individual accountability consistently increase student achievement in many academic subjects in elementary and secondary classrooms as do those methods that use task specialization and group rewards. However, cooperative learning methods that use only group study and not rewards are not effective in increasing achievement. Cooperative learning focuses on shared goal attainment and increase the likelihood that students will learn.

When one child achieves a goal, all others to whom he or she is cooperatively linked, achieve their goal (Johnson and Johnson, 1983).

Sherman (1988) attempted to provide comparisons concerning the effectiveness of a cooperative method (Sharan's Group Investigative Method) versus an individually competitive structure in two secondary biology classrooms. Identical units of study were taught to two classes and the achievements were evaluated. Even though no significant differences were found between the two classes on the pre-tests, both groups were expected to
obtain significantly higher post-test scores. The results showed that there was no significant difference between the achievement scores of students learning in a cooperative environment and those learning in an individually competitive class. However, the study does confirm that there is no academic disadvantage in using the cooperative Group Investigative strategy.

Yager, Johnson, and Johnson (1985) in a study of second grade students found that the students in cooperative learning groups achieved higher scores than did students learning individually. Sharan, Ackerman, and Lazarowitz (1979) did a three week study comparing the academic achievement of pupils in five classes taught in small cooperative groups to the achievement of pupils taught in the traditional whole class approach. Findings obtained generally supported the hypothesis that small group learning with pupils cooperating in the study of academic matter can lead to superior achievement in higher order thinking than in a classroom where there is traditional lecture method instruction.

Lazarowitz, Hertz, Barod, and Bowlden (1988) investigated whether a change in the instructional procedures from a competitive, individualistic approach to a cooperative approach could affect students' on-task behavior and academic achievement. For this they used the modified Jigsaw method, combined with the Group Investigative method, to teach two biology units to tenth grade high school students. They were unable to make clear conclusions on academic achievement. It was seen that for one learning unit the experimental group did better. Lazarowitz et al. (1988) attributed these results to an inherent difference in the two learning units. The study did show that the cooperative small group investigative method of teaching resulted in
higher pupil on-task behavior during the experiment and this high on-task behavior continued even after the end of the experiment.

Slavin (1983b) identified 46 field experiments on cooperative learning conducted in elementary and secondary classes (grades 2-9). The effects of cooperative learning on student achievement were clearly positive. Out of the 46 studies, 29 (63%) showed cooperative learning methods to have significant positive effects on student achievement. In 15 (33%) no difference was found and 2 studies showed (4%) significantly higher achievements for the control group than for a cooperative groups treatment.

Okebukola and Jegede (1988) attempted to determine the learning mode, cooperative or individualistic, under which the students using a concept mapping strategy would achieve better. They used 145 students enrolled in a pre-degree science program. They found that whether a student was engaged in concept mapping alone or in a group was significant, in terms of student learning. Students working cooperatively on concept mapping tasks were found to learn more meaningfully than the students who worked alone. Peer tutoring and sharing of ideas in a cooperative learning group could be factors contributing to the improved performance.

Slavin and Karweit (1981) undertook a study to determine whether or not student team learning methods could in fact be used effectively for an extended period of time. The three methods used were: Student Team Achievement Divisions (STAD); Teams, Games, and Tournaments (TGT); and the Jigsaw method. These methods were used with the same group of students at the same time over the instructional day for a semester to determine whether the cognitive and affective outcomes of cooperative learning found in the short
term experiments do in fact enhance or diminish with time. The results showed that the experimental group had better scores than the control group. But what was most significant about this study was that the researchers did manage to implement cooperative learning in a class for a full semester. Most often cooperative learning methods are used as a temporary break in routine.

Johnson et al. (1986) report that 122 research studies between 1924 and 1981 indicate that cooperative learning experiences promote higher achievement in students than do competitive and individualistic learning experiences. They go on to say that this finding holds for all age levels, all subject areas, and a variety of tasks. In addition, they claim that cooperative learning also promotes critical thinking skills, positive attitudes towards subject area, psychological health, acceptance of peers and self, ability to collaborate on tasks, and a positive perception of the teacher.

Miller (1992) reports a study in which two seventh grade teachers taught the same unit to the students. The first half of the unit was taught using cooperative learning strategies about 60% of the time. Typical strategies included using a jigsaw technique for reading the text and groups for reviewing subject matter and to develop answers to teacher directed questions. For the second half of the unit the teachers were the main speakers in the classroom and students worked individually to complete laboratories, homework assignments, and readings. Results of the study determined by comparing pre-test and post-test scores showed greater academic achievement and retention of the subject matter when the students were taught using the jigsaw techniques. Also, it was seen that the cooperative learning environment resulted in a high level of student participation. Students were seen to take
their responsibilities seriously and were disappointed when they could not work together during the individualistic half of the unit.

ATTITUDES

Cooperative learning experiences compared with competitive and individualistic ones promote more positive attitudes toward the subject area, more positive attitudes toward the instructional experience, and more continuing motivation to learn more about the subject area being studied (Johnson and Johnson, 1989a). Bligh (1972) reports that students who had opportunities in class to interact with classmates and the instructor were more satisfied with their learning experience than students who were taught exclusively by lecture. Kulik and Kulik (1979) say that students who participate in discussion groups are more likely to develop positive attitudes toward the course's subject matter. One of the conclusions made in the Harvard Assessment Seminars was that the use of cooperative learning groups resulted in a large increase in satisfaction with the class (Light, 1990). Johnson, Johnson and Smith (1991) say that these findings could have important implications for influencing female and minority students to enter careers oriented toward science and mathematics.

Swing and Peterson (1982) investigated student attitudes and student behavior during small group interaction as mediators of effectiveness of small group teaching. They used fifth graders from a mathematics class. Results indicated that low ability students benefited from a small group approach. Cooperative learning in a small group approach showed that the achievement of high ability students was facilitated by learning in a small heterogeneous
ability group (Amaria, Biran, & Leith, 1969). Also, the results of the study by Swing and Peterson (1981) showed that medium ability students did not engage in less interaction than did high and low ability students. Correlations of the small group behavior of high, medium, and low ability students, however, are consistent with claims that small group work is more beneficial for high and low ability students than for medium ability students.

Slavin (1981) notes that students working in cooperative groups enjoy doing so because work becomes more exciting and social. That is probably why academic achievement is greater. He notes that the most successful method for improving student achievement seems to be the student learning techniques. Nine out of ten TGT studies (DeVries & Slavin, 1978), four out of six STAD studies, and one study of a combination of TGT, STAD, and Jigsaw II all found significantly positive effects on academic achievement (Slavin, 1980). Slavin also notes that the positive effects of cooperative learning methods on student achievement appear frequently in elementary and secondary schools where this instructional strategy is used. Slavin (1980) and Sharan (1980a) have hypothesized that more tightly structured cooperative methods such as the TGT and STAD will have the largest effects on basic skills but higher order cognitive skills may be best increased by more open ended methods such as the Group Investigation.

There is considerable evidence that cooperative learning procedures promote more positive development among heterogeneous student groups than do competitive and individualistic learning experiences (Johnson, Johnson, & Maruyama, 1983). Most of the research, however, either deals with heterogeneity in the form of low and high ability students or inter-racial
relationships. Naam and Tamin (1989) compared boy and girl students' abilities and achievements in a research class which included both classroom and research institute experience. Even though the academic achievement of both boys and girls was comparable, it was found that the boys were more active in classroom interactions. Different studies (Tobin, 1988; Banks, 1988) indicate that male students are involved in greater classroom participation in science classes than the females. Failure of a significant number of females to participate in science classes is in fact a concern of society. After a study of women's attitudes towards mathematics, Urbanek (1983) concluded that encouragement, positive reinforcement, and access to special programs to motivate female achievers are necessary to increase the number of women entering mathematical studies.

Waring, Johnson Maruyama, and Johnson (1985) examined the effects of different levels of cooperation on cross sex and cross ethnic relationships in two separate studies. In the first study sixth grade students were randomly assigned to three conditions: cooperative controversy, cooperative debate, and individualistic. In the second study, fourth grade students were randomly assigned to two conditions of inter group cooperation and inter group competition. Results from the first study indicated that there was little difference between the cooperative controversy and cooperative debate in promoting relationships between black and white and male and female students. This supports the findings of previous researchers (Deutsch, 1962, Johnson & Johnson, 1979) that certain types of conflict result in the development of positive relationships. The authors note that it is possible that the interpersonal competitive elements in a cooperative debate are insignificant.
as compared to the resource interdependence and the collaboration of learning information from one another. Results from the second study showed that inter group cooperation promoted more positive cross ethnic and cross sex relationships than did the inter group competition. Inter group competition was seen to promote a competitive orientation among students and negatively to affect cross ethnic and cross sex relationships. So, in fact, it appears that when the competitive elements dominate cooperative learning within a mixed situation, cross ethnic and cross sex relations are damaged.

Attitudes toward science are in fact as important as the understanding of science, because it is the students' attitudes that determine how they will use their knowledge (Omerod & Duckworth, 1975). Secondly, even those students who possess abilities within the cognitive and psychometrical domains to do tasks get their willingness from the affective domain (Haladyna & Shaughnessy, 1982). Cooperative learning is extremely conducive to the present day science teaching environment of facility shortage, large classes, and small science teacher to student ratio (Okebukola, 1986). A larger number of students can interact with fewer learning materials when they work in small cooperative groups. Okebukola (1986) believed that an examination of the gender factor would be an important contribution to the understanding of the impact of cooperative learning on student attitudes to laboratory work. In 1986 Okebukola conducted a study with ninth grade biology students to explore the effects of cooperative learning on the attitudes of students toward lab work and to identify whether any sex differences with respect to attitudes toward laboratory work existed between students working in cooperative groups (experimental group) and students working in a traditional learning setting.
(control group). Results indicated that the experimental group subjects had more favorable attitudes toward laboratory work in comparison with subjects in the control group. Also, male students were more favorably inclined toward laboratory work than were their female counterparts. Another interesting result of this study was the seeming ability of cooperative learning to promote favorable attitudes of girls toward laboratory work. Even though most female students on pre-tests had a negative attitude toward laboratory work, by the end of the study the girls had changed to a positive outlook. In the control group there was no change in attitudes.

Previous research has indicated that cooperative learning promotes favorable attitudes towards science work (Gunderson and Johnson, 1980). Okebukola's (1986) study supported the finding that the cooperative groups and cooperative learning featuring inter group competition is a potent way of assisting students in developing favorable attitudes toward laboratory work. Okebukola (1986) is of the opinion that several mechanisms could be responsible for explaining the positive effects of cooperative learning on students' attitudes toward laboratory work. First, the peer tutoring component of cooperative learning results in increased knowledge due to sharing of resources, low anxiety, and high satisfaction in the learning environment. These behaviors could induce positive learning attitudes toward instructional activities in the students and make them more inclined to participate meaningfully in laboratory activities. Second, in cooperative learning high ability students can be seen explaining issues to other students in the group and teaching other students how to go about certain tasks to develop certain skills. This ensures that all the students in the group and the class as a
whole participate in classroom activities. Third, the motivating effect of
competition between groups could be responsible for the development of
favorable attitudes in students toward science.

PROCESS SKILLS

Jerome Bruner (1961) stressed the need for science curricula which
would allow students to solve problems on their own and develop skills for
manipulating, classifying, and ordering objects. Bruner, in fact, thought these
processes to be "educational ends in themselves" (Shulman & Tamir, 1973).
Science for a long time was thought to be an organized body of knowledge.
However science is more a process and a product and goes far beyond being a
mere collection of facts (American Association for the Advancement of Science,
1968). In Science - A Process Approach or SAPA (AAAS, 1968), an elementary
school curriculum, the focus is on these skills. SAPA defined process skills as a
set of broadly transferable abilities, appropriate to many science disciplines,
and reflective of the true behavior of scientists. SAPA divided process skills
into two types, basic and integrated. Basic process skills are observing,
classifying, communicating, measuring, using time space relations, using
numbers, inferring, and predicting. These skills provide a foundation for the
development of integrated process skills which include controlling variables,
interpreting data, formulating hypotheses, and defining operationally.

While the philosophical importance of the integrated science process
skills is often unchallenged, there is a lack of research with middle and
secondary school students to indicate how these skills might best be
taught (Padilla, Okey & Garrad, 1984, p. 277).

O'Donnel and others (1990) examined the efficacy of peer cooperation in
learning concrete procedures and found that, in general cooperative learning
enhanced the learning of a complex concrete procedure. The effects of cooperation among peers, however, was shown to depend on the nature of the learning script used by the cooperating learners.

Swain (1991) talks of collaborative learning being in tune with the social needs of the students. He says that if these social needs are met in the classroom, the students will also learn better. Swain's approach to experiential learning is with an emphasis on process and collaborative learning.

Thayer (1990) was involved in the reorganization of the curriculum and instructional program in schools in her county. The core curriculum was revised to emphasize hands-on instruction, to foster positive attitudes, to develop problem solving skills, and to increase understanding of the nature of science. Students learned science by doing science projects in groups and the instructional program at each grade level was developed around skills, as well as concepts. As a result of this lab oriented, non-textbook, cooperative learning approach the students are motivated to undertake more science activities, spend more time doing science, and seem to have developed a greater interest and self confidence to do science.

Berge (1990) investigated the effects of group size (individuals, pairs, or quads of students), gender, and ability groupings of seventh and eighth grade students on science process skill achievement using the Test of Integrated Process Skills (TIPS) and TIPS II. Results indicated that there were no significant differences in the achievement of process skills between the two genders or groups of different sizes. It was found that the low ability students gained the most from the experience.

Project 2061 (Rutherford & Ahlgren, 1989) also recommends a change
from the current textbook based, fact memorization approach to a more hands-on one that will motivate students to be involved in the process of science education. As such it seems possible that a cooperative learning instructional strategy could enhance the acquisition of science process skills in middle school science students.

**OTHER OUTCOMES**

Self esteem in school age children has been shown by Coppersmith (1967) to be strongly influenced by the students feelings that they are doing well in school and in their peer groups. Slavin (1983a) feels that because cooperative learning has been found to increase students' academic performance and to increase interpersonal relations among peers it would seem logical that it would improve students self esteem as students are likely to perceive that they are doing better in school and getting along better with peers. Slavin (1983a) says that the value of increasing student achievement is a demonstration to the student that he or she can learn. This is of critical importance because only then would the students be able to be motivated to learn. Self-esteem is normally associated with a feeling that the individuals are well liked by their peers and that they are doing well academically. Student team learning has been found to increase students self-esteem (Lazarowitz & Kareently, 1990). Students in cooperative learning classes have been found to have more positive feelings about themselves than do students in traditional classrooms.

Cooperative learning prepares students for today's society and fosters active learning. Students have been found to learn more when they work
together in groups rather than sit passively and hear the teacher teach (Blosser, 1992). There is, however, some disagreement as to whether cooperative learning is helpful for the gifted. It has been claimed that cooperative learning exploits the gifted children's abilities and cuts down their own learning time which is spent helping peers (Matthews, 1992). Johnson and Johnson, however, do not believe that heterogeneous groups have any disadvantage compared to all-gifted groups (Blosser, 1992). Johnson and Johnson, in fact, believe that gifted students working cooperatively develop increased levels of achievement, cognitive reasoning, ability to view issues from different perspectives, the ability to participate in intellectual arguments, and to interact socially (Johnson & Johnson, 1991).

Although there are many questions that still need to be answered, it is possible to state that the principal cooperative learning methods are effective on a wide range of outcomes. They have been proven practical and acceptable to teachers. The research has clearly shown that changing from a traditional competitive classroom to a cooperative classroom most often results in greater academic achievement. However, it must not be forgotten that cooperative learning has been shown to enhance student achievement only when students are working toward a common group goal and, secondly, success at achieving this goal must depend on the individual learning of all group members. The degree of consensus on the achievement effects of cooperative learning methods that use group goals and individual accountability is considerable according to Slavin (1989). The research also overwhelmingly supports the usefulness of cooperative learning for improving the social outcomes of schooling such as inter group or cross-sex relations and attitudes toward
science.

While no reviewer has yet expressed any doubt that there is a broad set of conditions under which effects will be found, there is still a controversy about the specific conditions under which these positive effects will be found. Slavin (1989) notes that another issue of concern is whether cooperative learning is effective at all grade levels. There is a lot of evidence to show that these methods are instructionally effective in elementary schools but relatively few studies examined the higher grades. The fundamental goals of cooperative learning in small groups are to promote processes of learning which are intellectually more complex and richer than the presentation-recitation model and to stimulate the pupils on a higher level of affective and social involvement (Sharan & Sharan, 1987).

In conclusion, all the research on cooperative learning through the various studies justifies that for academic achievement, cooperative learning techniques are no worse than traditional techniques and, in fact, are most often better. Slavin (1980) feels that, for low level learning outcomes such as calculation and application of principles, cooperative learning techniques are more effective so long as they use a structured and focused schedule of instruction, individual accountability, and group rewards. For higher level cognitive learning outcomes such as identifying concepts, analysis of problems, and evaluation, less structured techniques that involve high student autonomy and participation in decision making may be more effective than the traditional individualistic techniques. Also, cooperative learning techniques have fairly consistent positive effects on mutual concern among students and increased classroom participation of boys and girls alike, regardless of the technique
used. Even with the little research done in this area, positive effects of cooperative learning have been found on cross sex relations and equal male-female classroom participation. Finally, students in classes using cooperative learning generally report greater liking of school than do students taught in traditional manner. Thus, cooperative learning could certainly lead to the development of positive attitudes in students. As far as attitudes toward science in particular are concerned, more research on the influence of cooperative learning on students attitudes toward science in particular would be helpful.
CHAPTER III
DESIGN AND METHODS

POPULATION AND SAMPLE

The population is seventh grade science students. The sample consists of five seventh grade classes from one of the local schools. This is an alternative middle school where students come from all over the city of Columbus. Admission is by lottery and a certain percentage of the seats are reserved for the neighborhood children. The students in this school range from a lower to a middle level socio-economic status. There are approximately 50% African American and 50% Caucasian students.

TIME FRAME

The study lasted for approximately seven weeks. Johnson and Johnson say that for any significant changes to be seen as a result of a cooperative learning strategy, at least four to five weeks of exposure are needed (in Blosser, 1992). Observation and data collection took place only during the scheduled science class period daily. Class period length is approximately forty-five minutes. The students were pre-tested at the beginning of the academic school year for attitudes and process skills, and then post tested after the unit was completed, i.e. approximately seven weeks later. Each of the tests was such that it could be completed in one class period, i.e. forty-five minutes. The
achievement tests were the regular teacher constructed tests. Since the unit to be taught consisted of two separate sections there were two pre-tests and two post-tests, one set for each section. The first section was completed in three weeks and the second section in four weeks.

**DESIGN AND PROCEDURE**

Before the study began, letters were sent out to the parents of all the students of the seventh grade informing them of the purpose and procedure of the study (Appendix A). They were informed of the tests that would be administered to the students and absolute confidentiality was assured. Also, an option was given to parents not willing to allow their children to be tested to exclude these children from the study.

The design used was the Quasi Experimental Control Group Design. Five sections taught by a seventh grade teacher were used. Two of the classes served as the control group and three classes received the treatment. In the treatment group the students worked in cooperative groups. The instructional activities involved hands on, laboratory activities, discussions, along with cooperative learning. At the start of the study the students in all the classes took the pre-test for the first section of the unit (variable: Achievement1). They also took the pre-tests for attitudes toward science class, and process skills.

One morning and one afternoon class were randomly chosen to serve as the control group. These classes were taught using the traditional teaching approach. "Traditional" refers to the fact that there was no formally structured cooperative or team learning taking place. The teacher taught in his/her usual manner which may include class discussions or even students working
together in pairs for certain laboratory sections of the unit. As part of the observation procedure, the teacher's style of teaching was documented. The teacher distributed the unit along with the assignments to each student who shared the laboratory equipment but who completed assignments individually without discussion. The class assignment was aimed toward hands-on and inquiry related experiences. Any home-work assignment that was given was completed by the students at home and no time was given in the class to discuss the homework with other students. The grade obtained in the homework contributed to the individual's cumulative grade. Once the teacher completed section one of the unit, each student took the post-test for Achievement1. Subsequently, section two of the unit was given to the students who then took a pre-test for this section. This pre-test will be referred to as the mid-test since the students took it after three weeks of the commencement of the study. At the end of seven weeks, when the teacher had completed section two of the unit, the students were given the post-test for Achievement2, attitudes toward science class, and process skills. At the end of the seven weeks, a cumulative score was calculated for each student. This score consisted of the scores on the two post-tests for achievement on the two sections of the unit, points awarded for homework assignments, bonus points awarded to groups for returning homework and classwork assignments on time, points on any class quizzes that were held during that period, and bonus points awarded to groups for behavior.

The treatment group consisted of a morning class and two afternoon classes. Both the treatment and control group were taught the same unit. Also, the assignment on the unit was the same for both the treatment and control
group classes. The treatment group classes were divided randomly into equal groups. The groups consisted optimally of four students. Each student was assigned a responsibility. The first student was the manager and his/her responsibility was to oversee the smooth functioning of the group. The second person was the equipment person and was responsible for collecting resources or equipment in case of a laboratory assignment. The third person was the reader and was responsible for reading aloud the material to be studied and leading a discussion among group members about it. The last person was the reporter and was responsible for presenting any reports compiled by the group, results obtained by the group on some experimental task, or simply reporting group activities. Tasks were assigned randomly to the students and were rotated after every section of the unit. For example, the unit of mass and balance has two sections, one in which the properties of balancing are explored, and another in which a relationship is derived between mass and length. Home-work assignments were completed by the individual students at home, but each group was given ten minutes at the beginning of the class period in which the home-work was due to discuss and review the assignment. Out of four papers submitted, the teacher graded the paper of any one pre-decided member depending on his/her position in the group. For example, she could decide on one particular day to grade all students at position four in the group, and on subsequent occasions the positions were rotated. The same grade was assigned to all four members of the group. However, if all four members of the group turned in all four home-work assignments, then each member of that group was awarded four bonus points, to be added to his or her final score. The same pre-tests and post-tests as the ones used by the
students of the control group for achievement, attitudes, and science process skills were given to these students. If all four students of a group passed the final test, ten bonus points were added to the grade of each member of the group. During the intervention period, the treatment groups devoted their time to the development of social skills. During this time they experienced group or team building activities with the aim of developing interpersonal relations. For this purpose group survey forms were completed by the teacher and the students to assure the smooth functioning of the groups (Appendix D).

TEACHING SOCIAL SKILLS

Teaching social skills to students should assist them in learning the objectives of the cooperative learning lessons and also help them in their life outside school. Rottier and Ogan (1991) divide social skills into basic and advanced social skills. Basic social skills include helping students to do things themselves, listening, sharing resources, following directions, responding to signals, using quiet voices, and everybody helping everybody. Advanced social skills include treating others with respect, solving problems cooperatively, explaining, sharing, summarizing, correcting, solving problems without arguing, compromising, and playing the assigned role to the best of the student's capability.

For the development of social skills, team building activities were used. The first time students assembled in their groups they exchanged names and telephone numbers so that they could call each other for help with homework or studying or to get an assignment and notes if they were absent. Next, each shared a personal experience or revealed an unusual attribute or talent. After
that a volunteer from each group introduced members of the group and recounted one of the sharings. This helped the group members to get acquainted with each other.

In order for students to learn how to be responsive to the needs of the group, an exercise called Broken Circles was used (Cohen, 1986). In this, the puzzle cannot be satisfactorily solved unless group members become aware of problems being experienced by others and are willing to give away some of their pieces of the puzzle in order to attain the group goal. Each member is given an envelope containing pieces of a cardboard. The task is not completed until each individual has before him or her a perfect circle of the same size as that formed by others in the group.

To allow development of cooperative problem solving, contributing ideas, giving directions without being bossy, and everybody helping, simple jigsaw puzzles were used (Cohen, 1986; Rottier & Ogan, 1991). Members had to complete the puzzle without a picture of the finished product in front of them. Talking was permitted. No one could take another’s piece and place it for him or her. Hints and encouragement could be given, but all members had to do their own part.

Students also need encouragement in asking each other questions, to be able to consult with others, and practice in listening behavior (Sutton, 1992). Discussions between group members were encouraged to allow any ill-feelings or misunderstandings to be removed. While working in groups the teacher observed the ongoing interaction between students to assess the smooth functioning of the group and be assured that there was no infighting or unequal distribution of work. Group cooperation checklists were completed
by the groups to enable the teacher to review the interaction amongst group members (Appendix D).

LIMITATIONS OF THE STUDY
1. The population of students in this study consisted of the science classes of one seventh grade teacher from one alternative middle school. Since the sample was not randomly selected, the results from this study may not be generalizable to all seventh graders.
2. The assessment of outcomes of academic achievement, attitudes toward science class, and science process skills are based on the quality of the instruments used.
3. Responses on the attitude instrument could have been influenced by any recent incidents recently during or prior to the science class and by the students' emotions at that time.

DELIMITATIONS
1. This study considered attitudes toward science as referring only to the general attitudes of the students toward the study of science, and toward the instruction of science in school.
2. Procedural knowledge beyond process skills could have been influenced by cooperative learning. However, this aspect was excluded from the study.

PRECAUTIONS EXERCISED
While attempting to implement cooperative learning, it must be remembered that simply placing students in groups and letting them work
together does not in itself promote higher achievement or greater productivity (Johnson, Johnson, & Smith, 1991, p. 15). The teacher attempted to ensure that less able members did not leave it to others to complete their tasks. At the same time more able members were urged to help their peers and not dominate to the extent that they benefit at the expense of others. Self induced helplessness by less able or simply lazy students, unequal divisions of labor, destructive conflict, or any other patterns of behavior that would debilitate the performance of the students individually or the group as a whole was discouraged.

INSTRUMENTATION

The achievement tests for both units were prepared in consultation with the teacher and were based on the unit selected. The tests focused on conceptual knowledge, application of concepts taught, and some problem solving.

The instrument to assess Science Attitudes was the *Attitude toward Science in School Assessment* (ATSSA) developed by Paul J. Germann (1988). The test consists of fourteen items.

The objective in the development of the Attitude Toward Science in School Assessment (ATSSA) was to measure a single dimension of a general attitude toward science, specifically, how students feel toward science as a subject in school. Attitude here does not include such scientific attitudes that might motivate a person to become a scientist; that affect performance, competence and success in science as a profession; that affect contributions to and acceptance of new knowledge; that deal with the foundations, interactions, and dynamics of science; or that apply to philosophy, ethics, or politics. Nor does it include other attitudes toward science, such as toward scientists, toward methods of teaching science, toward scientific interests, or toward
particular science courses. Another domain avoided was that of judgments of personal ability in science, the value of science to the individual, or the value of science to the society. The interest was in the degree to which students liked or enjoyed science (Germann, p. 694).

Germann's (1988) instrument is designed to measure a general attitude toward science in school without confounding the interpretation by including other dimensions of attitude or science. It is a Likert scale instrument and attempts to assess student attitude toward school science instruction rather than scientific attitudes.

Thirty-four positive and negative statements were phrased and listed randomly in the instrument. A Likert scale was devised for the responses of the students and included strongly agree, agree, neither agree nor disagree, disagree, and strongly disagree. The thirty-four items, some of which were from some other instruments, were then evaluated for construct validity and clarity by a panel of three judges. As a result of this evaluation, the number of items was reduced to twenty-four, which were further revised. These items were then pilot tested on a group of 125 science students in grades 7 and 8. The Cronbach's alpha of reliability was determined to be 0.93. The items were then subjected to a principal-component factor analysis. Fourteen items were found to load on a factor that best fit the desired construct of a general attitude toward science.

Since attitude, for this study was defined as affect for or against science in school, it was felt that the clarity and unambiguity of the construct being measured was dependent upon the requirement that all items be general statements of affect toward science in school (Germann, 1988, p. 695).
The fourteen items were used in the ATSSA instrument. Four field tests were then conducted to examine the reliability and validity of the instrument. The field tests were conducted on students ranging from grades 7 to 12. In all four studies, Cronbach's alpha estimates of reliability were greater than 0.95.

All 14 items loaded on only one factor with consistent factor loadings in all four studies. Percent of variation accounted for by this factor was 64.9, 69.8, 67.4, and 59.2. Discrimination was demonstrated by item-total correlation, ranging from 0.61 and 0.89. (Germann, 1988, p. 696).

The findings from these studies indicated that attitude toward science in school accounts for about 16% of the variation in the classwork compared to 7% or less for pretest and summative scores. Germann (1988) says that a possible explanation for this result could be that students with more positive attitudes attend better to classroom instruction, lab exercises, studying, and homework than do students with a less positive attitude.

The test used to assess process skills was the Performance of Process Skills (POPS) Test for Middle Grades Students (Mattheis & Nakayama, 1988b). During the test development, efforts were aimed at the modification and refinement of the set of process skill objectives and test items assessed by another science process skills test; that is the Middle Grades Integrated Science Process Skills Test (MIPT) (Cronin & Padilla, 1986). The MIPT test is aimed at testing seven integrated process skills and consists of forty items. The seven integrated process skills are identifying research questions (six items), stating hypotheses (six items), identifying variables (eight items), designing investigations (six items), constructing data tables (four items), constructing graphs from data (four items), and drawing conclusions (six items). Items for
MIPT were selected from a pool of test items such as The Test of Integrated Process Skills (Dillashaw & Okey, 1980), The Group Test of Integrated Process Skills (Tobin & Capie, 1982), and The Test of Graphing in Science (McKenzie & Padilla, 1986), and modified for use with middle school students.

Six process skill objectives were identified as a basis for the POPS test items (Matttheis & Nakayama, 1988b). They are identifying experimental questions, identifying variables, formulating hypotheses, designing investigations, graphing data, and interpreting data. It was decided to eliminate the objective of constructing data tables in the MIPT. These objectives were reviewed and found to be valid representations of the intended process skills.

From the pool of 40 test items of the MIPT, 21 items were judged by the reviewers to be the best measures of the process skills identified and were thus chosen for inclusion in the POPS test. All items were multiple choice and had four alternatives. The test contained at least three items for each objective. Five of the objectives were represented by three items, and the sixth objective of identifying variables was represented by six items.

Four science educators with experience in test construction and process skills reviewed the test for content validation. There was concurrence of all four reviewers on their judgement of almost all items in terms of the correct answer and the process skill assessed. This concurrence was taken as evidence for content validity and objective scoring of the test. Some revisions and modifications were made in wording and sentence length, for example to provide additional explanation for specific terms such as manipulated variable, which is referred to as the condition which is changed, and the responding
variable which is referred to as the condition that is the measured outcome of the experiment.

The readability of the POPS test was assessed to be an average grade level of 6.8 on the FOG index (Cunning, 1975), which predicts the reading grade level necessary to read with 90% to 100% comprehension. The POPS test was field tested on 1,042 students from a school district in North Carolina.

The mean score and standard deviation for overall students on the 21 item test were 9.77 and 4.16 respectively. Total scores ranged from 1 to 20 with a standard error measurement of 2.08. Total test reliability, as computed by the Kuder-Richardson formula (KR-20) was equal to .75. (Mattheis & Nakayama, 1988, p. 4)

Item discrimination indices ranged from .27 to .71 with an average of .49 and were above .30 for 20 of the 21 test items. These three test characteristics, reliability, item difficulty index, and item discrimination index are all within the acceptable range for reliable tests (Payne, 1974).

INTERVIEWS WITH STUDENTS

Six students were purposefully selected for semi-structured open-ended interviews. Letters asking for parental permission to conduct interviews and to note and tape record the interviews were sent in advance to the parents of the selected students (See Appendix B). A list of questions prepared by the researcher were asked and notes were taken (See Appendix C). The interview was designed to focus on the responses given by that person on the attitude instrument. The interviews took place during the intervention period, after prior appointment with the student. Each child was interviewed for about forty-five minutes. Three of the students were males and three females. One
pair of a male and a female student was selected from those that showed poor attitudes toward science at the beginning and at the end of the study consistently. The second pair was chosen from those who showed a positive change of attitude toward science at the end of the study. The third pair was selected form those students that showed better attitudes toward science at the beginning of the study than at the end of the study.

ANALYSIS

The SAS program on the Mainframe was used for the statistical analysis of the data. Cronbach's alpha reliability measurements were calculated for the science attitude instrument (ATSSA) and for the science process skills instrument (POPS).

Descriptive analyses which includes means and standard deviations, is provided for achievement, attitudes, and process skills scores for both groups of students. Also, differences between gender, and the time of day at which the classes were held were tested.

To determine if there were any differences in achievement, attitudes toward science class, and process skills between traditionally and cooperatively taught students, a 2 x 2 x 2. treatment by time of day by gender, MANCOVA was done. There were five dependent variables, achievement for the first part of the unit (Achievement1 : Ach1), and achievement for the second part of the unit (Achievement 2 : Ach2), cumulative achievement at the end of eight weeks of school (Achievement3 : Ach3), attitudes toward science class (Att), and process skills (Psk). A graphic representation of the analysis design is shown in Table 1.
The null hypotheses were:

1. For achievement, process skills, and attitudes toward science class, there are no significant treatment x gender x time of day interaction effects.
2. For achievement, process skills, and attitudes toward science class, there are no significant treatment x gender interaction effects.
3. For achievement, process skills, and attitudes toward science class, there are no significant treatment x time of day interaction effects.
4. For achievement, process skills, and attitudes toward science class, there are no significant gender x time of day interaction effects.
5. For achievement, process skills, and attitudes there are no treatment effects.

It was decided a priori that the multivariate analysis would be followed by the univariate analysis. If any significance was revealed in the univariate analysis, a followup of the interactions for the purpose of interpretation would be carried out.

The data from the interviews was analyzed qualitatively to provide an insight to the deeper issues underlying any differences in attitudes between genders. Responses from different students were tallied and compared. Relationships between different responses were investigated by comparing responses on one item with responses on other items, to identify any emerging patterns and themes. A secondary purpose of the interview was to get a personal viewpoint of the students' experience with cooperative learning. Also the interview was a follow up to the responses of the person being interviewed. The purpose was to get a clearer understanding of the person's beliefs.
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CHAPTER IV
RESULTS

REVIEW OF ANALYSIS PROCEDURE

The following strategy was used for the analysis of the quantitative data:

(A) The reliabilities of all the pre-tests for Achievement1, Achievement2, Attitudes toward science class, and Process skills were determined.

(B) Determination of the status of equivalence of the two groups: To determine if the students in the treatment and control groups were at the same level on the variables for Achievement1, Attitudes toward science class, and Process skills, the pre-test scores for these three variables were subjected to a one-way analysis of variance.

(B) Decision on method of analysis: Based on the detection of some pre-existing differences between the treatment and control groups, it was decided to carry out an analysis of covariance procedure on the data for all the dependent variables.

(C) Identification of covariates: For this purpose, a correlation matrix was developed for the scores on the pre-test for Achievement1, Achievement2, Attitudes toward science class, and Process skills, and the scores on the post-test for Achievement1, Achievement2, Achievement3, Attitudes, and Process skills. Based on the values of the correlation coefficients between
these scores, and the reliabilities of the pre-tests for these variables, the covariates were identified.

(D) A multivariate analysis of covariance was carried out so as to explore the relationship between the dependent variables.

(E) For the purpose of follow up, the univariate analysis of covariance was carried out on the post-tests for Achievement1, Achievement2, Achievement3, Attitudes toward science class, and Process skills.

(F) If any significant interaction effects were determined in (F) then, adjusted means were used in follow up procedures, and the interactions were plotted for the purpose of interpretation.

RESULTS

OBSERVATIONS AND DOCUMENTATION OF CLASS PROCEEDINGS

On the first day of class the teacher placed a teeter-totter in the classroom. The students were allowed to sit at different positions on the teeter-totter and just think about what was happening. Only after fifteen minutes of allowing the children to observe that the weight of the student as well as the position they sat at was making a difference in the balancing of the teeter-totter, did the teacher distribute the worksheet for the first section of the unit to the students of all the classes. The students were allowed to use small balances on their tables to help them figure out the answers to the questions on the worksheet.
CONTROL GROUP CLASSES

In the control group classes, the students were seated in groups of four at each table and had to share the lab equipment. However each of them had to work and complete the worksheets individually. The teacher assessed each students' work individually. All homework assignments too, had to be completed individually. After every two or three days the teacher would recapitulate what the students had worked on in the worksheet. This recapitulation took place in the form of traditional teacher directed learning, where the teacher would stand in front of the board and go over the science concepts. Minimum teacher-student interaction was observed and even though the teacher repeatedly asked the students if they had any questions, the students hardly ever asked them.

In the course of the study the students in the control group, where the students were completing the task individually, were observed to be working in complete isolation from one another. No discussion was taking place. There was thus great disparity in the progress level of the students. If a student had a question, he/she had to wait for the teacher to answer it. Some students raced ahead, while others were lagging considerably behind. On more than one occasion, some students were seen lazing around, or with their heads down in the class, or some that had simply not attempted to start working at all. A large number of students persistently forgot to bring their worksheets to the class. Students were most irregular about returning homework. The maximum amount of homework ever returned was fifty percent.
EXPERIMENTAL GROUP CLASSES

On the first day the experimental group had the same experience of the teeter-totter. However, before the worksheets were distributed, the students were assigned the roles of a manager, reader, equipment person, and reporter. The grading procedure was also explained. All group members of a group would have the same answer to the questions on the worksheet. At regular checkpoints indicated on the worksheet, the group was required to show their work up to that point to the teacher and get it assessed. Assessment would begin with a small presentation by the reporter on the group's accomplishments to the teacher. Then the teacher could question any member of the group on the task, and if he or she could not answer it, the teacher would leave the group, asking the other group members to explain it to that person and then call her back to reassess them. The teacher would then pick up the worksheet of any student in the group, assess it and then one grade would be assigned to all the students in the group. For homework assignments, the students in the treatment group would be given ten minutes at the beginning of each class period to discuss, compare answers, and complete their homework. Again all group members had to agree on one best answer, because here again the teacher would pick up one student member's homework and assess it. Subsequently one grade would be assigned to all members of that group for the homework. For example, on one occasion she could decide to correct the homework of the readers and on a subsequent occasion all the homework of the managers and so on.
In the course of the study, the students in the classes assigned to the treatment where group learning was being fostered, were observed to be deep in discussion and sometimes in debate or arguments. On some occasions, the teacher would get a complaint about a particular student in a group, from the other members. The teacher would then intervene and attempt to calm every one down. What was most distinguishing about these students as compared to the other group was that most students were observed to be on-task, most of the time. They were actively working and discussing, in an attempt to compete their task on time. Any question that arose in any students' mind, was first addressed by the group itself. Thus the students did not have to wait for the teacher to solve any problems, because most often the input of the group was enough. Most students were regular about bringing their worksheets to class and returning their homework on time. There were always some students who had not completed their homework at home. However, they did bring it back the next day, participated in the discussion, and almost always completed it. So return of homework was greater in these classes. Characteristically, the teacher recapitulated the concepts on the board in the traditional classes, whereas the teacher sat at the back of the class and allowed the reporters of each group to come to the front and give a report to recapitulate what they had learned, in the treatment group classes. If the student stumbled at any point, the group members were allowed to help him/her.

Another difference observed between the two classes was the discipline. The students in the classes where they were working in group were mostly on task. Talking that was going on included mostly
stimulating discussions. In the classes where the students were working individually, on many occasions students were seen loitering aimlessly or talking to another student about some non-task related issue. At the end of the class periods the classes with the groups almost always left the class tables clean and the equipment placed back. However, the students in the control groups were most careless and each student waited for the other student to clean up.

RESULTS FROM THE ANALYSIS OF THE QUANTITATIVE DATA

At the beginning of the analysis the reliabilities of the four different pre-tests were determined.

The Cronbach's Alpha Coefficient of Reliability for the pre-tests for the different dependent variable are listed below in Table 2. The range of the reliabilities is from 0.52 to 0.94.

**TABLE 2**

Summary of the Cronbach's Alpha Coefficient of Reliability for Achievement1, Achievement2, Attitudes, and Process Skills Pre-tests

<table>
<thead>
<tr>
<th>Pre-Test</th>
<th>No. of Items</th>
<th>Cronbach's Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achievement1</td>
<td>4</td>
<td>0.52</td>
</tr>
<tr>
<td>Achievement2</td>
<td>4</td>
<td>0.74</td>
</tr>
<tr>
<td>Attitudes</td>
<td>14</td>
<td>0.94</td>
</tr>
<tr>
<td>Process Skills</td>
<td>21</td>
<td>0.70</td>
</tr>
</tbody>
</table>
The abbreviations used for the various pre-tests and post-tests, in the tables, and results reported ahead are listed in Table 3.

**TABLE 3**

Summary of Abbreviations Used for the Various Pre-tests and Post-tests

<table>
<thead>
<tr>
<th>Test</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test for Achievement1</td>
<td>PreAch1</td>
</tr>
<tr>
<td>Post-test for Achievement1</td>
<td>PstAch1</td>
</tr>
<tr>
<td>Pre-test for Achievement2</td>
<td>Mid-Ach2</td>
</tr>
<tr>
<td>Post-test for Achievement2</td>
<td>PstAch2</td>
</tr>
<tr>
<td>Post-test for Achievement3</td>
<td>PstAch3</td>
</tr>
<tr>
<td>Pre-test for Attitudes</td>
<td>PreAtt</td>
</tr>
<tr>
<td>Post-test for Attitudes</td>
<td>PstAtt</td>
</tr>
<tr>
<td>Pre-test for Process Skills</td>
<td>PrePsk</td>
</tr>
<tr>
<td>Post-test for Process Skills</td>
<td>PstPsk</td>
</tr>
</tbody>
</table>
The scores on the pre-tests for the dependent variables PreAch1, PreAtt, and PrePsk were explored by using a one-way ANOVA for any pre-existing differences between the control and treatment groups. No significant differences (p<0.05) were found between the two groups indicating that the two groups started the study with essentially the same characteristics as defined by these variables. The analyses for the data for PreAch1, PreAtt, and PrePsk are reported in Table 4, Table 5, and Table 6. The p-values for the analyses of PreAch1 and PreAtt were insignificant (see Tables 4 & 5). For process skills, there was some slight indication determined for differences between the treatment and control groups (p<0.1). The average item score (possible range from 1 to 0) on the pre-test items was 0.57 for the control group, and 0.50 for the treatment group.
### TABLE 4

Comparison of the Treatment and Control Groups on the PreAch1 Scores Using a One-Way ANOVA,

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>1</td>
<td>86.60</td>
<td>0.15</td>
<td>0.70</td>
</tr>
<tr>
<td>Error</td>
<td>114</td>
<td>582.26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>115</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 5

Comparison of the Treatment and Control Groups on the PreAtt Scores Using a One-Way ANOVA.

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>1</td>
<td>48.02</td>
<td>0.33</td>
<td>0.57</td>
</tr>
<tr>
<td>Error</td>
<td>114</td>
<td>144.46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>115</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE 6
Comparison of the Treatment and Control Groups on the PrePsk Scores Using a One-Way ANOVA.

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>1</td>
<td>36.47</td>
<td>2.76</td>
<td>0.10</td>
</tr>
<tr>
<td>Error</td>
<td>114</td>
<td>13.21</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

At the start of the analysis it was decided to refer to the pre-test for Achievement2 as the mid-test, because the pre-test for this measure really took place at the middle of the study. By this time the students had already been in the treatment and control groups for three weeks and so could have been influenced by treatment effects. The testing pattern for achievement is illustrated in Fig. 3.

<table>
<thead>
<tr>
<th>Pre-test1</th>
<th>Post-test1</th>
<th>Mid-test</th>
<th>Post-test2</th>
</tr>
</thead>
<tbody>
<tr>
<td>PreAch1</td>
<td>PstAch1</td>
<td>MidAch2</td>
<td>PstAch2</td>
</tr>
</tbody>
</table>

Fig. 3: Testing Pattern for Achievement
A Pearson Product-Moment correlation matrix was computed to determine relationships between the pre and post-test scores for PreAch1, PstAch1, MidAch2, PstAch2, PreAtt, PstAtt, PrePsk, and PstPsk. This is shown in Table 7. The number of students that took the tests was 116. This table indicated that the scores on the pre-test for achievement and process skills were correlated with the scores on the post-tests for achievement and process skills, except for the post-test scores for Achievement1 which are correlated with the pre-test scores for process skills. Also, the scores on the pre-test for attitudes toward science class are correlated with the post-test for the same variable, but not correlated with post-test scores for achievement and process skills. After comparing the reliabilities and correlation coefficients between the different pre-tests and post-tests it was decided to use the pre-test for attitudes toward science class, and process skills as covariates for the analysis of the data for all the dependent variables. The reasons for the selection of these two covariates are delineated below:

Selection of PrePsk as covariate:
1. The difference between the experimental and control groups on the PrePsk measure was approaching significance.
2. The PrePsk score significantly correlated with the post-test scores on the achievement and attitude measures.
3. The reliability coefficient of PrePsk was adequate (0.70).

Selection of PreAtt as covariate:
1. The PreAtt scores strongly correlated with the PstAtt scores.
2. The reliability coefficient of PreAtt was extremely high (0.94).
<table>
<thead>
<tr>
<th></th>
<th>PstAch1</th>
<th>PstAch2</th>
<th>PstAch3</th>
<th>PstAtt</th>
<th>PstPsK</th>
</tr>
</thead>
<tbody>
<tr>
<td>PreAch1</td>
<td>0.07</td>
<td>0.26</td>
<td>0.36</td>
<td>0.12</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td>0.41</td>
<td>0.005</td>
<td>0.0001</td>
<td>0.21</td>
<td>0.02</td>
</tr>
<tr>
<td>MidAch2</td>
<td>0.16</td>
<td>0.29</td>
<td>0.37</td>
<td>0.14</td>
<td>0.23</td>
</tr>
<tr>
<td></td>
<td>0.08</td>
<td>0.001</td>
<td>0.0001</td>
<td>0.015</td>
<td>0.01</td>
</tr>
<tr>
<td>PreAtt</td>
<td>0.17</td>
<td>0.02</td>
<td>0.14</td>
<td>0.53</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>0.06</td>
<td>0.84</td>
<td>0.13</td>
<td>0.0001</td>
<td>0.36</td>
</tr>
<tr>
<td>PrePsK</td>
<td>0.33</td>
<td>0.42</td>
<td>0.39</td>
<td>0.004</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>0.0003</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.97</td>
<td>0.0001</td>
</tr>
<tr>
<td>PstAch1</td>
<td>1.00</td>
<td>0.34</td>
<td>0.50</td>
<td>-0.04</td>
<td>0.30</td>
</tr>
<tr>
<td></td>
<td>0.00</td>
<td>0.0002</td>
<td>0.0001</td>
<td>0.67</td>
<td>0.001</td>
</tr>
<tr>
<td>PstAch2</td>
<td>0.34</td>
<td>1.00</td>
<td>0.55</td>
<td>0.15</td>
<td>0.52</td>
</tr>
<tr>
<td></td>
<td>0.0002</td>
<td>0.00</td>
<td>0.0001</td>
<td>0.12</td>
<td>0.0001</td>
</tr>
<tr>
<td>PstAch3</td>
<td>0.50</td>
<td>0.55</td>
<td>1.00</td>
<td>0.11</td>
<td>0.47</td>
</tr>
<tr>
<td></td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.00</td>
<td>0.24</td>
<td>0.0001</td>
</tr>
<tr>
<td>PstAtt</td>
<td>-0.04</td>
<td>0.15</td>
<td>0.11</td>
<td>1.00</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td>0.67</td>
<td>0.12</td>
<td>0.24</td>
<td>0.00</td>
<td>0.03</td>
</tr>
<tr>
<td>PstPsK</td>
<td>0.30</td>
<td>0.52</td>
<td>0.47</td>
<td>0.20</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>0.001</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.02</td>
<td>0.00</td>
</tr>
</tbody>
</table>
The descriptive summary of means and standard deviations for the dependent variables, Achievement1, Achievement2, Achievement3, Attitudes, and Process Skills for the experimental (Treat) and Control groups are reported in Table 8 and Table 9. The means in Table 8 are the mean scores on the test. For the attitudes toward science class and process skills variables, the mean item score was calculated so as to give an indication of the average item score for the students. The means in Table 9 are the mean item scores of the students on the checklists for attitudes and for process skills.

To test for post-treatment differences in the dependent variables, Achievement1, Achievement3, Attitudes, and Process Skills, the data generated on these dependent measures was analyzed using a $2 \times 2 \times 2$, treatment by gender by time of day (morning or afternoon) MANCOVA. The results of the multivariate analysis are reported in Table 10. There were significant main effects for treatment ($F=7.56, p<0.0001$) and a near significance was found for time of day ($F=2.12, p<0.08$).
### TABLE 8
Descriptive Summary of Raw Means and Standard Deviations for Pre and Post-test Achievement (Ach1, Ach2, & Ach3) Scores

<table>
<thead>
<tr>
<th>Var.</th>
<th>Group</th>
<th>Test</th>
<th>N</th>
<th>Range</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Pre-test</td>
<td>48</td>
<td>0-100</td>
<td>56.66</td>
<td>25.54</td>
</tr>
<tr>
<td>Ach1</td>
<td>Control</td>
<td>Post-test</td>
<td>48</td>
<td>0-100</td>
<td>81.15</td>
<td>17.36</td>
</tr>
<tr>
<td></td>
<td>Treat</td>
<td>Pre-test</td>
<td>68</td>
<td>0-100</td>
<td>58.44</td>
<td>23.09</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post-test</td>
<td>68</td>
<td>0-100</td>
<td>79.01</td>
<td>22.50</td>
</tr>
<tr>
<td>Ach2</td>
<td>Control</td>
<td>Pre-test</td>
<td>48</td>
<td>0-100</td>
<td>5.67</td>
<td>16.57</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post-test</td>
<td>48</td>
<td>0-100</td>
<td>42.10</td>
<td>30.68</td>
</tr>
<tr>
<td></td>
<td>Treat</td>
<td>Pre-test</td>
<td>68</td>
<td>0-100</td>
<td>13.91</td>
<td>21.75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post-test</td>
<td>68</td>
<td>0-100</td>
<td>52.38</td>
<td>35.01</td>
</tr>
<tr>
<td>Ach3</td>
<td>Control</td>
<td>Post-test</td>
<td>48</td>
<td>0-100</td>
<td>59.41</td>
<td>20.14</td>
</tr>
<tr>
<td></td>
<td>Treat</td>
<td>Post-test</td>
<td>68</td>
<td>0-100</td>
<td>68.87</td>
<td>16.84</td>
</tr>
</tbody>
</table>

Var.: Variable  
Treat: Treatment Group  
SD: Standard Deviation
<table>
<thead>
<tr>
<th>Var.</th>
<th>Group</th>
<th>Test</th>
<th>N</th>
<th>Range</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Att</td>
<td>Control</td>
<td>Pre-test</td>
<td>48</td>
<td>1-5</td>
<td>3.05</td>
<td>0.81</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post-test</td>
<td>48</td>
<td>1-5</td>
<td>2.94</td>
<td>0.81</td>
</tr>
<tr>
<td></td>
<td>Treat</td>
<td>Pre-test</td>
<td>68</td>
<td>1-5</td>
<td>3.14</td>
<td>0.89</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post-test</td>
<td>68</td>
<td>1-5</td>
<td>3.39</td>
<td>0.81</td>
</tr>
<tr>
<td>Psk</td>
<td>Control</td>
<td>Pre-test</td>
<td>48</td>
<td>0/1</td>
<td>0.57</td>
<td>0.18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post-test</td>
<td>48</td>
<td>0/1</td>
<td>0.56</td>
<td>0.21</td>
</tr>
<tr>
<td></td>
<td>Treat</td>
<td>Pre-test</td>
<td>68</td>
<td>0/1</td>
<td>0.50</td>
<td>0.18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post-test</td>
<td>68</td>
<td>0/1</td>
<td>0.57</td>
<td>0.20</td>
</tr>
</tbody>
</table>
**TABLE 10**

Summary of the Multivariate Analysis of Covariance By Treatment By Sex and By Time of Day for Achievement, Attitudes, and Process Skills

<table>
<thead>
<tr>
<th>Source</th>
<th>Wilks lamda</th>
<th>Numdf</th>
<th>Dendf</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Covariates</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PrePsk</td>
<td>0.77</td>
<td>4</td>
<td>103</td>
<td>7.56</td>
<td>0.0001</td>
</tr>
<tr>
<td>PreAtt</td>
<td>0.69</td>
<td>4</td>
<td>103</td>
<td>11.63</td>
<td>0.0001</td>
</tr>
<tr>
<td><strong>Main Effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treat</td>
<td>0.77</td>
<td>4</td>
<td>103</td>
<td>7.56</td>
<td>0.0001</td>
</tr>
<tr>
<td>Sex</td>
<td>0.97</td>
<td>4</td>
<td>103</td>
<td>0.92</td>
<td>0.46</td>
</tr>
<tr>
<td>Time of Day</td>
<td>0.92</td>
<td>4</td>
<td>103</td>
<td>2.12</td>
<td>0.08</td>
</tr>
<tr>
<td><strong>Interactions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treat*Sex</td>
<td>0.97</td>
<td>4</td>
<td>103</td>
<td>0.76</td>
<td>0.55</td>
</tr>
<tr>
<td>Treat*Time of Day</td>
<td>0.96</td>
<td>4</td>
<td>103</td>
<td>1.18</td>
<td>0.33</td>
</tr>
<tr>
<td>Sex*Time of Day</td>
<td>0.96</td>
<td>4</td>
<td>103</td>
<td>1.22</td>
<td>0.31</td>
</tr>
</tbody>
</table>

Numdf : Numerator df  
Dendf : Denominator df
From Table 7 the correlations between the post-test scores for achievement and attitudes were found to be very low (-0.04, p<0.67; 0.15, p<0.12; 0.11, p<0.24). The correlations between the post-test scores for achievement and process skills were moderate (0.30, p<0.001; 0.52, p<0.0001; 0.47, p<0.0001) and the correlation coefficient between the post-test scores for process skills and attitudes was 0.20 (p<0.02). Due to the lack of strongly significant correlations between all the dependent variables, it was reasonable to carry out the univariate analyses for each of the variables.

Achievement1 was a measure of achievement on the first section of the unit. For the PstAch1 data, no significant treatment effects were determined. The F value for the time of day was found to be 3.53 (p < 0.06). Data on this dependent measure showed that achievement was greater for classes held in the morning (adjusted mean=84.47) than for classes held in the afternoon (adjusted mean=77.15). This finding was true for treatment and control groups combined. The results of the analysis on the data for PstAch1 are reported in Table 11. Thus, if we consider Achievement1 to be representative of the achievement during the treatment period there does not seem to be a treatment effect. As such null hypothesis 1 to null hypothesis 5 (p. 59) are not rejected for Achievement1.

When the univariate ANCOVA was carried out for PstAch2, significant main effects were determine for treatment (F=8.17, p<0.0005), and for time of day (F=3.96, p<0.05). The students in the treatment group (adjusted mean=55.91) did better than the students in the control group (adjusted mean=38.80). Also, the male students did better (adjusted mean=53.18) than the female students (adjusted mean=41.53). The results
of this analysis are reported in Table 12. Since there were no significant interaction effects observed in this analysis, null hypothesis 1 to null hypothesis 4 (pg. 59) are not rejected for Achievement2. However, because there are significant treatment effects observed, hypothesis 5 is rejected for Achievement2.
### TABLE 11

Summary of a Three-Way Analysis of Covariance on PstAch1 Scores By Treatment By Sex and By Time of Day

<table>
<thead>
<tr>
<th>Source</th>
<th>MS</th>
<th>df</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Covariates</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PrePsk</td>
<td>4362.20</td>
<td>1</td>
<td>12.04</td>
<td>0.0001</td>
</tr>
<tr>
<td>PreAtt</td>
<td>211.98</td>
<td>1</td>
<td>0.59</td>
<td>0.45</td>
</tr>
<tr>
<td><strong>Main Effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treat</td>
<td>141.64</td>
<td>1</td>
<td>0.39</td>
<td>0.53</td>
</tr>
<tr>
<td>Sex</td>
<td>333.24</td>
<td>1</td>
<td>0.92</td>
<td>0.34</td>
</tr>
<tr>
<td>Time of Day</td>
<td>1280.40</td>
<td>1</td>
<td>3.53</td>
<td>0.06</td>
</tr>
<tr>
<td><strong>Interactions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treat*Sex</td>
<td>289.97</td>
<td>1</td>
<td>0.80</td>
<td>0.37</td>
</tr>
<tr>
<td>Treat*Time of Day</td>
<td>919.86</td>
<td>1</td>
<td>2.54</td>
<td>0.11</td>
</tr>
<tr>
<td>Sex*Time of Day</td>
<td>303.17</td>
<td>1</td>
<td>0.84</td>
<td>0.36</td>
</tr>
<tr>
<td>Treat<em>Sex</em>Time of Day</td>
<td>108.28</td>
<td>1</td>
<td>0.30</td>
<td>0.59</td>
</tr>
</tbody>
</table>

Treat : Treatment
Time of Day : Morning / Afternoon
Sex : Male / Female
**Table 12**
Summary of a Three-Way Analysis of Covariance on PstAch2 Scores by Treatment by Sex and By Time of Day

<table>
<thead>
<tr>
<th>Source</th>
<th>MS</th>
<th>df</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Covariates</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PrePsk</td>
<td>25719.3</td>
<td>1</td>
<td>29.16</td>
<td>0.0001</td>
</tr>
<tr>
<td>PreAtt</td>
<td>366.21</td>
<td>1</td>
<td>0.42</td>
<td>0.52</td>
</tr>
<tr>
<td><strong>Main Effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treat</td>
<td>7209.42</td>
<td>1</td>
<td>8.17</td>
<td>0.005</td>
</tr>
<tr>
<td>Sex</td>
<td>3495.96</td>
<td>1</td>
<td>3.96</td>
<td>0.05</td>
</tr>
<tr>
<td>Time of Day</td>
<td>41.25</td>
<td>1</td>
<td>0.05</td>
<td>0.83</td>
</tr>
<tr>
<td><strong>Interaction Effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treat*Sex</td>
<td>1703.10</td>
<td>1</td>
<td>1.93</td>
<td>0.17</td>
</tr>
<tr>
<td>Treat*Time of Day</td>
<td>1091.86</td>
<td>1</td>
<td>1.24</td>
<td>0.27</td>
</tr>
<tr>
<td>Sex*Time of Day</td>
<td>331.99</td>
<td>1</td>
<td>0.38</td>
<td>0.54</td>
</tr>
<tr>
<td>Treat<em>Sex</em>Time of Day</td>
<td>0.81</td>
<td>1</td>
<td>0.00</td>
<td>0.98</td>
</tr>
</tbody>
</table>
The variable Achievement3, is an indicator of the total achievement at the end of eight weeks of school. In the univariate results using the ANCOVA, reported in Table 13, significant main effects (F=21.07, p<0.0001) were determined for treatment. The achievement of the treatment group was greater (adjusted mean=72.14) than the achievement of the control group (adjusted mean=57.32). Also significant effects (F=4.71, p<0.03) were found for the time of day. The students in the morning classes performed better (adjusted mean=68.29) as compared to the performance of the students in the afternoon classes (adjusted mean=61.17). Some indication of possible effect (F=2.86, p<0.09), was found for the three way interaction of treatment x sex x time of day.

Since in the analysis of Achievement3 Scores using ANCOVA, there were significant effects for treatment x sex x time of day, null hypotheses 1 to null hypotheses 5 (p. 59) for Achievement3 are rejected.

To help investigate the interaction further Table 14 was generated showing the adjusted means of the Achievement3 scores. The three-way interaction is plotted in Fig. 4 and Fig. 5. The graphs indicate that the treatment worked better for female students than for the male students in the morning classes. Overall, the treatment group did better than the control group for both male and female students. Also, male students in both groups and female students in the control group did better in the morning than in the afternoon classes. The female students in the control group did a little better in the afternoon classes than those in the morning classes.
### TABLE 13

Summary of a Three Way Analysis of Covariance on PstAch3 Scores By Treatment By Sex By Time of Day.

<table>
<thead>
<tr>
<th>Source</th>
<th>MS</th>
<th>df</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Covariates</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PrePsk</td>
<td>6541.93</td>
<td>1</td>
<td>25.47</td>
<td>0.0001</td>
</tr>
<tr>
<td>PreAtt</td>
<td>8.36</td>
<td>1</td>
<td>0.03</td>
<td>0.86</td>
</tr>
<tr>
<td><strong>Main Effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treat</td>
<td>5410.40</td>
<td>1</td>
<td>21.07</td>
<td>0.0001</td>
</tr>
<tr>
<td>Sex</td>
<td>273.35</td>
<td>1</td>
<td>1.06</td>
<td>0.30</td>
</tr>
<tr>
<td>Time of Day</td>
<td>1209.88</td>
<td>1</td>
<td>4.71</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>Interactions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treat*Sex</td>
<td>370.57</td>
<td>1</td>
<td>1.44</td>
<td>0.23</td>
</tr>
<tr>
<td>Treat*Time of Day</td>
<td>403.50</td>
<td>1</td>
<td>1.57</td>
<td>0.21</td>
</tr>
<tr>
<td>Sex*Time of Day</td>
<td>9.61</td>
<td>1</td>
<td>0.04</td>
<td>0.85</td>
</tr>
<tr>
<td>Treat<em>Sex</em>Time of Day</td>
<td>733.98</td>
<td>1</td>
<td>2.86</td>
<td>0.09</td>
</tr>
</tbody>
</table>

- **Treat**: Treatment
- **Time of Day**: Morning / Afternoon
Fig. 4: Graph of the Interaction Between Treatment, Sex and Time of Day for Male Students for Achievement3.

Time 1: Morning
Time 2: Afternoon
Fig. 5: Graph Illustrating the Relationship Between Treatment, Sex and Time of Day for Female Students for Achievement.

Time 1: Morning
Time 2: Afternoon
### TABLE 14
Descriptive Summary of the Adjusted Means and Standard Errors of the Scores for Achievement3 By Treatment By Sex and By Time of Day.

<table>
<thead>
<tr>
<th>Treat</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Morn.</td>
<td>Noon</td>
</tr>
<tr>
<td>Adj. Mean</td>
<td>71.15</td>
<td>66.03</td>
</tr>
<tr>
<td>Std. Error</td>
<td>4.84</td>
<td>3.50</td>
</tr>
<tr>
<td>N</td>
<td>12</td>
<td>21</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Control</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adj. Mean</td>
<td>61.55</td>
<td>53.67</td>
</tr>
<tr>
<td>Std. Error</td>
<td>4.30</td>
<td>5.22</td>
</tr>
<tr>
<td>N</td>
<td>15</td>
<td>10</td>
</tr>
</tbody>
</table>

Adj. Mean : Adjusted Mean
Std Error : Standard Error
Morn.: Morning classes
Noon : Afternoon classes
In the analysis of covariance on the PstAtt scores, significant main effects were determined for treatment (F=6.27, p<0.01). The results for this analysis are reported in Table 15. Data on this dependent measure showed that the post-test score for attitudes was greater for the treatment group (adjusted mean=3.39), than for the control group (adjusted mean=2.99). Since there were no interaction effects observed, null hypothesis 1 to null hypothesis 4 (p. 59) are not rejected. Since there are main effects for treatment, null hypothesis 5 is rejected for attitudes toward science class.

In the analysis of covariance on the process skills data, no significant main effects or interaction effects were observed. The results for this analysis are reported in Table 16. As such null hypothesis 1 to null hypothesis 5 are not rejected for process skills.

Table 17 gives a summary of the means for all the pre-test and post-tests for Achievement1, Achievement2, Achievement3, Attitudes, and Process skills.
TABLE 15
Summary of a Three Way Analysis of Covariance on PstAtt Scores By Treatment By Sex and By Time of Day.

<table>
<thead>
<tr>
<th>Source</th>
<th>MS</th>
<th>df</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariates</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PrePsk</td>
<td>0.02</td>
<td>1</td>
<td>0.85</td>
<td>0.04</td>
</tr>
<tr>
<td>PreAtt</td>
<td>21.35</td>
<td>1</td>
<td>43.57</td>
<td>0.0001</td>
</tr>
<tr>
<td>Main Effects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treat</td>
<td>3.07</td>
<td>1</td>
<td>6.27</td>
<td>0.01</td>
</tr>
<tr>
<td>Sex</td>
<td>0.16</td>
<td>1</td>
<td>0.32</td>
<td>0.57</td>
</tr>
<tr>
<td>Time of Day</td>
<td>0.66</td>
<td>1</td>
<td>1.34</td>
<td>0.25</td>
</tr>
<tr>
<td>Interaction Effects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treat*Sex</td>
<td>0.58</td>
<td>1</td>
<td>1.18</td>
<td>0.28</td>
</tr>
<tr>
<td>Treat*Time of Day</td>
<td>0.05</td>
<td>1</td>
<td>0.11</td>
<td>0.74</td>
</tr>
<tr>
<td>Sex*Time of Day</td>
<td>0.39</td>
<td>1</td>
<td>0.79</td>
<td>0.38</td>
</tr>
<tr>
<td>Treat<em>Sex</em>Time of Day</td>
<td>0.00</td>
<td>1</td>
<td>1.00</td>
<td>0.95</td>
</tr>
</tbody>
</table>
**TABLE 16**

Summary of a Three Way Analysis of Covariance on PstPsk Scores By Treatment By Sex and By Time of Day.

<table>
<thead>
<tr>
<th>Source</th>
<th>MS</th>
<th>df</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Covariates</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PrePsk</td>
<td>0.90</td>
<td>1</td>
<td>25.93</td>
<td>0.0001</td>
</tr>
<tr>
<td>PreAtt</td>
<td>0.02</td>
<td>1</td>
<td>0.45</td>
<td>0.50</td>
</tr>
<tr>
<td><strong>Main Effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treat</td>
<td>0.25</td>
<td>1</td>
<td>0.75</td>
<td>0.39</td>
</tr>
<tr>
<td>Sex</td>
<td>0.02</td>
<td>1</td>
<td>0.51</td>
<td>0.47</td>
</tr>
<tr>
<td>Time of Day</td>
<td>0.01</td>
<td>1</td>
<td>0.36</td>
<td>0.55</td>
</tr>
<tr>
<td><strong>Interactions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treat*Sex</td>
<td>0.01</td>
<td>1</td>
<td>0.17</td>
<td>0.68</td>
</tr>
<tr>
<td>Treat*Time of Day</td>
<td>0.01</td>
<td>1</td>
<td>0.23</td>
<td>0.63</td>
</tr>
<tr>
<td>Sex*Time of Day</td>
<td>0.06</td>
<td>1</td>
<td>1.70</td>
<td>0.20</td>
</tr>
<tr>
<td>Treat<em>Sex</em>Time of Day</td>
<td>0.00</td>
<td>1</td>
<td>0.06</td>
<td>0.80</td>
</tr>
</tbody>
</table>
**TABLE 17**  
Summary of the Raw Means of the Four Pre-test and Five Post-test Scores By Treatment By Sex and By Time of Day

<table>
<thead>
<tr>
<th>Sex T</th>
<th>N</th>
<th>Pre-tests</th>
<th></th>
<th>Post-tests</th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ach1</td>
<td>Ach2</td>
<td>Att</td>
<td>Psk</td>
<td>Ach1</td>
<td>Ach2</td>
<td>Ach3</td>
<td>Att</td>
</tr>
<tr>
<td>F a m</td>
<td>12</td>
<td></td>
<td>64.0</td>
<td>15.1</td>
<td>3.27</td>
<td>0.50</td>
<td>85.30</td>
<td>56.20</td>
<td>83.32</td>
<td>3.55</td>
</tr>
<tr>
<td>p m</td>
<td>21</td>
<td></td>
<td>50.96</td>
<td>16.24</td>
<td>2.75</td>
<td>0.50</td>
<td>76.28</td>
<td>47.96</td>
<td>65.65</td>
<td>3.27</td>
</tr>
<tr>
<td>Treat</td>
<td>Mam</td>
<td>10</td>
<td>60.0</td>
<td>18.25</td>
<td>3.77</td>
<td>0.48</td>
<td>90.92</td>
<td>52.50</td>
<td>69.12</td>
<td>3.49</td>
</tr>
<tr>
<td>p m</td>
<td>25</td>
<td></td>
<td>63.81</td>
<td>8.09</td>
<td>3.19</td>
<td>0.52</td>
<td>72.48</td>
<td>55.76</td>
<td>65.6</td>
<td>3.39</td>
</tr>
<tr>
<td>F a m</td>
<td>10</td>
<td></td>
<td>66.0</td>
<td>8.50</td>
<td>2.94</td>
<td>0.59</td>
<td>77.80</td>
<td>32.20</td>
<td>58.65</td>
<td>2.81</td>
</tr>
<tr>
<td>p m</td>
<td>13</td>
<td></td>
<td>49.23</td>
<td>2.62</td>
<td>3.19</td>
<td>0.51</td>
<td>75.54</td>
<td>28.77</td>
<td>56.92</td>
<td>3.04</td>
</tr>
<tr>
<td>Control</td>
<td>Mam</td>
<td>15</td>
<td>61.33</td>
<td>6.80</td>
<td>3.41</td>
<td>0.65</td>
<td>89.47</td>
<td>53.06</td>
<td>67.16</td>
<td>3.01</td>
</tr>
<tr>
<td>p m</td>
<td>10</td>
<td></td>
<td>50.0</td>
<td>5.10</td>
<td>2.45</td>
<td>0.49</td>
<td>79.30</td>
<td>52.90</td>
<td>51.81</td>
<td>2.84</td>
</tr>
</tbody>
</table>
ANALYSIS AND INTERPRETATION OF INTERVIEWS

The purpose of the interviews was an attempt to get an insight into the thinking of the students. The question that the researcher wanted to explore was, how do students feel about cooperative learning? It is possible that the existent attitudes students have toward science class are a result of the experiences they have had in the past in their science classes. The students were chosen according to their responses on the pre-test and post-test for attitudes toward science class. Six students, three boys and three girls were chosen according to their responses on the pre-test and post-test checklists for attitudes toward science class.

To decide which students to interview, the standard error (0.08) for the pre-test scores on the attitude measure was used. To describe positive, neutral, and negative attitudes, it was decided a priori that the interval around an average score of 3.0 should be used. Thus, the interval between 2.92 and 3.08 was considered to represent a neutral attitude. Any score below 2.92 represented a negative attitude, and any score above 3.08 represented a positive score. Student A and Student B were two students who had a negative attitude and moved toward a less negative attitude in the checklists administered for attitudes toward science. Student Y and Student Z changed from a positive attitude to a negative attitude and Student U and Student T had negative attitudes toward science and retained that attitude. Students A, Z, and U were girls and Students B, Y, and T were boys.

Among the interviewed students all but one indicated that this was the first time he/she had been exposed to a cooperative learning experience.
Science had always been taught to them from a textbook where the major activity or learning experience consisted of reading the chapter and answering the questions at the back. There was limited social interaction in the classroom and if the student did not understand something he/she had only the teacher to ask. Because of this, Student T (boy) said he did not understand much in the science class. Learning in groups provided a more fun filled setting for science learning along with providing, or at least encouraging, the necessary peer support for learning. Science to him had always meant a lot of memorizing. What textbook learning meant to Student T (boy) was never doing any "fun" things or laboratory activities. This thought did not seem to excite him in the very least. He said,

"What makes science difficult for me is trying to understand it, so learning in groups helps."

Student B (boy) felt that learning science from a textbook "really does not help you to learn" and when you work in groups you can come to know what the others know and learn from other people and their knowledge as well as from the teacher and the textbook.

Student A (girl) said that in the past in their science classes all they did was sit and passively listen to the teacher. Any questions that arose just went unanswered. Thus, understanding was limited. Student U (girl) said that sometimes in her past science classes that, even though they were paired for the seating arrangement, they did their work individually. The whole experience of working in groups appeared to be exciting to these students because they were interacting with each other and in the words of
Student B (boy) not just "sitting and listening to the teacher writing on the board".

In terms of the cooperation and efficiency of working together, everyone did admit to having problems sometimes. There was a certain amount of arguing among group members and sometimes tempers did flare up. But it seems this anger was more because of some task related problem rather than any other procedural issue. Either somebody was acting up, being lazy, or simply was not doing his/her work. For example, Student T (boy) said that sometimes the reason for arguing was,

"some people would not do their job on time."

and this,

"slowed us all down and we had to wait for that person to finish."

He also said that this was frustrating, especially if this person was not serious about completing the work and paying attention. Also, sometimes egos clashed. One student would ignore the other, who was trying to get the task completed. Thus the ongoing social interaction did include some degree of conflict as well as healthy discussions.

Student U (girl) said that it became particularly frustrating if someone was trying to concentrate on completing the task and some people in the group were acting up. Rather than dealing with such situations she would prefer to work alone, because such problems slow her down. But later on she contradicted that and said that given the choice she would rather work in groups.
The conflicts mainly appeared to take place when one member of the group did not get their work done in time or do their homework, thus making the whole group lose points. However, Student B (boy) said that, since all four group members had to have the same answer to a question, and be convinced that it was the right one and thus be able to justify it, sometimes there were arguments in his group when someone insisted his answer was the right one and everyone else was wrong. But generally it seemed that group members did try to amicably settle arguments and solve any problems that arose.

The students frankly admitted that the best thing about learning in groups was the fact that they could get help from each other in understanding and getting the homework completed. Student T (boy) said that he liked working in groups because "he gets the help he definitely does need at times". Student A (girl) admitted that if they had not learnt the unit on mass and balance in groups she would have been totally lost and probably failed the test. Student U (girl) said that cooperative learning made learning better because they were not working alone but with three other people and so if one person did not understand something or had difficulty with a concept there were others to explain. Student U (girl) also said that a good thing about cooperative learning is the fact that it helps make science learning a more fun filled experience. She said,

"When you're just sitting there doing classwork and not learning anything, science is boring, however when you are in a group working with other people and the teacher, it becomes more fun."
Student B (girl) pointed out an advantage of cooperative learning so easily overlooked in a classroom environment: that it allows students to get to know each other better. Social interaction is an integral part of the learning process and sometimes a traditional teacher-directed classroom can provide a barrier to the student-student interaction and thus discourage healthy discussion and arguments that could augment the learning process.

Another interesting fact that emerged from the interviews with all six students was the fact that all six of them assessed that in general their groups worked very well and they achieved above average grades. This is indicative of the fact that with the conflict that arose and all the discussion that took place, the students did get a feeling of harmony and increased enthusiasm.

"Science is boring!" Out of the six students interviewed all found science boring. However five were ready to admit that they could learn to like science more if they were taught in a more interesting way or if the science learning experience was made more fun. Even if their responses on the checklists did not show any change in attitudes toward science, they did perceive that science is any less intimidating if learnt in groups. Student T (boy) said,

"Maybe if science was always learned in groups I could like science because maybe it could be easier."

Science did not seem to hold any fascination for them, or at least it never interested them in the past. Student A (girl) thought that the reason for this was the instructional method. She said that the way she was taught
science in the past made her find science boring. They never did any activity on their own and just took notes. However learning in groups seemed to have made an impression on her. She said,

"I think it has changed my attitudes toward science. Because earlier I would not even come to the science class. When I was in my previous school I did not even go to the science class. I skipped it, I did not even like science class."

The important point that emerged from the conversation with Student A (girl) was that after being taught in groups she was "starting to feel comfortable with science now". Student A said that the change in the way she felt about science was because of the new way of learning science in groups, because as she said that in the past,

".........in some science classes I would go to sleep because they were so boring, but this year I have never gone to sleep in science class and I am always awake, taking notes or doing my worksheet or something."

Science did not appear to be a popular subject at all with these students. Student U (girl) said that, "if it was not mandatory to take science," she would not take it because she wants to be a lawyer when she grows up and does not need any science for it. Obviously the day to day relevance of science has not been made apparent to her and so she feels that if she is not going to need it in her future studies, why should she study it now.

When asked what was the worst thing about cooperative learning, the universal answer was arguing. Cooperation is an integral part of success for the groups. Even if one member did not cooperate it could
hamper the group performance. Because of this everyone must work efficiently and in cooperation with others. It hurt the students to see their group lose points over matters of discipline or late returning of assignments. Student U (girl) said that she found that the worst thing about learning in groups was the fact that people sometimes did not do their work on time and this was very frustrating. Student B (boy) said that he did not like the fact that when he came back after being absent, he found it difficult to catch up. He said,

"When I'm absent and they are already half finished and they are going on to the next thing and I'm trying to catch up, I haven't finished this thing I'm supposed to."

However he did go on to admit that they did help each other catch up when someone had been absent. When asked if given a choice would they choose a traditionally taught science classroom or a classroom where cooperative learning was taking place, five of the six students chose the latter, because they felt that working in groups made science more fun and also helped facilitate their understanding of science concepts.

It does not seem that gender played a role in their attitudes toward science. Boys and girls both did not like science. The experiences they had outside school that could indicate their interest in science out of school, mainly were limited to attempts to repair broken stuff. However, even of these, two of the boys said they would do only if they had some prior knowledge while one boy said he never attempted since he was not interested. A comparison between the responses of the boys and the girls did not reveal any significant difference, so it appeared that gender did not have much to do with any exploration of mechanical/electrical devices.
It seems that the students feel more comfortable with the concept of asking their peers for help and explanations rather than the teacher. In traditional learning, although most of the teachers would attempt to answer any questions asked, students seem to have some hesitancy or reluctance in standing up in front of the class and asking the teacher a question or to explain a concept more explicitly. Perhaps, because this is in fact admitting to the class that he/she has not understood something.

Also, from what the students said, the major result of the treatment that emerges is the fact that these students have found science boring and difficult in the past but the experience of cooperative learning combined with laboratory activities, has made a change in their attitudes towards science in that they find science class more fun and science learning not an impossible task.

Among the two students whose responses on the attitude checklist did not show a positive change (Student U (girl) & Student T (boy)) and the two students who showed a positive change (Student A (girl) & Student B (boy)), all four clearly indicated that given the choice, they would choose to be taught in groups. Also it is interesting to see that even Student U (girl) and Student T (boy) admitted that they found science more enjoyable if taught in groups. One of the students (Student Y, boy) who showed a positive to negative change in attitude also preferred to work in groups. So even though the checklist responses did not indicate a change in attitude toward science class, after seven weeks of a cooperative learning experience, the students admitted that their attitudes towards science and the science
class have changed. They do not skip science classes as much and they are starting to find science class interesting, easier, and more fun.

Student U (girl) seemed to have had a bad experience in the group she was placed in for the second section of the unit. She was named the manager of the group and she was the only girl in the group. She seemed to have had a frustrating experience in trying to get her group members coordinated and on task. If she had the right answers the others seemed hesitant to listen. She said,

"There was arguing on which answer is right and then you show them how you got it and they really let you know .... they really felt kind of .... they didn't .... you know they felt like .............. kind of as if they were being embarrassed and they did not like it."

At another instance she says,

"They did not like it when I was right and they were wrong".

It was interesting to read Student Y (boy) and Student Z's (girl) responses on the interview. They were two students who showed a positive to negative change from the pretest to the posttest on the checklist for attitudes. Even though such a change could be indicative of a dislike of the instructional experience they had the past weeks, only Student Z (girl) was vehement about her preference to work individually. Student Z (girl) was the only student who had experienced cooperative learning before and this had not been a new experience for her. However Student Y (boy) had always been taught traditionally from the book. Similar to other students interviewed he said that,
"Last year we just would read the chapter and then at the back of the chapter we might even like answer four or five questions or we'd talk about the chapter, do four or five questions at the back and then be done with the chapter."

He clearly seemed to have enjoyed the new experience of doing hands-on science, using equipment, and doing lab in science. For him that seemed to be the major difference in the science classes he had this year and what he had the past years. Science instruction had never meant doing lab activities or in fact doing anything other than reading the book. This he said did not help him to understand science at all. He did say that even though his responses indicated a positive to negative change in attitudes toward science class, he was actually undecided about science and science class, and this could be a reason for contradiction in his responses on the checklists. He said,

"I think I really do not know much about science. I think I would really like to learn more about science...to know what science really is. But I would like to do more science to decide how I feel."

He did add, however, that whether he likes or dislikes science, "depends on the way it is taught...it depends on how we learn." So actually he did not dislike the treatment composed of cooperative learning experiences along with laboratory based activities, and in fact preferred it to working individually. What he really enjoyed was a combination of learning in groups, laboratory activities, and hands-on science. He indicated his liking for chemistry because he associated chemistry with,

"...a lab, measuring things, testing things, and making different things, testing to see what they are and stuff like that."
His experience with cooperative learning seemed to have been a good one. There was good cooperation in his group and working with others certainly helped him to understand the task more easily, because if he needed help he could ask his group members. Also he liked the idea of doing things, "on your own". He said,

"I get to see it and I get to like, prove it and I get to see if it is the right one or not. I haven't been able to do it before. Earlier I was just reading the book. I wasn't really understanding what was going on in the book..."

Thus even though his responses on the checklist showed a negative attitude toward science, his responses on the interview indicated that he had become more tolerant toward science. In the interview he clearly said that he enjoyed learning science in groups and would choose this any day to learning alone, through traditional book directed learning. He admitted that he was unsure about his feelings about science but felt that there had been a change in his attitudes toward science class because of the cooperative learning experience. He said.

"Last year I never really liked science, actually I never really wanted to learn science. I really wasn't interested and I thought we'd be taught the same way in this class too. If that were the case I wouldn't have wanted to have science. But now I've come to the seventh grade and we're doing and learning science in groups and also doing lab and I'm ready to give it a try."

Student Z's (girl) interview is very interesting. She was the only student for whom cooperative learning was not a new experience. She did
not have a positive experience and disliked working with others. She said she likes to work alone because if, "they mess up it affects our grades too". By, "they", she referred to other members of her group. She did not like the idea of group points and a group grade because that way part of her own individual grade was dependent on the performance of her group members. She said,

"....if I do work by myself I can fend for myself and not worry about everyone else's work."

Working with others did not seem to have been an enjoyable experience for her at all. She said,

"....its like two people working together, they might have different opinions and start arguing about the right answer and then like you'll never get done."

She did not like waiting to help others catch up and felt her time was wasted. That could come from the response she got when she needed and asked for help. She said,

"Its just like that some people we got put with I might not get along with. Its just that when we ask for help some of them just won't give us that help. They just don't like to help. This happens mostly when we ask for help, if when we need help and there are lots of times when we need help and then we have to go and ask the teacher and she's there but that's not nice and most people ignore us like we do that and don't know that, so I'd rather be by myself."
So, since she did not get any help when she needed it she'd rather not give help to others. She decided that people ignored her and were not helpful and so would rather work alone.

"...I just don't like to talk to other people about the answers, because if I figure it out by myself, I do not want to share it, because no-one else shares with me.

This outburst could have been a result of some bad experience she had in her group. She admitted that things were fine when she was with the previous group, but in the second group she seemed to have had trouble getting along with the members of the group. There was an indication of clash of egos here and so her strong reaction to the statements on the checklist could be a result of this conflict. Later on in the interview she admitted she liked labs in science and also doing labs with others. She said,

"When we do lab its better to get the work done, to have it done, to do lab is sometimes better, but it also is better to do lab with someone else because the work gets done faster."

So here again there is a contradiction from what she said earlier about totally disliking working with other people. She did go on to say that it was okay to work with others if everyone else's "attitudes" were right.

In Appendix L are shown two tabulated representations of some of the results from the interviews. The Table 18 in Appendix I, lists the general categories or themes that emerge from the interviews and also indicates the responses of the different students in terms of an affirmative or negative. Table 19 in Appendix I, reports common words/phrases
mentioned during the interviews and also illustrates whether each of the students interviewed did mention that word or phrase.

TEACHER'S VIEWPOINT

The teacher involved in this study has been teaching science in elementary schools for over twenty years. She said that it was only after some inservice teacher training programs, a couple of years ago that she was introduced to the concept of cooperative learning. Before that she taught by using the book most of the time. For this study, she used a cooperative learning, combined with inquiry oriented instructional approach for the treatment group. The control group classes were taught in a traditional method that did not involve much student-student or student-teacher interaction. The students worked individually and competitively against each other. The task however was the same for both the groups and involved hands-on inquiry related activities.

The teacher was of the opinion that it made sense to use cooperative learning combined with inquiry in teaching. She felt it really worked well together. According to her, in science class she has to make students work in groups anyway, while doing a laboratory activity, because of the shortage of equipment. So, when the task was appropriately structured and cooperative groups were used for the same activity, it really worked well. She felt it was also important to consider that most students do like to work together. She said she was aware that,

"......lots of teachers feel uncomfortable with it. They do not like to see kids talking. Its scary to them to see kids moving around the room....,"
However she liked the teaching through cooperative groups. She said that it is boring for the students to sit and listen to the teacher talk for forty minutes at a stretch. She felt that students in middle school liked to socialize, they liked talking to one another. She said,

"The students in my school come from fourteen different neighborhoods. They need to get to know each other, they need to learn to socialize with every-one, with kids of different races. Cooperative learning so becomes a way to learn about each other, not feel scared of each other and develop friendships."

Thus, she felt that by socializing they learnt to work with each other and with every-one. It was interesting for her to see the group camaraderie when the teacher was taking a group quiz. She said the students of a group would all try to teach the answer to each other and make sure that they did well as a group.

She felt that students in middle school generally are scared of science. They have had very little science in elementary school, where they did not have to use more thinking skills. She said that the students in her class were mostly used to just reading the chapter in the book and answering the questions at the back of the chapter. When they did science in seventh grade they had to think and reason for the first time. She felt that working in groups made that a less scary experience for them.

The teacher felt that even if the attitude checklist had not been administered, she knew after two weeks that the attitudes toward science class were different for the treatment and the control group classes. Also, she felt the control group classes were very chaotic. The students worked individually and were very involved in the competitive aspect of
achievement. Some of the students just were bothered about racing ahead and being the best. They would not share information, were not friendly and were secretive all the time. So, they developed enemies and other students hated them.

The teacher was surprised that there was no change in the process skills between the two groups after the treatment. She felt that it could be because this was the seventh grade and that this was their first experience in the type of thinking the test required. She felt that perhaps by the end of eighth grade they would be ready for it. She said that they had not had too much science in the past to be exposed to reasoning needs. Most of them studied the little bit of science they did have in traditional classes. She also suggested that perhaps these kids had not reached the level of abstract thinking as yet. Also, the test required some math skills which she felt they were very poor on.

The difference in achievement between the two groups was very pleasing to her. She felt that one reason for the increase in achievement in the treatment classes was that students pressured each other to learn. However, she felt that such peer pressure to learn was not bad. She said,

"It's interesting to see how they pressure each other to learn. It's okay to have some peer pressure. If it works, why not? With the kind of students that I have, some students that always get A's and some students who just do not care at all, I think peer pressure works well. I think if peer pressure works, why not?"

The teacher also said that it was only because of peer pressure that most students in the treatment group returned their homework assignments on time. In the control group classes, she got on an average of a maximum of 6
papers back from a class of 24 students. Contrary to this, in the treatment group 1 or 2 students, at the most, would not return their homework. So, if it was peer pressure working she felt it was okay, because at least the students were doing the task.

The teacher also felt that it was much easier to teach the treatment group classes. She said the discipline was certainly better in these classes because it was much better organized. There was one equipment person and so only one member of each group got up from the seat and got the equipment. Also, one person was reading and trying to keep everyone at the same point at the same time. She also said it was much easier for her to interact with the students and assess them because,

"...I have to go one table and can talk to four students at one time, which makes it easier than talking to 24 students individually."

So, she said the assessment was much quicker and easier in the treatment classes with the added benefit of facilitation of more interaction with the students. Also the students enjoyed having responsibility. The managers especially enjoyed the feeling of power their position gave them. They had to make sure that all members of their group behaved and were on task all the time. The teacher said she did not mind the fact that the students in the treatment classes were talking with one another. She said that at the age at which they were, they would anyway be tempted to talk with each other. So, she said if the students were talking about the task instead of some non task related issue, it was better.
As far as the time of the day effects are concerned, she said that she felt any teacher would agree with the fact that the students in the morning classes are easier to handle and perform better than the students in the afternoon classes. She said,

"...by afternoon, once the kids have had lunch, they are very active, they have been socializing running around outside and suddenly they have to come in and calm down. I think it is very hard for them. They got up at 6 a.m. and by afternoon they are tired."

She also said that the reason for their hyperactivity could be related to the food they ate at lunch. Most of the students, she felt ate food that was not good for them. It mostly included a lot of candy and sugar.

The teacher was of the opinion that in the treatment group, the girls worked better in cooperative groups than the boys. She felt that could be because the boys felt pressured to be competitive academically or sometimes they were just competing with each other in being the chief "class clown". According to the teacher cooperative learning groups also allowed the students to understand the material better. She said,

"Sometimes kids understand material better from a peer than a teacher. They are so turned off by teachers that they will not listen. So, it's really important to have the students work together for academic as well as social reasons."

The teacher felt that an added advantage of cooperative groups was the fact that it forced all students to be actively involved in the task. In the traditional classes, it was usually the boys who were handling and using the equipment, while the girls just sat and watched. According to the teacher
even though it may seem like some students are having a free ride, it's okay to her, because,

"...even if they are copying or listening to another person, maybe they are learning something. Sometimes some kids are very good verbally but not good writers. It is also true the other way, and so if they are helping each other, I think it's okay, because at least they are doing their work and not skipping class."

In conclusion, the teacher felt she must add that she was well aware that cooperative learning does not work with everyone. However, she said that she has had very positive experiences with it and would like to continue using it in her science classes.

A SELECTION OF NEGATIVE STATEMENTS MADE BY THE INTERVIEWEES RELATED TO SCIENCE AND THE INSTRUCTIONAL METHOD

1. "I did not like science, so I did not go to science class." Student A.
2. "Earlier we just did stuff from the book." Student A
3. "The way I was taught science before, I found science boring." Student A
4. "I never like to go to science class because I could never understand anything." Student B.
5. "...we never did do as much science before." Student B.
6. "Sometimes everybody really did not help each other." Student B.
7. "There was some arguing." Student B.
8. "I found science boring." Student B.
9. "...sometimes when people in your group are playing up its better to work alone." Student U.
10. "Science is boring when you have to learn it alone." Student U.
11. "Science never really interested me." Student T.
12. "...I never really liked science." Student T.
13. "I did not understand too much in science class before." Student Y.
14. "Actually, I'm not sure about science." Student Y.
15. "I'm kind of confused about science." Student Y.
16. "If others do not work, it affects you too." Student Z.
17. "...its a lot easier to work by yourself." Student Z.
18. "I'd say I dislike science." Student Z.
19. "Its just that science and me don't go together." Student Z.
20. "I find it (science) difficult and boring." Student Z.

**SELECTION OF POSITIVE STATEMENTS MADE BY THE INTERVIEWEES RELATED TO SCIENCE AND THE INSTRUCTIONAL METHOD**

1. "I am getting interested in science." Student A.
2. "I am starting to feel comfortable with science now." Student A.
3. "I was always interested in science. I just did not like science class." Student A.
4. (If she had not been working in groups) "I would have been lost. I would fail the test." Student A.
5. "I find science fun the way our teacher is teaching." Student B
6. "I think learning in groups is a better way of learning, than the regular way of teaching, just sitting and listening to the teacher writing on the board." Student B.
7. (When learning in groups) ".....I can help them and they can help me and we can get to know each other much better than just sitting and working alone with the teacher." Student B
8. "Science is more fun now because we are allowed to discuss our work and do it together." Student B.
9. "Its fun working in a group" Student U.
10. "(Science is ).......sometimes its okay." Student U.
11. "Its (learning in groups) better because like if you don't understand something, you can ask your group people...." Student U.
12. "I think I can like science if I had to learn it in groups...." Student U.
13. "Learning in groups makes it (science) better." Student T.
14. "I can tolerate it (science) if I did it in groups." Student T.
15. " I think its (learning in groups) fun, its better." Student Y.
16. "Science is fun when we're doing hands-on activity, working with things, trying to find out things." Student T.
17. "I like doing activities and I think its fun doing activities together." Student T.
18. "I think I would like to learn more about science." Student Y.
19. "I think I'm ready to give it (science) a try." Student Y.
20. "This is the first time I'm actually doing science." Student Y.
LIST OF FINDINGS FROM THE QUALITATIVE ANALYSIS OF DATA

The qualitative analysis of the responses in the interviews resulted in the following generalizations:

1. Cooperative learning was definitely a new experience for five of the six students interviewed.

2. Most students were more motivated to study science if they could work in groups. The general opinion showed a positive feeling to the cooperative learning experience. Most of the students found that working in groups made the task more interesting, better, and more fun, and helpful in understanding, completing class and home assignments, getting better grades, and making science less boring.

3. Most students enjoyed the experience of cooperative learning.

4. Most of the students admitted that even though arguing and non cooperation at times is possible when working in groups, they still would prefer working in groups in the science class rather than learning from the textbook or working alone.

5. Even though at present there was a general dislike for science, they felt that if they were allowed to work in groups in science classes and given the opportunity to do more activities in science classes their attitudes toward science could change. Even those students whose responses on the checklists showed poor attitudes toward science class at the end of the study said that science had never been so much easier and fun before. So, most of the students said that they would prefer to work in science classes where students were working in groups and there were hands-on laboratory activities required.
6. Most of the students liked the fact that being allowed to work in groups gave them an opportunity to get to know their classmates, interact with them, and if needed get help from them for academic tasks.

7. Most of the students felt they were more regular in returning both class and homework assignments because of fear of losing group points. Even though this may be simply because of peer pressure, effectively it resulted in having more students on-task in the classroom and also having them become more regular in their homework. As far as learning is concerned most of the students felt that working in groups helped them subsume the science concepts more easily and that they felt better prepared for the tests than they had in previous years.

8. Only one of the six students interviewed said that working in groups was irritating, difficult, unfair, and forced you to get along with people you did not like. She also felt that working in groups harmed her grade and slowed her down in her work and so she'd rather work alone.

9. Home environment and external influences seemed not to have influenced students' attitudes toward science as much as their experience with science in school in the past grades. Present attitudes seemed to have developed as a result of having found science difficult to understand, not having had much science before, having to memorize a lot of facts in science before, finding science irrelevant with daily life, and having science learning in the past restricted to answering questions at the back of the chapter.
LIST OF FINDINGS FROM THE QUANTITATIVE ANALYSIS OF DATA

ANSWERS TO THE RESEARCH QUESTIONS
Listed below are the answers derived from this study to the research questions decided upon at the end of Chapter 1.

1. The use of cooperative learning showed significant improvement in the achievement of middle school science students who were taught through the treatment that consisted of cooperative group work characterized by significant student-student and student-teacher interaction, as compared to students who were taught through a traditional approach using individualistic learning and the lecture method.

2. In the analysis of the Achievement3 data (the cumulative score at the end of the eight weeks of school) a near significance was determined for the treatment by sex by time of day interaction. The graphs showed that the treatment group did better than the control group for both boys and girls. Also, the boys in both groups and the girls in the treatment group did better in the morning than in the afternoon classes. The female students in the control group did slightly better in the afternoon classes than their counterparts in the morning classes. A comparison of the two graphs revealed that the treatment had a greater effect on the female students than the male students in the morning classes.

3. The treatment improved attitudes toward science class of middle school science students as compared to traditionally taught students. The students with negative attitudes toward science, started to view science in a less negative manner.
4. There were no gender difference in attitudes toward science class observed at the end of the study.

5. The treatment did not influence process skills.

6. There were no gender difference observed in process skills abilities at the end of the study.

7. The time of the day influenced only the achievement of the students and not attitudes and process skills. The students in the morning classes did better than the students in the afternoon classes. There were no differential effects between the treatment and control groups related to the time of day.
CHAPTER V
CONCLUSIONS

SYNTHESIS AND SUMMARY OF RESULTS

ACHEIVEMENT

In this study achievement was measured in terms of three variables, Achievement1, Achievement2, and Achievement3. Achievement1 was measured on the first section of the unit of mass and balance. In this, the students merely manipulated the variables, mass and length and attempted to discover the relationship of these variables to balance. Achievement2 was measured on the second section of the unit, where the students needed to apply the knowledge acquired, and the formula demonstrating the relationship between mass and length. Achievement3 data consisted of a cumulative percentile score for each student. It was indicative of the cumulative achievement at the end of eight weeks of school. The analyses of the data on achievement showed that the students in the treatment group had better scores than the students in the control group, both for Achievement2 and Achievement3. Thus, it can be said that after eight weeks of school the achievement levels of the treatment group were higher than the achievement levels of the control group.

These findings corroborate each other and are in concurrence with the
evidence from research that suggests that a cooperative learning/hands-on, inquiry oriented instructional strategy, such as one used in this study can improve the academic achievement of the students. Johnson and Johnson (1986) report on a meta analysis of 122 studies of cooperative learning done between 1924 to 1981 where 286 findings were analyzed using three different methods of analysis: voting, effect size, and z score. All methods of analysis found that cooperative learning tended to promote higher achievement than did a traditional/lecture strategy. This finding holds true for all age levels, across subject areas, and a variety of tasks. Johnson and Johnson (1983) also cite 19 studies which found that cooperative learning promoted higher achievement than did competitive and individualistic learning experiences. Slavin (1983b) reviewed 46 studies to determine the effectiveness of cooperative learning on individual academic achievement. He found that 63% of these studies showed significant positive effects on student achievement.

Inquiry oriented experiences too have been shown to influence academic achievement (Germann, 1988; Lott, 1983; Mattheis & Nakayama, 1988a). Alvin (1993) found that changes made in the instructional strategy from an expository one to an inquiry approach, provides more opportunities for students to apply intellectual skills, resulting in greater achievement.

The plot for the significant interaction between treatment, sex, and time of day in the analysis of the Achievement3 data indicated that in general the treatment had a greater effect on the female students than the male students in the morning classes. This could be attributed to a number of reasons. Sometimes girls are more socially oriented than boys (Berndt, 1982; Fisher & Narus, 1981). Masten, Garmezy, Tellegen, Pellegrini, and Larkin (1988) suggest
that girls are more socially competent at pre-adolescence and adolescence than boys who are more preoccupied with instrumental tasks at this age. Forehand, Neighbors, and Wierson (1991) say that differential changes by gender in social and cognitive competence are prevalent from the preadolescent to adolescent years. Girls at this age are becoming conscious of themselves and behave in a more mature manner. The social orientation of the girls is also interwoven with their increasing concern over their physical appearance. Richards and Larson (1989) are of the opinion that while the girls are drawn into interpersonal friendships, boys prefer to spend more time alone and in instrumental activities. To be able to work efficiently in groups, students need to be able to undertake responsibility and carry out assignments in a responsible manner. It is possible that boys at this age are uncomfortable in a cooperative learning/hands-on, inquiry strategy, where a certain amount of maturity and responsibility is needed, works better for girls than for boys.

The three way interaction also revealed that the students worked better in the morning classes than in the afternoon classes. Most students have specific learning styles which could have influence the students in the morning group to perform better in the control group students. Dunn, Beaudry, and Klavas (1989), say that most students have a preference for optimum learning at a particular time of day. The interesting thing here is that they say that most students are not morning alert. At the elementary level, only about 28% work well in the morning and many do not begin concentrating on difficult material until after 10:00 am and many are best in the afternoon. Dunn et al., (1989) also say that only about one third of the more than one million students they have tested prefer learning in the morning. At
the high school level Dunn et al., (1989) say that almost 40% are early morning learners, but a majority remain alert in the late morning and early afternoon too.

In conclusion, it can be said that the treatment by gender by time of day interaction for achievement, needs to be explored further, because it is quite possible that the result was a random occurrence and thus no generalizations can be drawn from it at present.

It is important to note that even though the analysis on Achievement2 and Achievement3 data showed treatment effects, the analysis of the data on the post-test for the first section of the unit (Achievement1) did not reveal any significant differences in achievement between the treatment and control group. The fact that the treatment group did not outperform the control group after three weeks of the treatment is probably because three weeks of exposure to cooperative learning/hands-on, inquiry experience is not enough to show any post-treatment differences that can be attributed to a change in the instructional strategy. For cooperative learning/hands-on, inquiry experience to be completely effective, the study duration has to be at least four weeks (Slavin, 1990). This brief period may be useful for theory building, but too short to serve as evidence of achievement effects of cooperative learning/hands-on, inquiry experience, as the mode of instruction. Slavin (1990) says, that results obtained from a brief periods of treatment can have some artificiality in them.

No significant gender by treatment interaction effects were observed. Gender seemed to play a role only for the Achievement2 measure for which the analysis revealed a gender effect. In this measure the boys did better than the
girls. However this was true for both the treatment and control groups and so it is not of particular interest to this study.

The time of day influenced both PstAch1 and PstAch3. However, these results were true for both the treatment and control groups. There were no significant interaction effects of treatment and time of day. Analysis of Achievement1 and Achievement3 data revealed that students in the morning classes performed better than the students in the afternoon classes. Thus, overall achievement at the end of eight weeks of school was generally higher for students with science class in the morning than for students with an afternoon science class. However, again since this is true for all the students in the study, it is not of particular interest to this study.

Stokes (1968) and Craig (1986) postulated that for most people the prime time for learning is in the morning. There is literature to suggest that there is a high correlation between optimum mental performance and eating breakfast (Laird, Levitan and Wilson, 1931; Pauk, 1983; Levertan, 1965; Powers, 1973). Teachers state that students attention span, academic achievement, and behavior improved drastically as a result of their eating breakfast in the Congressional Record, 90th Congress, 1968. Landis (1988) states that overeating at lunch time could result in an uneven flow of nutrients to the mind and body which results in the improper and inefficient use of nutrients. Bartley and Chute (1947) say that overeating results in blood redistribution sending a high concentration to the stomach for digestive purposes leaving relatively little for the brain and muscle. This results in fatigue and a decided disinclination for thought.
ATTITUDES TOWARD SCIENCE CLASS

Ormerod and Duckworth (1975) say that sometimes student attitudes toward science are considered more important than their understanding of science, since it is their attitudes that determine how well the students use their knowledge. Johnson and Johnson (1978) indicate that achievement and attitude are related. If the students have favorable attitudes toward that subject area, and increased motivation, then they are more likely to show greater achievement in that subject area as well as a more favorable perception of school as a whole. Cannon and Simpson (1985) found that attitude toward science appeared to be an important factor in science achievement.

The analysis of the data for attitudes toward science indicated significant treatment effects. At the end of the study, the students in the treatment group had better attitudes toward science class than did the students in the control group. This is indicative of the fact that a cooperative learning/hands-on, inquiry experience can help improve the attitudes toward science class of middle school science students.

Numerous studies have shown that cooperative learning experiences as compared to competitive and individualistic ones, promote more positive attitudes toward the subject area and the instructional experience (Wheeler & Ryan, 1973; Garibaldi, 1979; Johnson & Johnson, 1979; Johnson, Johnson, & Skon 1979; Lowry and Johnson, 1981; Smith, Johnson, & Johnson, 1981). Talton and Simpson (1987) investigated the relationship of attitude toward science, the classroom environment and achievement in science among tenth grade biology students. They found that 8% to 18% of the variance in achievement was accounted for by both attitude toward science and the classroom
environment; 5% to 14% of the variance in student achievement was predicted by the students attitude toward the classroom environment and 56% to 61% of the variance in attitude toward science was accounted for by their attitudes toward the classroom environment.

Johnson and Johnson (1975) found that students working with other students in a cooperative relationship show more positive attitudes toward science. Gunderson and Johnson (1980) are of the opinion that the use of cooperative learning can promote more favorable attitudes toward science. There is also evidence to support the contention that cooperative learning experiences promote more continuing motivation to learn than do individualistic learning experiences (Lowry and Johnson, 1981; Smith et al., 1981). Johnson and Johnson (1983, 1987b) showed that cooperative learning experiences compared with competitive and individualistic ones, promote more positive attitudes toward the subject area and the instructional experience, and also provide continuing motivation to learn more about the subject area being studied.

**PROCESS SKILLS**

The cooperative learning/hands-on, inquiry experience did not influence the problem solving and process skills abilities of the students in this study. There were no significant effects observed. This was an unexpected result. Johnson, Johnson, and Holubec (1986) are of the opinion that cooperative learning experiences promote the use of higher reasoning strategies and greater critical thinking competencies than do competitive and individualistic learning strategies. Presseisen (1992) says that cooperative
learning provides an environment for mastering the essential skills needed for becoming an effective thinker and good problem solver.

Laughlin (1973) from his research on college students in laboratory settings concluded that cooperative groups are superior, because the discussion process in cooperative groups enables the students to evolve more cognitive strategies for learning. Johnson, Skon, and Johnson (1980) studied the effects of interpersonal, cooperative, individualistic, and competitive strategies on problem solving tasks. Results indicated that on all the tasks the students in the cooperative conditions achieved higher than did those in the individualistic conditions and competitive conditions.

As such, it could have been expected to find that the treatment group would achieve higher scores on the process skills checklist. However this was not the case. One reason for this could be that the test was too advanced for the students in the sample used in this study. Even though the test was designed for this age group, on retrospect, it appears that the prior knowledge and processing skills abilities of these students were not developed enough for them to score well on this checklist.

There is some research evidence to support the fact that the acquisition of process skills is not improved by the use of cooperative learning or that there are any gender differences in the achievement of process skills. Berge (1990) studied the effect of group size, individuals, pairs, and quads of students, and gender on student achievement in a classroom using microcomputers as tools in learning science process skills. From his results he concluded that teams of four members working together solved problems as effectively as did individuals. Also, he did not find any significant gender
differences in the achievement of process skills.

McKenzie and Padilla (1984) studied the effect of three instructional strategies and student entry characteristics on student engagement and the acquisition of skills necessary for graphing. The strategies examined were an activity based approach, a written simulation based approach, and a combination of activity and written simulation instruction. No single instructional strategy among these appeared superior to the others with respect to increased levels of graphing achievement of the students.

Middle and junior high school students find problem solving difficult and are probably developmentally unable to benefit from instruction in a general problem solving approach (Helgeson, 1992). In this study, the teachers instruction was not specifically directed to the teaching of process skills. In fact it was a combination of concept teaching along with some derivations, reasoning, and problem solving. As such it seems reasonable that a change in instructional method alone could not bring about increased level of performance in the checklist for process skills. It had to be accompanied by other factors.

Wise and Okey (1983) examined the effects of various science teaching strategies on achievement. They defined twelve categories of teaching techniques. They concluded that an effective science classroom appears to be one in which students are kept aware of the instructional objectives and receive feedback on their progress toward these objectives. So introducing a new method of instruction such as cooperative learning did not improve problem solving abilities or overall academic achievement of the students, simply because the unit demanded the possession of skills that they did not posses or
had been specifically taught in the past. Brassel (1987), for example, says that if we want to teach students graphing we need to teach these skills explicitly and directly. If the process skills of middle school science students have to be improved then those specific skills must be taught directly to them. In most but not all cases using a science curriculum aimed at inquiry has resulted in significant gains in problem solving skills. Using a curriculum designed to promote an inquiry approach may result in gains in process skills (Helgeson, 1992).

No gender and treatment interaction effects were observed. There have been a number of studies that have used gender as a factor in process skills abilities and reported non significant differences (Helgeson, 1992). Humrich (1988) while studying the results of the Second IEA Study concluded that for fifth graders there was no significant difference between boys and girls scores on tests for process skills. Schmeiss (1971) also reported that there were no significant differences in sixth grade boys and girls ability to solve problems in science. Egolf (1979) while studying word problems found that gender was not related to problem solving ability. Ronning and McCurdy (1982) and Ronning, McCurdy and Ballinger (1984) found no significant gender differences in junior high school students process skills abilities. Coble (1986), Spooner (1986) and Matheis, Coble and Spooner (1986) found no significant gender differences on a sample of North Carolina students in their performance on TIPS II.

Also, no significant treatment by time of day interactions were observed.
QUALITATIVE DATA

The qualitative analysis of the information received from the interviews indicated that, generally the students preferred cooperative learning/hands-on, inquiry oriented experiences to textbook learning. There is earlier research to support this. Johnson (1976) attempted to determine whether students involved in an inquiry based science program perceived the class to be more cooperative or competitive. He studied three groups of students taught by different methods: textbook only, textbook supplemented with lab, and only lab. His results found that the inquiry oriented classes were perceived by the students to be more cooperative than were textbook classes. Also, the students preferred a cooperative science class to a textbook class. The students in the study indicated a clear preference for their science classes to be cooperative. He also found that students in science class with inquiry as the focus found science more enjoyable than did students in a textbook class.

In this study, too, the students reported that working in groups and actually doing activities in the class, be it mere discussions or some lab based experience, made them find science class fun and certainly more interesting than they had found it in the past. Being part of a cooperative group has been shown to be related to continuing motivation and a desire to achieve (Gunderson & Johnson, 1978). Cooperatively taught students have been found to show more motivation, belief in their efforts, and desire to achieve academically (Johnson & Ahlgren, 1976). The interviews in this study indicate that students felt more enthusiastic about science class. Johnson, Johnson, Holubec, and Roy (1986) say that cooperative learning should be used when we want students to learn more, like school better, like each other, and learn
more effective social skills. Finally, the fact that five out of six students interviewed said that given the choice they would certainly prefer being allowed to learn science in groups rather than do it alone, in itself is indicative that most students enjoyed the experience and felt more motivated by it to learn science. They also admitted that at present they dislike science but could learn to like science if they were taught through groups.

Finally, the teacher also reported that the treatment influenced the classroom environment and facilitated classroom management. The students were more on-task and the discipline in the treatment classes was better than the control group classes. Even though there was talking going on in the treatment classes, it was constructively oriented toward the task. However, students in the control group classes tended to get distracted more easily, go off-task, and talk arbitrarily with each other.

In synthesizing the results from the quantitative and qualitative analysis of data, it can be said that the significant increases in academic achievement and attitudes toward science class of students exposed to cooperative learning/hands-on inquiry experience were as expected. The qualitative analysis also showed that the students felt more motivated, seemed to have become more tolerant toward science, and appeared to find science more fun, if they learned in groups. Therefore, it can be said that the results suggest that a change in instructional strategy from a traditional teacher directed one to an approach that allows more student-student interaction and actual hands-on activities could result in improving the attitudes of middle school science students toward science, at least in making them less negative, and in the long run perhaps improving their desire to learn science.
RELATIONSHIP OF THE QUANTITATIVE AND QUALITATIVE RESULTS TO THE MODEL

The cooperative learning/hands-on, inquiry, approach implemented in this study took precautions to account for the inclusion of all the four essential components of cooperative learning depicted in the model (p. 23). The students were not simply placed in groups and told to cooperate. To prevent some group members from seeking a free ride on others by leaving their work for others to do, the task was appropriately structured. First, the students could not proceed in the task until each of them performed efficiently the role they had been assigned. The equipment person had to get up and collect the equipment needed, the reader had to read aloud the question/task to be worked upon, the reporter needed to understand and accurately report the results, and the manager had to assure the smooth functioning of the group. The students were expected to work on their worksheets, discuss their answers, and agree on one correct answer. The worksheet required the students to get their work assessed at regular pre-determined intervals. At this point the teacher would come to any one group member and ask a question concerning the response written on the worksheet. If the group member could not answer or justify the response, the teacher would leave the group, asking the student to learn from the rest of the group members and then call her back for assessment. The whole group was awarded one grade. However, at the end of the each section of the unit the students took a test which they completed individually. In this way individual accountability was structured along with positive interdependence. Face to face interaction was assured because of the discussion among students required for each of them to
complete and understand the task. Group processing and social interaction were encouraged through the organization of activities such as the selection of a group name, and the composing of a group song. This gave them a feeling of belonging. To help develop social skills needed to work harmoniously together, group games and quizzes were played. Also the students completed group process checklists which allowed the teacher and the students of a group together to discover and solve any problems they might have.

Motivation is important for achievement. It is commonly viewed as a combination of perceived likelihood of success with the incentive of success. The greater the likelihood of success and the more important it is to succeed, the higher the motivation. (Johnson and Johnson, 1978, p.6)

Both the qualitative and quantitative analyses showed that students who had cooperative learning/hands-on, inquiry experiences developed less negative attitudes toward science, toward the science class, and toward the instructional experience itself. In the interviews, the students mentioned the role the group grades and bonus points played in serving as a stimulus for increased regularity in homework and classwork as well as for overall achievement. As proposed by the model, the qualitative analysis of data revealed that there was an increased enthusiasm for the science class combined with a desire to achieve. This intrinsic motivation helped the students to persevere in their learning goals and increase their desire to be good students and get good grades.

Slavin (1983a) states that "group reward" means that the reward for each group member is a function of the extent to which each member of a group has
performed and learned in the task. Group rewards help to greatly enhance motivation (Slavin, 1983a). Because in this study there was group assessment along with individual tests, members were forced to ensure that every person in the group understood the concepts and could explain the observations that were made and the reasoning behind these observations. This is supported by Slavin's (1983a) contention that group rewards based on group members' learning increase instructional effectiveness. This could be because such rewards are likely to motivate students to do whatever is necessary to make it possible for the group to succeed, because no individual can succeed unless the group succeeds. The high percentage of homework assignments returned in the treatment group also indicates that the group points put some peer pressure on the students to complete their assignments and be regular with their work.

The students interviewed in this study indicated that doing activities and working with others made the learning experience more enjoyable and also less intimidating. Thus, the affective and motivational outcomes proposed by the model were corroborated.

Social interaction was very much an integral part of this study. Considerable time was spent on building social skills and allowing the students to become more comfortable with each other. Every week the intervention period was used to allow the students to initially introduce themselves, get to know each other, and become comfortable with each other. They were given time where each of them was asked to share experiences with another. They also selected names for their groups, wrote songs describing their groups, played group games, and completed checklists to ensure that
their group was in fact functioning smoothly. The emphatic above average assessment of their group efficiency indicated by the students interviewed suggests that the students did function well in groups. Group members did help each other understand and learn science concepts, because this was the most popular positive point of cooperative learning cited by the students interviewed. The students said that they liked cooperative learning better than any other instructional method because it allowed them to get the help from others that they so often need in understanding difficult concepts in science. Also, even though arguing was cited as the major problem, the students went out of the way to assert that arguing was not really a problem and they could solve any problems that did arise in the group. So, obviously, their social skills had led them to a point where they could amicably resolve any differences that arose among group members.

The importance of socialization in education has been emphasized before. In schools, most of the student-student interaction are limited to extra-curricular activities (Johnson, Johnson, Holubec, & Roy, 1986). Peer relationships are critical to the development and socialization of children (Hartup, 1976, Johnson, 1980) and should be an integral part of the school environment. Constructive relationships with peers can result in both social and cognitive development of children. Through social interaction with their peers, children can learn attitudes, skills, values, and other competencies which they may happen to admire in each other (Johnson & Johnson, 1986). Thus, it is obvious that through interactions students can learn to assist, share, and help others. There is a synergistic relationship among thinking skills, social skills, and cooperative learning. Certain thinking skills and social skills facilitate
cooperative learning activities, while many cooperative learning activities reinforce these same thinking and social skills. Cooperative learning experiences also promote more liking among students than competitive or individualistic experiences (Johnson & Johnson, 1983, 1987, Johnson, Johnson and Maruyama, 1983). Johnson, Johnson, Holubec, & Roy, in their book, Circles of Learning (1986, p. 26) say,

This is regardless of differences in ability level, sex, handicapping conditions, ethnic membership, social class differences or task orientation. Students who collaborate on their studies develop considerable commitment and caring for each other, no matter what their initial impressions and attitudes toward each other were.

Johnson and Johnson (1986) also say that to counter the socialization crisis cooperative learning experiences, where students work together to maximize each others achievement, can help promote positive relationships and a gradual acceptance among students.

A cognitive outcome of cooperative learning proposed by the model dealt with the academic achievement. The qualitative analysis of data found that most students interviewed found science easier to understand when learning in groups. They felt they were actually doing the activity, getting to find out what happens, and in fact getting to prove something. This seemed to make knowledge more viable to them. Students were involved in the active construction of knowledge through hands-on and lab experiences in groups. The interviews indicated that working in groups helped the students to solve any problems or difficulties that arose in the understanding of the task as well as in learning the concepts. Knowledge being acquired was both theoretical
and procedural. The fact that there was increase in academic achievement for two measures, it seems evident that the treatment did influence meaningful learning. There is no doubt that the knowledge, ability, and energy required for meaningful tasks is available within cooperative groups.

The third component in this model involving the relationship between readiness to learn in students and cooperative learning, was not explored in this study. Here a revision of the model is proposed. The readiness factor, is replaced with the teacher as a facilitator of learning. In a cooperative group setting much of the teacher's time was spent observing group members in order to see what problems they might be having, and also providing task assistance wherever needed. Monitoring students' behavior, and intervening were essential components of a successful cooperative instructional strategy. While monitoring the working of the groups, the teacher needed to constantly be moving around the room, clarifying instructions, reviewing procedures, and strategies for completing the task, and constantly asking and answering questions. The revised model is shown in Fig. 6.

In conclusion, it can be said that even though the factors involved in this study are in concurrence with the model, this study does not conclusively validate the model. More focused work needs to be done for this purpose. However, it does indicate that cooperative learning can play a significant role in increasing the motivation level of students to study science, and improve their attitudes toward science. This study also helps establish from the qualitative analysis of data, that the cooperative learning/hands-on inquiry experience can help develop attitudes and perceptions that create a less negative mental climate and thinking needed to increase achievement.
Fig. 5: A Revised Model of the Graphical Representation of the Factors Involved in Cooperative Learning
IMPLICATIONS OF THE STUDY FOR PRACTICE

There is considerable evidence that most students in the United States dislike science and fail to take advanced courses in science (Walberg, 1982). There is a critical need, therefore, to develop instructional strategies that will promote more positive attitudes toward the subject area being studied and increase students' motivation to study and learn more about that subject area. This study provides evidence that cooperative learning/hands-on, inquiry experiences improve attitudes toward science as well as the academic achievement of middle school science students. While recognizing the limitations of this study, it may not be out of place to consider the implications of this study for future ways in which science may be taught to middle school science students. Science can be made more enjoyable for students through cooperative learning, which also gives the added benefits of increased academic achievement. If a change in instructional approach can really help develop more favorable attitudes toward science, students may slowly give up this dislike for science and we could see more students opting for advanced science courses. Also, this study demonstrated the poor problem solving skills of these middle school students. As such it is recommended that more emphasis be paid to the teaching of process skills including reasoning and problem solving. This could involve both the introduction of new curricula designed specifically to teach these skills accompanied by an instructional approach geared at the teaching of these skills.
IMPLICATIONS FOR FUTURE RESEARCH: RECOMMENDATIONS

Although the pattern of results obtained in this study, supports the importance and benefits of using a cooperative, hands-on, inquiry oriented instructional strategy, it does raise further questions. The treatment by gender by time of day interaction for achievement revealed here needs to be further explored to substantiate this finding. It is recommended that similar studies be conducted at the fourth grade and high school levels, so that a comparison can be made between elementary, middle, and high school students. This could also facilitate in exploring whether the gender related developmental differences are influential in achievement and success of a particular instructional strategy.

A second recommendation is further exploration of the relationship between a cooperative learning instructional strategy and science process skills. The absence of any influence of the treatment found in this study is somewhat contrary to what the research suggests. As such, future studies are recommended, where different process skills instruments, with different levels of difficulty, are used.

A third suggestion is that the time of day influence on achievement be investigated further. If time of day does make a significant difference in the performance levels of the students, new innovative instructional strategies or activities may be needed.

Also, further validation of the model is needed. There could be other factors besides the cooperative group factor that were affecting the outcomes in this study. These factors might overshadow the benefits achieved through cooperative learning or be detrimental to the whole experience. Such factors
might include the prior conceptions of the students toward science, the students' perceived relevance of science, teacher behavior, and knowledge etc. If any of these factors can be shown to influence cooperative learning significantly, then their inclusion in the model might be considered.

Lastly explorations of varying strategies and activities specifically designed for morning and afternoon class times is suggested.

CONCLUSIONS

Even though the purpose of this study was to investigate the outcomes of a cooperative learning instructional strategy, it is reasonable to say that it is not always practical to use this strategy in the class. Even though there is enough research indicating that cooperation produces better results than having the students work alone, there is an important place for competition, and individualistic goal structures within a classroom. The teacher needs to use judgment in selecting the instructional strategy, based on the unit to be taught, and the students learning styles. Sometimes it may be appropriate to integrate a competitive, individualistic, and cooperative goal structure within one umbrella.

This investigation represents an expansion on the work that has been done on cooperative learning. Because of its exploratory nature, no final conclusions can be decisively drawn. Further work would have to be done to provide conclusive evidence. This is true especially for the relationship between achievement and time of day for which there is not much supporting literature available.
APPENDIX A

Letter to the Parents/Guardians of Participants in the Study.
Dear Parent or Guardian,

My name is Alka Ahuja. I am a doctoral student at The Ohio State University, Department of Science Education, working with Dr. S. L. Helgeson, Dr. Patricia E. Blosser and Dr. Arthur L. White. The current emphasis in science education research today is to encourage the use of an instructional strategy which will increase student participation in the classroom, give students opportunities to experience success, foster the development of positive attitudes toward science, and ultimately encourage them to choosing a science-related career. Such a strategy is the cooperative learning approach where students work in groups to understand subject matter under teacher supervision.

In my research effort, we will try to identify whether a cooperative learning strategy can influence student learning and attitudes of the students. Your child will be either in a traditionally taught classroom or a cooperatively taught one, depending on the period he/she has his/her science class in. The class will be taught by the regular science teacher. I will appreciate it if you would give me the permission to administer checklists for attitudes and process skills to your child. The scores obtained on the teacher constructed test for the unit will constitute the data for academic achievement. Let me assure you that the data would be kept absolutely confidential and the names of your children will not appear anywhere in the report. If you have any
questions, please feel free to call me at my home. The number is 614-293-0703, in Columbus, Ohio. If you do not want your child to be a participant in the study please sign this letter and return this form to the science teacher. If you do not send this letter back within ten days, I will assume that you do not mind your child being a participant of the study.

Thanking you in anticipation,

ALKA AHUJA

Name of Student ______________ __________

Signature of Parent/Guardian _______ ___
APPENDIX B

Letter to the Parents/Guardians of Students to be Interviewed.
Dear Parent /Guardian,

Hello! Thank-you for giving me the permission to test your child and collect necessary data for my study. Now I would further ask your permission to allow me to interview your child, with the purpose of getting some feeling as to how he/she perceived the experience of a cooperative learning strategy and also to get an insight to his/her attitudes and feelings toward science. There are no right or wrong answers to the questions. The child will simply be asked to give his/her opinion and personal viewpoints. The answers will be kept strictly confidential. Even though teachers at the school will be informed of the results of the study they will not read individual answers.

I would like to tape record this interview so that I can write less and pay greater attention to what the child is saying at the time of the interview. Is that okay with you? If you have any questions I will be happy to answer them. My telephone number at home is 614-293-0703. If you do not have any objections I will be grateful if you would sign above.

Thanking you in anticipation,

Alka Ahuja

Student name__________________________

Signature of Parent/Guardian___________
APPENDIX C

Interview Protocol: Sample questions for the interviews.
These are examples of the type of questions that will be asked in the interview.

1. For the past few weeks you have experienced an instructional strategy different from the kind you are used to. Which do you like better?

2. How interesting did you find your work in the group?

3. How difficult was it working in the group?

4. Did you get along with everybody in your group?

5. Did every-one in the group discuss ideas amicably?

6. Did you like how the different jobs were divided between members of the group?

7. Did your group members help each other?

8. Do you like science? What are your feelings about it as a subject?
9. Do you think you would like science more if you were taught through cooperative learning?

10. Would you consider taking science in college?

11. If no, why not?

12. What experience in school has contributed most to increasing your interest/disinterest in science?

13. What experiences outside of school have contributed to your interest/disinterest in science?

14. What would be the one most positive and one most negative aspect of cooperative learning in your opinion?

15. Do you think the experience of cooperative learning has influenced your attitudes towards science in anyway?

Thanks a lot for your cooperation!
APPENDIX D

Three checklists for Assessing Group Functioning: Form A, Form B, & Form C.
NAME: _____________ GROUP: __________ PERIOD: ________

Please circle the number that shows exactly how you feel. The numbers indicate the following:

1: Always
2: Sometimes
3: Never

1. I shared my ideas with others. 1 2 3

2. I asked others for their ideas. 1 2 3

3. I asked others for help if I needed it. 1 2 3

4. I helped the group to work efficiently. 1 2 3

5. I helped other group members to learn. 1 2 3

6. I checked to see that everyone in my group understood the task. 1 2 3

7. I included everyone in our work. 1 2 3

8. I helped summarize the group report. 1 2 3
FORM B: GROUP EVALUATION

NAME OF GROUP MANAGER: ____________________

MEMBERS OF GROUP: _______________________
                       _______________________
                       _______________________

1. I helped the group by ________________________________
                       ________________________________
                       ________________________________
                       ________________________________
                       ________________________________

2. ____________________ helped the group by _______________________
                       ________________________________
                       ________________________________
                       ________________________________
                       ________________________________

3. ____________________ helped the group by _______________________
                       ________________________________
                       ________________________________
                       ________________________________
4. ___________________________ helped the group by ___________________________

______________________________

______________________________

5. My group was efficient in ________________________________

______________________________

______________________________

6. My group was inefficient in ________________________________

______________________________

______________________________

7. On a scale of 1 to 10, I think that my group scores _____ for working well.
FORM C: GROUP PROCESS SURVEY

TEACHER OBSERVATION

DATE ________ PERIOD ________

MEMBERS OF GROUP:

________________________

________________________

________________________

________________________

Circle the number that indicates your assessment.

1: Good
2: Average
3: Needs Improvement

Group members understood the group goal. 1 2 3
Group members worked well together 1 2 3
Group members shared the work. 1 2 3
Group members took turns. 1 2 3
Group members listened to each other. 1 2 3
Group members understood what was being said. 1 2 3
Group members agreed on most answers. 1 2 3
Group members completed the group goal. 1 2 3
Group members evaluated how well they were cooperating.
APPENDIX E

Four Tests for Academic Achievement:

Test 1: Pre-test for Section 1 of the Unit
Test 2: Post-test for Section 1 of the Unit
Test 3: Mid-Test or Pre-Test for Section 2 of the Unit
Test 4: Post-Test for Section 2 of the Unit
A. Draw the following situations:

1. Lynn and Lauren are on opposite sides of a teeter-totter. Lynn weighs 80 pounds and is on the right side. Lauren weighs 100 pounds and is on the left side.

2. Jack and Tom are on opposite sides of the teeter-totter. Jack and Tom weigh 80 pounds each. Jack is on the right side.

B. Jack is helping to construct a new high-rise building downtown. He is standing at the end of a beam. Jack weighs 160 pounds. Study the diagram.

1. If each block weighs 10 pounds, what is the greatest number of blocks that can be removed without causing Jack to fall?

2. If each block weighs the same as three bricks, what is the minimum number of bricks needed to replace blocks and keep Jack from falling?
1. Study the diagram below:
What is indicated about objects A and B if the arm of the balance is in the position shown in the diagram?
A. 

[Diagram A]

B. 

[Diagram B]

C. 

[Diagram C]
2. A. Bob balances with 30 bricks on a see-saw. Sara balances with just 15 bricks. How does Sara's mass compare to Bob's? Explain your answer.

Bob also found that he can balance with 90 science books.

B. How many science books would it take to balance Sara?

C. How many books would it take to balance 10 bricks?
1. Draw the mass (shown in the circle) on the right side of the balance, so that it can balance.

2. Kisha and Antwan are balancing on a teeter-totter. Antwan weighs 40 pounds and is sitting four feet from the center (fulcrum). Kisha is sitting 8 feet from the center. How much does Kisha weigh?

Explain your answer.

Draw a diagram:
3. Consider the two layers shown in the diagram mobile.

In the upper layer, what is the mass of the car?

Explain your reasoning.
1. Draw the mass (shown in the circle) on the right side of the balance, so that it can balance.

![Diagram of a balance with mass and fulcrum]

2. Kisha and Antwan are balancing on a teeter-totter. Antwan weighs 40 pounds and is sitting four feet from the center (fulcrum). Kisha is sitting 8 feet from the center. How much does Kisha weigh?

Explain your answer.

Draw a diagram:
3. Consider the two layers shown in the diagram mobile.

In the upper layer, what is the mass of the car?

Explain your reasoning.
APPENDIX F

Student Interviews

Interview 1 : Student A
Interview 2 : Student B
Interview 3 : Student U
Interview 4 : Student T
Interview 5 : Student Y
Interview 6 : Student Z
INTERVIEW 1

Researcher : R

Subject : A

R: Hi! I would like to talk to you about your science class. Please feel free to tell me when you would rather not answer a question and we will just move on to the next question. You have been taught science now for seven weeks in this grade. Is it different from the way you have been taught science before?

A: Yes here we were allowed to sit in groups. We were allowed to do our work together, talk about our problems and teach other. Yes, it is different from before.

R: Is this the first time you have had this experience in your science classes?

A: Yes. Earlier all the time we were just sitting and listening to the teacher. But this is much more fun.

R: How do you like working in groups?

A: I think it's okay. I like it. I think it has changed my attitudes toward science. Because earlier I would not even come to science class. When I was in my previous school I did not even go to science class. I skipped it , I did not like the science class. I did not like science, so I did not go to science class.

R: But now...?

A: Now I like science class.

R: What's different?

A: Well earlier the teacher did not explain the stuff. We just did stuff from the book. They did not let us work together. Here the teacher explains the stuff
and then also if we do not understand, somebody from the group can help and explain it to us, so its much easier.

R: Did you have any problems working in groups?
A: No. We had no problems.
R: So your groups worked well together.
A: Yes, pretty well.
R: Was everybody helpful and cooperative in your group?
A: Well most of the time. Not always, all the time.
R: What happened when they were not?
A: I just sat down by myself and tried to work my way through the stuff and tried not to interfere.
R: But as a group did you try to solve your problems?
A: Yeah. We tried to make everybody friends and solve any problems or if there was a reason why they were fighting we tried to solve it and make everybody friendly and cooperative.
R: Was there much arguing?
A: No, not really.
R: So in your opinion, your group worked well.
A: Yes, definitely.
R: Is there any bad thing about learning in groups?
A: I guess its the arguing, but as I said that's not really a problem.
R: What about your learning and understanding? Has your performance improved?
A: I think I'm doing better than before.
R: Why do you think so?
A: Because now we’re learning in groups. So if we do not understand something, someone can explain it to us.

R: Okay, if we see your responses on the checklists, I see that in the pretest you said that science is boring, but now you say that science is fun. Why this change?

A: Because the way I was taught science before, I found science boring. But now that we are learning science in groups, I am getting interested in science. Earlier I was not interested in science at all. Earlier we never did labs in science at all. We just worked form the book and on the board. We took notes and just wrote and wrote.

R: So the reason for your change in attitude is.....

A: The reason for my change in my attitude toward science is because now we are learning science in groups. I can understand science more, I enjoy my science class more and I am starting to feel comfortable with science now.

R: So if you had a choice to sit in a class where you were taught traditionally, or in a class where you were taught in groups, which would you choose?

A: I would choose to sit in the class where I could learn science in groups. I would not like to sit in the other class, I may try it out for some days, but I know I would not like it, because that is the way I have been taught all my life, and if I did not like it I probably would not do my work.

R: What about homework? Has learning in groups made any difference to it?

A: Yes. I think I do it more regularly now.

R: What happens if you do not do your homework?

A: Well it affects our group points and other people in the group get mad and so I have always been doing my homework.
R: Have you always been regular with your homework?
A: I did some of it last year, when I went to class, but not so regularly.
R: Forget about what you felt about science before, if I was to ask you how do you like science now, what would you say?
A: I'd say I like science. My attitude toward science is much better than before. I find science fun in the way our teacher is teaching. I think I am learning more.
R: So what would you recommend to other science teachers about making science more interesting for the students?
A: Put the students in groups, just like our teacher does.
R: Will you take science in college?
A: Yes. I want to be a doctor, a pediatrician.
R: That's great!
A: So my mom says I have to take my science and math in school. It helps a lot. I have to take it seriously. That's one of the reasons I have been paying a lot of attention in science classes, so I can do well and.....
R: and...?
A: ......because earlier when I was in my previous school I was more interested in boys but now since I have got a new boyfriend and he is in high school and he has been encouraging me a lot. He is really encouraging me to study science and become a doctor. Last year I hated school so much...
R: And science...?
A: ...and science too and I was thinking of dropping out when I was old enough to work. But now I want to go to college.
R: So what do you think this change is because of?
A: Probably because of the new way we are learning science. I mean learning science in groups. Because see, in some of the science classes I would go to sleep because they were so boring, but this year I have never gone to sleep in science class and I am always awake, taking notes or doing my worksheet or something.

R: What experiences in or out of school, do you think have affected your attitudes toward science?

A: Sometimes I like watching movies on science.

R: So you are interested in science, enough to make you want to see science movies?

A: Well I was always interested in science. I just did not like science class. But I like science in seventh grade and I like what she's doing with mass and balance and I like the hands-on stuff she does with the teeter-totter. I really like it....

R:....and?

A: ....and I like doing the activities she's doing with the teeter totter. I think it makes us understand the stuff more when we are actually doing the activities.

R: You never did stuff like this before, hands-on science?

A: No and so even though I may have been interested in science, I never liked to go to science class because I could never understand anything.

R: Tell me what was the best thing about learning science in groups?

A: I'd say working with people...cooperation and all that.

R: What do you find good about that?
A: Because when you are helping each other out.......I like helping people out in school, whenever I can. I like working with people, I like working in groups, because it gives me an opportunity to help others more.

R: ...and how do you like being helped?

A: I like it because its also helping me to understand science and stuff because if there is something I did not know..........like mass and length, I did not get that until one of my group people taught me. She knew it and I did not know it and so she taught me and now I understand it.

R: So learning in groups helps you understand science better?

A: Yeah, she taught me how to do it...that is the relationship between mass and length and now I know how to do it.

R: What if you had not been working in groups?

A: I would have been lost. I would fail the test.

R: So your attitudes toward science...

A: ...have changed for the better.

R: .....and learning, has that changed?

A: I feel I know the stuff more and better, because of learning in groups and I am certainly learning science more now.

R: What about other subjects in school? Any particular one you really like?

A: Health. I have always like it, but we have not done any this year.

R: What else do you like?

A: Science and math.

R: Any reason why?

A: Science because we learn more about the different.....like electricity. I like to learn more about electricity and stuff because everybody in my family is in the
electronic line. I like to learn more about the scientific stuff and I like math because I am good at it.

R: Your response on the checklist to "If I knew I would never go to science class again I would feel sad", seems to be undecided, why?

A: I don't know. I wouldn't know what I would feel.

R: During science class you are not sure if you are interested?

A: I'm not sure if I'll always be interested. Now I am but I do not know if I'll always like science and I don't know if I'll always do well in science, because when I go home, I like to go out with my friends and everything and so that's the only reason why I am not sure if I always will like science or if I really love science now, because usually everyday we have science homework. In the previous school we never had science homework, so I am not used to that. But I do want to study science and go to college, and I do like learning science in groups.

R: Thanks a lot for your time. All the best to you..
INTERVIEW 2

Researcher: R
Subject: B

R: I'd like to talk to you about your science classes. You have now had science for about eight weeks in this grade. Is there any difference in the way you have been taught science?
B: Yeah, its different because now we are learning science in groups. Its different because well I haven't been to a school before where they really teach in groups which I think is a better way of learning than the regular way of teaching, just sitting and listening to the teacher writing on the board.
R: So you have never been taught science in groups before?
B: No. Never. This is the first time.
R: Why do you think its better?
B: Well because you can learn a lot from the people in your groups than when the teacher is the only one teaching, because sometimes you do not know all the answers and you are just listening to the teacher talk but you can......some people in the group can help you if you have a problem or do not understand something. That's why I think its better to learn in a group rather than sit and listen to the teacher talk.
R: How were you taught science in elementary school?
B: Well we really did not do as much science as we do in the seventh grade. Well we really did science but not really....we did some things but not like this.
R: You mean to say never in groups.
B: Never in groups. We never did science in groups. We just sat and listened to the teacher talk to us about how...how different science projects are and how......different things in science, but we did not do anything.

R: How did you like working in groups?

B: Well its pretty fine with us. I can find out what other people know and see I can help them with what I know and see what they are doing or I can kind of..... I can help them and they can help and we get to know each other much better than just sitting and working with the teacher.

R: Was everyone helpful and cooperative in your group?

B: Well most of the time everyone helped each other but really not everybody. Sometimes everybody really did not help each other.

R: .....how?

B: .....because they were either arguing with each other or....just not paying attention....talking to other tables which meant losing group points. Yes there were a couple of times when there was arguing.

R: ...like?

B: .....like over the homework.....over the answers. Well we would tell people to make sure that their homework was done. Like sometimes people would not do their homework and come or sometimes some people thought their answers were right and others thought their was.

R: How did you solve your problems?

B: We mainly went to the teacher to get the right answer or sometimes we just picked the answer most people thought was right. We tried to solve our problems, most of the time we agreed and everyone understood their mistake and we solved problems calmly or at least tried to.
R: Did everyone get their work done?
B: Yeah in their own way everyone tried. Everyone would get down...when we first came in a couple of times more than once we would all get down and work on lab and get our work finished as soon as possible.
R: Did you do your homework?
B: Almost always.
R: What do you think of the way your group worked?
B: I think...well if I had a scale of 1 to 10 I would give them a 8 or 9 because we really tried to get our work done as soon as possible.
R: Was everyone in your group helpful?
B: Well yeah, they did argue a little but we figured if we solve our problems we'd start working better
R: What was the best thing about working in groups?
B: The best thing about working in groups is helping each other and learning more about science working in groups with people I like.
R: What would be the worst thing about working in groups?
B: The worst thing would be..., when like ....when I'm absent and they are already half finished and they are going on to the next thing and I'm trying to catch up I haven't finished this thing I'm supposed to.
R: But as a group you did try to help each others catch up?
B: Yeah and then like when some people were out from the group and when they came back we would help them figure out and write down the stuff we had done.
R: What about the arguing?
B: That's not much of a problem, because there are a lot of smart kids in the
class who like to do their work and do it all the time and we have a lot of
kids....well not a lot of them, but some kids who just slack off and try to as
much as they can and we usually have one good student, one smart person in
every group, so that cuts off the problem.
R: So if you had a choice of choosing to be in a class of traditional teaching or
one where the students learn in groups, what would you choose?
B: I would choose learning in groups.
R: Why?
B: Because learning from a textbook does not really help you to learn. It does,
but it doesn't....it helps you better when you learn in groups like you come to
know how much they know about science and how much you know and you
can help each other and you can learn more things from people that you work
with.....people around us.....people you are working with instead of just
learning from a textbook.
R: What don't you like about working from a textbook?
B: Well I do not have anything against the textbook as such, but I have worked
alone and I really do not like working alone.....I do sometimes when I am in the
mood but it is better, its funner to me when I am working in groups.
R: When I see your responses on the checklist I see that when you came to this
class you did not like science.
B: I found science boring. I just did not like it because we had to work out of
the book all the time, we could not discuss, we had to work alone and we were
not allowed to do things we are allowed to do now.
R:...which are?
B: We are allowed to discuss our work and do it together. We do a lot of lab and I think that helps us and we get to discuss our answers and we try to have everybody to have the right answer.
R: How do you think lab helps you?
B: Oh, it makes science more fun and we can enjoy science better.
R: How else is it different?
B: ....and we don't have to work out of the textbook because we have these booklets to work from....
R: You like these better?
B: Yeah.
R: Why?
B: They explain what to do very clearly and make it easier.
R: Okay, so earlier you found science boring...
B: Well actually when we first started, it was like I really don't like science. I did not even want to be in the science class. I'm not good at science and math because really its like when I first started science I didn't like it and I thought well I really don't know how to do all this stuff but then as soon as we got into groups, my feelings started to change, I started to exchange news with other people and learn more from each other and that made science better, it made it more fun.
R: So now you find science fun, but you did not earlier. Why?
B: Because of the new way we are learning science. We learn science in groups and that is more fun.
R: So now does it bother you to study science?
B: Well not really.
R: Why are you unsure?

B: Because I am not sure if I really like science. But I know I find science more interesting and fun when we learn in groups.

R: ...and there has been a change in your attitudes?

B: Yeah, definitely.

R: ...and why?

B: Because we are now working in groups, which is a lot better.

R: Do you think you will take science in college?

B: Yeah, well I like math now but I'd probably take science in high school and college and try to learn more about it.

R: What is your favorite subject?

B: Math. I always really like it math because I always thought it was such a challenging, such a different thing to learn.

R: Don't you find science challenging too?

B: Well, now I do.

R: If you were a science supervisor what would you suggest to science teachers about making their science classes more interesting?

B: Well first of all if I was a science supervisor and I saw the teacher just teaching out of the textbook I would have to tell....I would have to tell them that maybe you should change the way you teach because when I was in seventh grade and worked in groups I enjoyed learning science and maybe learning science could be made better if you teach in groups.

R: So it seems learning in groups has really influenced your attitudes about science?
B: Yes most definitely. I would probably have put a 2 on most of the statements on the test, if I wasn't in groups and was just sitting there. I get bored just sitting and listening to the teacher preach about science and I'd rather do it on my own with my friends.

R: Do you do any science at home?

B: Sometimes.....like when we do science projects and stuff.

R: do you like to fix stuff that is broken?

B: Yeah. I like to do a lot with bike parts and sometimes help my dad with the car.

R: Do you think any experiences in or out of school have contributed to your attitudes toward science today?

B: Yes, earlier I found science boring because of the boring way it was taught to us, but now I do not mind science because science class is a lot more interesting and fun.

R: What about you performance? Do you think you are doing better?

B: Yes, because we are now allowed to discuss our answers on the lab booklets and she makes sure everyone has understood the answers and she goes around to check if you just haven't copied down the answers and you really know how to do it.

R: In conclusion would you like to say something?

B: Yes. I think science can be made fun if you are working in groups and it can be made kind of boring if you are not working in groups and it can also be made kind of boring too if no one's working in your group and the people you are working with are troublesome, but we don't have that problem and its fun working in groups.
INTERVIEW 3

Researcher : R
Subject : U

R: Hi! I would like to talk to you about your science classes and about science in general. Please feel free to tell me when or if you'd rather not answer a question and we will just move on. Okay, so you have been having science class since you joined back school, i.e. for approximately the last eight weeks. Have you found anything different in the way you have been taught science in seventh grade?

U: Yeah, sort of, 'cause when we had science in the sixth grade we wasn't like in groups. We were like on a table.....there were two people at each table, but we worked like alone, like we did all our work alone. Now like this year where we get to work in groups......(pauses)

R: ....and ?

U: ..and last year we had books.

R: which were used when...?

U: All the time....like we would read a chapter and then answer the questions at the back of the chapter...like...I mean we would work mostly from the book. The teacher would tell us what work to do and tell us to read it and do the answers. We had to write down the questions and then answer them.

R: ...and this year ?

U: This year we are working in groups, like doing science in groups.

R: So its a new experience for you. How do you like it?
U: ... its okay
R: Is it better or worse?
U: ...than what?
R: ...than working alone.
U: Its better 'cause like if you don't understand something, you can ask your group people before you ask the teacher and sometimes the teacher is busy and sometimes you can ask your group questions that is... questions that one can't always ask the teacher.
R: ...And is it fun?
U: Its fun sometimes, but...well most of the time it is, But sometimes I like to work on my own.
R: Okay, why do you like to work on your own sometimes?
U: Because when you're working in a group and you don't understand something another person can explain it to you, but sometimes when the people in your group are playing up then it is better to work alone or when the whole group does not understand or does not do their work seriously, it kind of slows you down.
R: If you were given a choice to select being in a class where you may be taught either in groups or alone what would you choose?
U: I would choose to work in groups.
R: Why?
U: it makes learning better. It makes you learn better working together and not alone by yourself.....like you can get help from three different people.
R: Do you think learning in groups has helped you?
U:....in what way?
R: ...in learning, understanding or liking science.
U: It has helped me a lot 'cause earlier I really did not like science as much. Science was not my subject. I mean if it was not mandatory to take science I would not take it 'cause when I grow up what I want to do has nothing to do with science.
R: What do you want to when you grow up?
U: I want to be a lawyer.
R: So what do you think about science?
U: I think I can like science if I had to learn it in groups but I think science is boring if I have to learn it alone. When you work in groups you can discuss and understand stuff you can't understand on your own.
R: So, you like working in groups?
U: Yeah, most of the time.
R: Most of the time?
U: Yeah when we did not have any problems.
R: What problems did you have working in groups?
U: Its just that the people in our group you know... they were goofing around most of the time.
R: What about your first group?
U: They were goofing around too. There were two boys and one girl and me. In the second group there were three boys and me and all of them were goofing around. No one wanted to do anything.
R: So you think it really matters who you are grouped with?
U: Not necessarily. Its just that if they do their work and if they take it seriously or not, that matters.
R: What about cooperation? Was everyone in the group helpful and cooperative?
U: Yeah. It was like... it was just like most of the days if one person didn't do their work everybody got mad.
R: What about agreeing on how the work has to be done?
U: Oh yeah everyone agreed most of the time.
R: Was there any arguing?
U: It was like...there was arguing on which answer is right and then you show them how you got it and they really get you know........they felt kind of.....they didn't......you know they felt like....kind of as if they were being embarrassed and they didn't like it.
R: Now was this more in the first group or the second?
U: ....the second.
R: ...where you were one girl and three boys?
U: Yeah.
R: Did you think this had something to do with you being the only girl in the group?
U: Yeah. I think so because basically I got all the same people in this class as I did last year. They did not like it when I was right and they were wrong.
R: What about the either way around, when they were right and you were wrong?
U: Hm.....Well sometimes I agreed and sometimes I got mad. It was like both ways because sometimes they were like getting on your nerves.
R: Who was your group leader?
U: Well it was basically me because we had a manager but he was... well he was goofing around too. So, it was just me who had to get the work done.
R: So, according to you how well did your group work do in general?
U: Well we worked pretty well together until......until the teacher started talking to someone else and then somebody would start goofing around too.
R: Did your group members help each other if there was a problem?
U: Oh yes.
R: Did you find this helpful?
U: Yes.
R: Why?
U: Because we can get help from three different people.
R: OK lets talk about you feelings about science. Do you like science?
U: Sort of.
R: So you like science.
U: ...sort of.
R: But from your responses on the checkiist I get the impression that you do not like science.
U: That was because....I really did not......really like science,... because of like the people I got put with because I wasn't like really learning anything because they would not get......like the packet we had got, they weren't getting it, and I would have to work on my own to go ahead and they would not tell the teacher they were ready for a check-in and I had to wait for them to catch up.
R: So your feelings about science were affected by your group members.
U: Yeah.
R: How?
U: Well...because they really did not let me work. They were goofing around and I guess that's it.
R: So you would rather work alone.
U: I don't know. It's fun working in a group but if people in your group don't cooperate it can get real tough to do well.
R: So do you like science?
U: Well....Hm......sort of.
R: So will you take science in college?
U: I don't know if it's useful for the kind of thing I want to do when I grow up. I don't think I'll take it.
R: Why?
U: Science is a ....something....it is....science is the study of the earth and like other things you know like how things are made you know and all that stuff, but I want to be....I'm really not doing stuff that goes with it, so I'm not sure I'm interested.
R: So then do you like or dislike science?
U: I mean I like it sort of......you know....I mean I like it but I don't love it & if it's not mandatory for me to take it when I get to college, then I won't take it.
R: You seem to be undecided about your feelings about science....
U: Well, sometimes it's okay, but when we get into groups sometimes I can't really be interested...it was like two conversations going on at the same time. The teacher was talking and the people on my table were talking, and I couldn't really focus because they would be talking of something that happened outside and I would try to focus but you know it would not be too interesting because I was hearing two things at the same time.
R: So..?
U: So, I could not understand the stuff sometimes.
R: Do you think learning in groups contributed to your attitudes toward science.
U: I think so.
R: Think....You're not sure?
U: Its either that or that people....like that....its how people can learn you know...not playing around or making fun or something, but its a lot of things and its working in groups, and actually the group I worked with that make me feel that way about science.
R: What things...?
U: Science is hard and difficult to understand and if people do not let you concentrate it becomes difficult.
R: Your feelings about science class are...?
U: Its okay.
R: Do you think any experience/s in school could have contributed to your attitudes toward science?
U: ....Well earlier I did not care for science all that much, but now I think it can be okay.....I think its the new way of learning...learning in groups.
R: Do you like it?
U: Yeah.
R: Do you know any experiences outside school that could have contributed to your attitudes toward school......do you like to mess around with stuff?
U: Yeah...with different stuff.
R: What stuff?
U: Different stuff. I like to mess around with my moms stuff, like ingredients, you know like flour, cream & water & see what it makes.
R: What about fixing stuff.
U: No......not that much, sometimes if its broken.
R: What do you think is the best thing about learning in groups?
U: Being able to see who....you know being able to....not to have to do it by yourself but being able to change your answers, because someone else comes up with a better answer......being able to compare your homework together. I wish people would do more homework at home and then come to class.
R: From what I hear, you seem not to be too sure about your feelings about science?
U: ....Because like....when she's like reviewing something and reads something. Since the beginning of the school year we review again and again do it...over and over again makes me impatient it......kind of makes me impatient cause we're not learning anything new. I don't think I really like science.
R: Why?
U: I don't know,...I just don't like it. I guess because its hard and difficult to understand.
R: How did you find the test?
U: Well last year we had to memorize stuff, but this year we kind of helped each other to learn and understand.
R: What do you think is the worst thing about learning in groups?
U: People coming to class without homework and class work that they are responsible for, because then our group points are lost.
R: Did you do your homework regularly?
U: Yes.

R: What is the best thing about learning in groups?

U: Well science is fun with groups sometimes...because like science is fun...when people you know make it fun and the teacher makes it fun but when you're just sitting there doing class work, not learning anything and it gets boring or when people are playing around and it becomes a bore. So in general it is fun but everybody needs to do their stuff.

R: So then in conclusion would you say you would like to learn science alone or in groups?

U: Oh, I think I would like to work in groups, definitely.

R: Thanks a lot for sparing your time to talk to me. Wish you all the best in life.
INTerview 4

Researcher : R
Subject : T

R: Hi! I would like to talk with you about your views about science and the science classes you have been attending these past few weeks. Please be assured that if you do not want to answer any of the questions please just say so, and we will move on. Okay, have you found any difference in the way you have been learning science these past weeks?
T: different from when.?
R: like different from the way you have been taught science in the earlier grades, fifth, sixth etc. ?
T: Yeah.
R: How?
T: Earlier the teacher came into the class and taught from the book. The teacher would not let us work in groups. Only sometimes for like something in the book that says science lab, where we’ll work each other.
R: ..in groups ?
T: Sometimes in groups or sometimes in pairs. But we hardly ever worked in groups.
R: So this is the first time you have worked in a group ?
T: Yeah.
R: How did you like it ?
T: It was okay except when people in your group are not cooperating and creating trouble for the whole group.

R: Were there people in your group who were not cooperating?

T: Yeah. Some of them.

R: In what way were they not cooperating?

T: ...like some people wouldn't do their job on time. Everybody would be doing one thing and one person would be doing something different. It slowed us all down and we had to wait to let that person finish. The whole group would be doing one thing and this person would be doing their own work, trying to catch up. So this person was left behind for whatever reason, not paying attention, being absent or just being lazy and did not become serious and complete their work.

R: What did you find good about learning in groups?

T: ...letting other people help you. I liked being helped by my group. I think its better and I liked working in a group because I think sometimes I need it. I need help from others.

R: Did you have any trouble working with others?

T: Yeah.

R: In what way?

T: Cooperating.

R: You did not want to cooperate or they did not want to cooperate?

T: It'll be like someone who acted stubborn and did not want to do what everyone was doing, like some people did not cooperate. They want to do what they want, like act lazy and do not do their work when everyone was doing it and then when we finished our work we have to wait and explain to the
person and make him/her finish their work. So we slow down. So everybody is not helpful and cooperative in the group and then points get cut from our group grade.

R: I see, so not everybody was helpful and cooperative in your group?
T: Yeah.
R: Was there much arguing?
T: Yeah.
R: Like for what?
T: Like when someone has a group job and we would tell them or remind them to do something they would get all smart Alec and they would ignore or start talking to someone else or doing some other job and if you say pardon me, they would say keep your own business or something like that. So sometimes we did argue.
R: So then what do you think about learning in groups?
T: I think it's fun, it's better.
R: What about the arguing?
T: I still think that it does not matter so much because it is at least better than working alone. Sometimes you don’t understand something and the teacher has finished explaining it or something and then somebody in the group can explain it to you. I never had this before and so I did not understand too much in science class. We were taught from the book and we would never talk to anyone in the class or ask them to explain anything.
R: If you had to evaluate your group, how would you assess it?
T: What do you mean?
R: Like did your group work well overall or did your group work badly?
T: Our group worked in between. It was like pretty good some days. Some
days we would work really well and other days it was real low. So it
depended on the day and how everyone was feeling that day.
R: Do you like science?
T: No!..like when you entered this class at the beginning of the school year did
you like science?
T: No!
R: Why don't you like science?
T: I find science kind of boring. I think I just don't like it.
R: Okay, let's talk about what you find fun. Is there anything in school that
you really find fun?
T: Nothing in science. Perhaps physical Education.
R: Now why do you find science boring and Physical education fun?
T: I find science boring because you like have all these things..... It's like
being.....or that you have to learn sitting there and sometimes you get sleepy,
like when you work in groups that's fine, but sometimes you'll get real bored
with it, its bad because like last year we were not allowed to talk or ask
anything in science class or anything like that. We just had to listen to what the
teacher was saying and we had to remember all this and that. Its kind of crazy
and when it comes to the test, science is the subject I really always mess up on.
R: So you did not like memorizing
T: No! I do not like memorizing and remembering stuff.
R: But what about this year....?
T: We can learn science stuff in groups and we don't have to remember stuff. I
can find science interesting sometimes.
R: So you could like science if it was taught in groups. But if you see your responses on this checklist you said science is boring in September and then you learnt science in this new way for the past few weeks and you still say science is boring. Is there a reason for that?

T: I think in general science is kind of boring. I just find it all boring. Science is kind of a difficult subject for me. You have to listen or you have to pay a lot of attention in class and you have to learn stuff. I kind of do not like that.

R: Would you think of taking science in college?

T: Never.

R: Why?

T: I don't like it and find it difficult. You know its like somethings are not your subject.

R: Why?

T: Its hard like I don't understand it...like if we learn something maybe I'll get it but for some reason the next day I won't understand it.

R: How do you think science can be made more interesting?

T: ...like by having more activities or doing something after school so that the kids can enjoy science, like science activities,...like if there are a whole bunch of kids that are having difficulty with science like every Monday, Tuesday, and Wednesday, the kids can come in and they can find some easier way to do science.

R: What is the hard way of doing science?

T: ...doing it yourself. Doing it yourself is the hard way and doing it in groups is the easier way. Maybe if science was always learnt in groups I could like science because maybe it could be easier. The class is longer and if they did
more like activities..... if I was a science teacher, though I doubt I'll ever be one, if the kids thought that they don't want to be in it or there or that they do not like science and if I asked them to come after school or come to this group where there are activities they can do that are real fun, I'm sure they'll really come.

R: Can you tell me any experience in or out of school that has contributed to your present dislike about science?

T: Every year I had science...some of the teachers would never have fun with it, ...like they would never do a whole lot of activities and let you sit down and have fun with it. They would make you sit with the book and look into it and see what they say and you have to do it

R: All throughout, you had this experience?

T: The teachers would never make science fun. All throughout elementary school we always used the textbook.

R: So, what's wrong about using the textbook?

T: We never did fun things or lab. We could not talk or let anyone explain the stuff to us.

R: Do you like doing any science activities or science connected activities at home?

T: None.

R: Repair stuff, broken equipment etc. ...?

T: Never. If I know something about it then maybe, otherwise no.

R: What's the best thing about learning in groups?

T: You can have other people helping you and be able to...not feel alone when you have a question, you have other people, other different people who may
know the answer and when you put all the ideas together you’ll find out what it is. I like all the help I can get. What makes science difficult for me is trying to understand it so learning in groups helps.

R:.....and can you tell me one disadvantage about learning in groups?
T: How some people won't cooperate or anything. If there was more time maybe the teachers could work with them or something.
R: You found science boring before entering the seventh grade and you do so even now. Am I right?
T: From working in groups?
R: Yes.
T: Well, learning in groups makes it better. By other people helping you, it makes it more interesting. But I never liked science. But I can tolerate it if I did it in groups. I just think science is difficult.
R: You say science is not fascinating or fun. Why?
T: Science never really interested me. I don't do too much of science out of school. Like if there's a project or something, yes. But no, I never do any science stuff at home or touch electric stuff. I'm just not interested.
R: How do you feel about the test? Are you ready for it?
T: Yeah, because I worked in groups like when I learnt in a group and did not understand something or know something they say, they stopped and explained me until I understood it.
R: Did you do your home-work regularly?
T: Most of the time.
R: When you did not do your home-work did you lose a grade, how did this work?
T: Our group lost points.

R: What do you feel about the group grade?

T: I think so much points should not be taken out of the group grade because it could be one person out of the whole group that's showing out and then the whole group has to lose point for it. Sometimes it hurts, but......R: ....but...?

T: But I would still definitely like to learn science in groups. Maybe everyone should cooperate.. and do their work on time.

R: Thanks a lot t for sparing your time to talk to me. I wish you all the best in life.
INTERVIEW 5

Researcher : R
Subject : Y

R: Hi! I would like to talk you about your science classes and what you think about them. If at any point you do not want to answer a question please feel free to let me know and we will move on. OK, I know you must have studied science in school in your previous grades and now again you are studying it in the seventh grade. Do you find any difference in the way you have been taught science?

Y: Well this year our teacher teaches differently from the way we were taught last year. Last year we just would read the chapter and then at the back of the chapter we might even like answer four or five questions or we'd talk about the chapter, do four-five questions at the back and then be done with the chapter. So I was never sure about how I feel about science.

R: How do you learn science this year?

Y: Well this year we are using equipment and getting into it, I didn't get to do it last year.

R: What do you mean by "getting into it"?

Y: Well we are doing labs in science now.

R: So the main difference from the past and now is that you are doing more labs in science this year.

Y: Yeah...

R: Have you worked in groups in your science classes earlier?
Y: Sometimes...well not really in science.

R: So if you never worked in groups in your science classes before, isn't that different from before?

Y: Yes...that and also that we are doing lab.

R: How do you like working in groups?

Y: I think its fun.

R: You think its better or worse?

Y: than what?

R: ...than working alone.

Y: Oh yes!...its better!

R: Which way would you like to be taught science?

Y: I like doing labs in science in groups. I don't like science to be taught all by the book, chapter by chapter and then learn sentences and not understand what you learn.

R: From your responses in the science checklist, I get the impression you are not sure about science. Your responses on the pretest indicated that you are usually interested in science but the posttest indicates that you are undecided and not so interested. How come?

Y: Actually, I'm not sure about science.

R: Why are you not sure about science?

T: I mean this is really the first year I've had science actually. This is the first time I'm actually doing science.

R: What do you mean, I'm sure you have had science before?
Y: Well, yeah, but we've never had lab before and this kind of stuff. We've done like science in the book, we read something and then do questions on it, but never like this.
R: So this is the first time you have actually done lab?
Y: Yeah.
R: So how do feel about doing lab in science?
Y: I like it because we are actually doing something with equipment and so we're kind of really doing science.
R: So you like lab and science.
Y: Well I like lab.
R:...and science?
Y: When we do lab.
R: Why are you so undecided about your feelings about science?
Y: Well, I'm undecided because I'm not...I'm kind of confused about science...I'm not sure.
R: What are you confused about?
Y: Well...I'm not sure if I like science or dislike science, so I don't know where I am.
R: If you had to assess your liking to for science on a scale of 1 to 10 where would you place yourself?
Y: Probably around 6.5...I guess more on the liking side.
R: Okay, so it seems you do like science a little bit.
Y: Well it depends on the way it is taught...it depends on how we learn. Sometimes it can be real boring.
R: When is it boring?
Y: Well its fun when we're doing hands-on activity, working with things, trying to find out things. Its really boring when I'm just reading the book because when I'm reading the book and think its boring, I'm just not going to understand it. I like science when I'm doing activities in groups and doing stuff with equipment.

R: So its important for you to work in groups...?

Y: Yeah...'cause I like working in groups.

R: Did you have any problems working with others?

Y: Well...not really.

R: Did you have any fights or arguing?

Y: Well sometimes we were talking around a bit but not really.

R: So, is there a bad side to learning in groups?

Y: Not really.

R: What about the home-work? Did everyone in your group do it?

Y: Yeah.

R: What about your group scores?

Y: They were pretty good. I think our groups worked pretty well. Most people cooperated and so we could get the work done.

R: So how would you like to be taught science?

Y: Well in the way we were taught this year. I like getting into activities and I think its fun doing activities together. Also I like chemistry and I think we are getting into it next year and I say I really can't wait to get to it.

R: Why do like chemistry?

Y: I just like it.

R: What do you connect or associate with chemistry?
U: I'm thinking of a lab, measuring things and making different things, testing things to see what they are and stuff like that.

R: So you would like science if there are labs and activities involved. Is it important for you to work with other people?

Y: Well it makes it easier because everybody helps.

R: Was everyone cooperative and helpful in your group?

Y: Hm...most of the time.

R: When they were not, what would you do?

Y: Everybody would try to cool down because like when it got crazy and when everybody tries to talk at the same time it gets kind of crazy and so we try to cool down and let one person talk and try to figure out what went wrong.

R: How well do you think your group worked?

Y: Well it was kind of in between. We got the work done but we kind of talked a lot and stuff.

R: ....and everybody in your group did the homework?

Y: Yes.

R: Would you have still done your home work if there were no group points involved?

Y: Well.....sometimes, I'm not sure if I would be so regular.

R: So you like working in groups.

Y: Oh yes.

R: ...and you are unsure about science and...

Y: I think I would like to learn more about science.

R: But did the checklist not indicate that you do not find science interesting?
Y: I think I really do not know much about science. I think I would really like to learn more about science... to know what science really is. But I would like to do more science to decide how I feel.

R: Have you thought about taking science in college?

Y: Well ....yes I've thought about taking science in college.

R: Even though you are undecided about science?

Y: Well because I think more I talk about it, more I do it, I may learn to like it. I want to see what chemistry is like next year.

R: How come you have this interest in chemistry?

Y: I just wanted to do chemistry for a while. I don't know how.

R: How has this interest come up?

Y: I've seen it done on TV. I've seen people doing it. I don't know I've just seen it in surroundings and stuff. I've just seen it and like to do it.

R: Do you do any science at home?

Y: Yes sometimes, I like to mess around with electric equipment.

R: Do you think any experiences you might have had in or out of school could have contributed to your present feelings about science?

Y: Well I really am not sure why I do not like science as much. I guess its...well sometimes we like sit and like....sometimes I just really don't understand it and that makes it kind of boring, when I can't understand what I'm doing I kind of don't like it.

R: What about this class? Have you been understanding anything at all?

Y: Yeah..but its different from before. I get to see it and I get to like prove it and I get to see if its right or not. I haven't been able to do it before. Earlier I
was just reading the book I wasn't really understanding what was going on in the book to really have liked or disliked anything about science.

R: You said you like working in groups?
Y: Yeah. I would choose to work in groups because when we work in teams we like get more work done and also its helpful.

R: How is it helpful?
Y: Well like if I wasn't able to do something, wasn't able to do something right or like I wasn't able to understand something, then my group would help me to understand it and I would get it right.

R: Do you think learning in groups could change your attitudes about science?
Y: I think they already have changed a bit. Last year I never really like science, actually I never really wanted to learn science. I really wasn't interested and I thought we'd be taught the same way in this class too. If that were the case I wouldn't have wanted to have science. But now I've come to the seventh grade and we're doing and learning science in groups and also doing lab and I'm ready to give it a try.

R: Do you think your learning has or can change?
Y: I think now I understand better. If I don't know something my group teaches me and so I think I'm learning better.

Thanks a lot for your time.
R: Hi! I would like to talk to you about science and science classes and get your opinions. You have been studying science in the seventh grade for the past eight weeks. Have you found anything different in these science classes?
Z: No.
R: Have you always been taught science in groups before?
Z: Yes. I have always been taught science in groups.
R: Do you like it?
Z: No. Not really.
R: Why?
Z: I like to do work on my own.
R: How come?
Z: ...because if they mess up, it affects our grades too.
R: ...they?
Z: ...the other members of the group you are in... Besides on a test if I do good work and if somebody doesn't do their work, then it means it messes up everyone else's work too and it means if... if I do work by myself I can fend for myself and not worry about everyone else's work..
R: ...so...?
Z: So I do not like to work in groups.
R: ...mainly because?
Z: Mainly because if others do not do their work, then it affects you too.
R: Is there anything else about working in groups that you do not like?
Z: Like what?
R: Like how cooperative your group was? Did you agree on most things?
Z: Of yeah, there was arguing all right. Oh yes, in our group there was a lot of arguing... because if someone did not do their work or if someone did not bring their pages or if someone just won't do their work or bring their work, you've got to help them catch up and even if sometimes the teacher gives extra time to do that, but still it takes up my time. Besides I think its a lot easier to work by yourself because its like other people......you both have .........like its two people working together, they might have different opinions and start arguing about the right answer and then like you'll never get done.
R: How much science did you have in your previous grades?
Z: A lot, because ours was a math and science school and we had science everyday and we had science projects like we have here..
R: And you learnt science in groups always?
Z: Yeah and our teachers....yes in fifth grade.....,we were taught science in groups because she gave us our work in groups and together and stuff and then we got to do science and stuff in groups and of course sometimes we did it on our own.
R: Did you have problems working their in groups too?
Z: Its just that some of the people we got put with I might not get along with. Its just that when we ask for help some of them just won't give us that help, they just don't like to help. This happens mostly when we ask for help if when we need help and there are lots of times when we need help and then we have
to go and ask the teacher and she's there but that's not nice and most people ignore us like we do that and don't know that, so I'd rather be by myself.
R: ...and?
Z: And I do not think everyone is cooperative about doing their job and getting the work done. I don't know why.... I just don't know but I like to work alone, because for me its easier... because I'm like.... I just don't like to talk to other people about the answers, because if I figure it out myself I do not want to share it, because no one else shares with me.
R: How well did your groups work?
Z: The first group worked OK. In the second group I had the same people, only one person was switched. But there was this one person who we worked with and really helped and now he's beginning to have an attitude problem and him and another person in our group do not get along and....
R: ...and?
Z:........and so its a mess. Our group members did not help each other always. Sometimes like everybody else didn't do it and one person did it, he'd help us do it but if like if all of us did it and one person didn't do it you know they'd probably not help.....I'd do it but they'd probably not do it....they'd be like "you should have done it, you should have done it at home".
R: What are your feelings about science?
Z: I don't know because I've got all these projects we've got to do and all that and all these papers and all that.
R: So... what about science?
Z: Its all right. I really can't say, because I have always had to do it.
R: So it should be easier for you to say if you like or dislike science?
R: I'd probably say I dislike science.

R: Why?

Z: I don't know. Its just that this science thing.... its just that science and me don't go together.

R: why?

Z: I don't know...but they definitely do not go together.

R: Okay, lets talk about what you find interesting in school.

Z: I'd say history.

R: Why?

Z: I don't know. Its just that history is......in history we learn about different cultures. In science we just learn mass and weight and length.

R: You don't like that.

Z: Na -a-a-h.

R: What else? Do you find .... lets think ....math interesting?

Z: Math is Okay. Its all right. I guess its just that science and me do not go together.

R: How do you think science can be made interesting so everybody enjoys it?

Z: I don't know.

R: What about working in groups?

Z: Yeah...in a way it is because it is a way of making it more interesting because everyone gets to help each other, but people in our groups worked and acted so negative that I don't know. Its just that I think it will probably be better if we worked alone and I mean if everybody depended on themselves and nobody else.

R: What about labs? Would you like to see more labs in science classes?
Z: Oh yeah. When we do lab its better, to get the work done, to have it done, to do lab is sometimes better, but it also is better to do lab with someone else, because the work gets done faster.
R: So then we come back to, "Is it better to work together"?
Z: I guess it is if everyone's attitudes are right.
R: Do you think you will take science in college?
Z: I doubt if I will do that.
R: Why?
Z: I don't know. I want to be a lawyer and I don't know if science is any good for a lawyer.
R: Why don't you like science?
Z: I find it difficult and boring.
R: Do you do any science at home?
Z: Well, when my dad's not there I mess around and I do a lot because someone got to do it, if something got broke I do it...like me and my dad when we are together we do stuff, like repair stuff, fix the vacuum cleaner.
R: But still you do not like science?
Z: Science just does not interest me. My mom says I should be an engineer because I know all this stuff, but I just don't want to be that. I just don't like science. Science just does not interest me.
R: Do you think any experience you have had in or out of school could have contributed to the development of this dislike toward science?
Z: Its just that I've had science for so many years and every school I went to, would do science. I think it got something to do with too much science.
R: So coming back to learning in groups, I just want to know if you find anything good about it?
Z: Its just that the things we do, we get done faster, quicker, if we do it all together.
R: ...And a bad point?
Z: ...is that if somebody don't get it done we all got to suffer because its just that our grades get affected if somebody don't do their work, or if all of us don't do our work.
R: Has learning in groups not affected your attitude toward science in any way?
Z: No. I always have found science boring.
R: Okay, now coming to your responses on the attitude checklist, in the first instance you seemed not to mind science as much as when you completed the checklist at the end of eight weeks of school. How come?
Z: Its probably because I don't like to work in groups. In fact at first it worked out, when I was in the first group, but in the second group I started getting messed up. The homework was messed up. Nobody got it done. In the first group everybody got their work and homework done and I got an A on my test and now I don't know what's happening, everybody's just going down.
R: So you really did not mind working in the first group.
Z: No. Not at all.
R: What about science, how did it get affected?
Z: Well its just that its going down and down. We used to get 20, i.e. 20 in group grades, full points that is, but now we hardly get 5 points out of 20.
R: Did you do your homework?
Z: Yeah. I always do my homework.

R: How have your grades been in science?

Z: I do well in science because I have to keep going.

R: Do you work a lot at home, I mean do your academic stuff and all that?

Z: Yes. In science I work hard, I go home and do my lab sheet and all that and when we get homework I do that.

R: But you don't like it?

Z: No... I mean, I put time into it but I don't think I put as much time in it as someone who likes science would put into it.

R: ...and how much is that?

Z: Oh, probably around one or two hours.

R: How much time do you give to stuff you like?

Z: Like history....the history class in school, we always get homework and I always do that and all that, and math is not my favorite, but I do my homework and then I do my science homework too, but I give more time to history.

R: So if you had a choice of choosing a way to be taught science, what would you choose?

Z: I would choose studying individually.

R: Why?

Z: Because I can depend on myself and nobody else and that mean that I can get it done and if somebody else don't get theirs done, I already got mine done, and I don't have to worry about somebody else, I already got mine done.

R: ...and learning? Would you like to learn alone?

Z: I think I learn better if I learn alone.
R: You understand better if you learn alone?

Z: Yeah, about as much as I can anyway. See I never liked science, so I don't understand much, and I don't know if it makes any difference how I work. In fact because of my groups I think I am going down in my grades.

R: Well thank you very much and I wish you all the best in your life.
APPENDIX G

Tabular Representations of Findings From the Interview Data
# TABLE 18
Categories That Emerge From The Interviews

<table>
<thead>
<tr>
<th>Categories</th>
<th>A</th>
<th>B</th>
<th>U</th>
<th>T</th>
<th>Y</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>This is the first cooperative learning experience.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Science was mostly learnt from the textbook in the past.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Sometimes there is arguing when learning in groups.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>Arguing is not really a problem.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Learning in groups helps provide the extra help needed for understanding science.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Learning science in groups is better than learning alone.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Learning science in groups is more fun.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<td>This is the first time they have had lab in science class.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>Science is boring if taught from a textbook.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>?</td>
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<td>Talking to others &amp; discussing is helpful.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>If given the choice would always choose learning science in groups.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Science is boring and difficult.</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>Yes</td>
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<td>Question</td>
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<tr>
<td>The worst part of learning in groups is the arguing.</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Attempts to repair broken mechanical/electrical stuff at home.</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Would recommend teaching science in groups to other teachers</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<td>Will take science in college</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Science is his/her favorite subject.</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
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</table>

? indicates the interviewee was undecided.

A, B, U, T, Y, and Z refer to the students who were interviewed.
TABLE 19
Common Words or Phrases Used in the Interviews

<table>
<thead>
<tr>
<th>Word/Phrase</th>
<th>A</th>
<th>B</th>
<th>U</th>
<th>T</th>
<th>Y</th>
<th>Z</th>
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**TABLE 19 (contd.)**

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* : indicates that the word/phrase was used by the student during the conversation.

A blank space indicates that the word/phrase did not occur during the conversation with that particular student.

A, B, U, T, Y, and Z refer to the different students interviews.
LIST OF REFERENCES


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