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The Effects of Written and Meaningful Teacher Feedback on the Achievement of Fifth Grade Science Students

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THE EFFECTS OF
WRITTEN AND MEANINGFUL TEACHER FEEDBACK
ON THE ACHIEVEMENT OF
FIFTH GRADE SCIENCE STUDENTS

THESIS
Submitted to the Graduate Committee of the
Department of Curriculum and Instruction
Faculty of Education
State University College at Brockport
in Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Education

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ACKNOWLEDGEMENTS

To Joe, without whose constant support and encouragement this work would not have been completed.

I would also like to sincerely thank my advisor, Dr. Betsy Balzano, my parents, Mr. and Mrs. Vincent Gerace; and my cousin and typist, Miss Amy Voelkl.

They have shared the gifts of their time and talents in helping me with this manuscript.

I couldn't have done it alone.
Abstract

There are many teacher behaviors that affect student achievement. Research on student achievement has dealt with a variety of grade levels and subject areas. The purpose of this study was to determine whether consistent and meaningful written teacher commentary affects the achievement of fifth grade science students. Two groups of fifth graders (n=46) were utilized in a statistical split half study designed to compare achievement both between groups as well as within the groups themselves. Through the use of independent t-tests, no statistically significant difference in achievement was found between or within groups as a result of consistent and meaningful written teacher commentary, or the lack of it. The results of the study, as well as implications for teachers and for further research, are discussed.
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CHAPTER ONE

STATEMENT OF THE PROBLEM
Purpose

Teacher behaviors have long been thought to affect student outcome, both in a positive and negative manner. Researchers are constantly conducting studies in order to determine the many times far-reaching effects of teacher behaviors on students. One common method of evaluating the effects of a particular teacher behavior is to measure achievement made by students subjected to this behavior. The present study deals with one type of teacher behavior, written feedback, and its effect on student achievement in science at the fifth grade level.

Questions

The questions to be answered by this study are related to written teacher commentary on daily homework, and achievement made by fifth grade science students. Specifically:

1) Is there a difference between the achievement of fifth grade science students receiving consistent and meaningful written teacher commentary on their daily homework and those students who do not?

2) Within groups of fifth grade science students, is there a difference between achievement with and without consistent and meaningful written teacher commentary on daily homework?

Need for Study

Although some research has been done in the area of written teacher response and its effect on student self-concept and achievement,
most deals with verbal commentary, mainly in the form of praise and punishment. Little research deals with written teacher feedback at the elementary grade levels.

Many teachers feel that when a student spends time and effort on an assignment, ideally the work should be corrected and returned as soon as possible. To correct student's work is one method of monitoring progress and, through written teacher comment, providing individualized instruction to the student. Recognizing the importance of teacher corrections and comments, many teachers spend untold hours of their professional lives correcting and commenting on student work.

Many teachers have more than one class for which they are responsible. This includes, among other things, additional students and their respective efforts. To personally correct and comment on each student's work becomes very time consuming. Complicated by the fact that, besides the physical act of teaching, teachers have many other professional responsibilities, to consistently provide meaningful written teacher comments on student assignments often becomes unrealistic as well.

These conditions can lead to much frustration for the teacher who feels that this behavior is advantageous to students. Especially for this type of teacher, it would be beneficial to ascertain whether or not this time consuming, but seemingly helpful teacher behavior, would have any effect on students. Specifically, would consistent and
meaningful written teacher feedback on daily assignments have any
effect on the achievement made by students? This is the main purpose
for the study.

Definitions of Terms

The following terms found throughout this study are defined
below:

Consistent Feedback - Every time an assignment is handed in,
it will be corrected with written commentary and handed back to
students at the beginning of the next class.

Meaningful - Having meaning for individual students; relating
to each student's effort, achievement or lack of achievement. Student's
work will be individually corrected by the teacher. Comments directed
to the student will be written on the basis of the teacher's knowledge
of the student, his or her ability in science, and apparent effort
expended on the assignment.

Limitations of the Study

As with all research, this particular study has limitations
which need to be considered along with the results. First, the
teacher in this study (who taught science to both groups of fifth
grade students) was also responsible for teaching reading, literature,
religion and/or spelling to about half of the subjects. In these
classes, papers were corrected and returned as consistently as possible,
complete with written comments (as this is how the teacher normally corrected and re-distributed students' work). In this, about half of the students in the study were exposed to two different treatments: either consistent written teacher commentary or lack of it on science assignments (in concurrence with the study) and "normal" corrections (that type of correction which they were used to receiving by this teacher) on other assignments. This may have adversely affected the outcome.

Research has shown that, as a result of teaching the same topic again, teachers are more effective. (Clark, Snow & Shavelson, 1976.) In teaching a given curriculum, the teacher is usually more efficient the second or third time through, as measured by the amount and kind of student learning (Peterson, Marx & Clark, 1978). In this study, although all efforts were made to keep the daily presentations to Group A and Group B identical, it is probable that more efficacious teaching took place with Group B than Group A, as Group B regularly had science class after Group A.

Furthermore, Group A was included in the homeroom of the science teacher used in the study. Science class for this Group was scheduled for the period immediately following homeroom, from 8:40 - 9:20 AM. During the homeroom period, mandatory attendance and lunch counts were taken, the Pledge of Allegiance and Morning Prayers (Parochial School) were recited, any school or class announcements were made, and the students were to "get ready for the day". Because of the
sometime hectic homeroom period, there were days when science class for Group A did not begin until after the scheduled starting time. Although the time lost was usually made up later in the day or during subsequent science classes. On these days, students in Group A did not receive the same uninterrupted forty minute science period as did Group B, whose scheduled science period was from 9:20 - 10:00 daily. As a result of this schedule and its implications, it could be argued that the quality and quantity of science instruction was not identical for Group A and Group B, possibly affecting the results of this study.

The motivational levels of the two groups involved in the study also need to be considered. Although the pretests given for both Unit #1 and Unit #2 indicated no statistically significant difference between Groups, it was the opinion of the four departmental teachers who worked with both Groups, that of the two, Group B was more "highly motivated and enthusiastic" in their individual and group personalities and learning styles. Although casual relationships between student enthusiasm and/or motivation and student achievement have not been proven, it is possible that these characteristics (or lack of these traits) could have played a part in the overall achievement of both Groups. Furthermore, teaching may have been affected by the personalities of those students in the individual Groups.

Finally, the delayed time element by which the feedback was given to students can be viewed as a limitation. Although the corrections and commentary on student assignments were consistent from
one day to the next, it could be argued that the feedback was not immediate and/or specific enough to cause a difference in student achievement.

**Summary**

To date, research designed to determine the effects of consistent and meaningful written teacher commentary on student achievement has not been conducted. Many teachers consider "correcting papers" to be an important part of their job as it is one way of monitoring student work. In addition, through use of commentary, it is a way of individualizing instruction. Correcting and commenting on students' work is very time consuming, and it is not known if doing so has a beneficial effect on students and/or their achievement, hence the purpose of the present study. The terms **Consistent Feedback** and **Meaningful** have been defined as they will be used in this study. The potential limitations of the study, such as possible inconsistencies in teaching, have been discussed.
CHAPTER TWO

REVIEW OF RELATED LITERATURE
Student achievement is an intricate process. What specifically causes students to achieve is not easily identified. Research has long been attempting to establish those determinants of student progress, specifically related to teacher behavior. Over time, multitudes of studies have been designed in order to decide whether or not teacher behaviors influence student achievement and, if so, to what extent.

As a result of this research, certain teacher behaviors have been shown to facilitate student achievement. The research continues in the endeavor to name those behavioral characteristics of the "effective teacher"; the teacher who, through his/her behaviors, effects student achievement.

Presage, Process, Product

Harrison (1976) writes that, in order to learn more about the "effective teacher", the entire educational process in the classroom needs to be examined. This includes all domains which interact in order for a student to experience achievement: presage, process, and product.

Presage includes all traits which the teacher brings with him/her into the classroom. These characteristics include attitudes and qualities of personal and professional background. Process includes all teaching behaviors used in the classroom, and product focuses on achievement, most often of the entire class rather than that of individual students.
Because each of the three domains makes a unique contribution to class achievement, the parts are not wholly independent of one another. In this, presage, process, and product should be considered concurrently in order to gain an understanding of the nature of the truly "effective teacher".

Most of the research that has been done in the area of teacher behaviors is of the process-product type: teacher behaviors which have an effect on achievement, usually that of the class. There have been a number of in-depth reviews of the research pointing to various teacher behaviors/methods which do indeed lead to predicted student outcomes. The numerous teacher behaviors and methodologies have been separated into five broad categories, all of which have been shown to have an effect on student achievement:

a) classroom management techniques
b) direct and structured learning strategies
c) academic focus and student opportunity to learn
d) flexibility in instructional planning and variability in media and methods
e) democratic, "warm" behaviors, as well as teacher enthusiasm and teacher acceptance of student ideas and feelings (Brophy, Gage, Good, Medley, Rosenshine, cited in Ornstein, 1985, p. 28)
Many researchers have pointed out that, in considering the results of any study, one needs to realize that the strength and consistency between teaching patterns vary considerably, and findings are not all applicable to every student (or group of students), grade level(s), subject(s), or school setting(s) (Gage; Hammond, Wise, & Pease; Soar, Medley & Caker, cited in Ornstein, 1985). Medley (cited in Ornstein, 1984) reviewed 289 process-product studies and, in his conclusion, determined that what caused an "effective teacher" was the teacher's ability to behave differently with different types of students. For instance, the effective teachers of low socioeconomic status elementary school students would not benefit the students of middle-class background unless he/she changed teaching styles. This is so because the quality of instruction, type of questions, and management techniques which are effective with low socioeconomic students tend to be ineffective with middle class students.

Therefore, when considering the effects of research, it is most important that the characteristics of the student or group of students with whom one is working be fully considered as well as the conclusions of the study itself; not all teacher behaviors which help to facilitate student achievement with one student or group of students will automatically do so with another. This principle can and will be demonstrated with one of the behaviors shown by research to be characteristic of the "effective teacher": enthusiasm.
According to prior research (Evertson, Anderson, Anderson & Brophy; Larkins & McKinney; McKinney & Larkins; Mastin; Ware & Williams; Williams & Ware, cited in McKinney, et. al., 1983; Rosenshine & Furst, cited in Good, 1984), teacher enthusiasm has a positive effect on the instruction and achievement of adolescent and young adult students. On the other hand, Collins, Oldham and Larkins (cited in McKinney, et. al., 1983) determined that, in deliberately creating a calm social environment in the classroom, the best kindergarten and first grade teachers avoided extreme variations in the voice, dynamic gestures and/or expressions, and/or sudden movement of any kind. According to certain researchers (McKinney, Larkins & Burt, cited in McKinney, et. al., 1983), these high enthusiasm teacher behaviors serve to overstimulate young children, thereby creating problems in classroom management. However, this is not a problem with older, more mature students.

In order to determine the point at which this negative relationship between teacher enthusiasm and student achievement noticed in the younger grades switches to a positive relationship as evident in the upper grades, McKinney, et. al., examined the effects of teacher enthusiasm on pupil achievement in grade four, which "seemed a reasonable mid-point at which to look for answers to that question" (McKinney, et. al., 1983, p. 249).

The results of the study indicated that children in the high enthusiasm treatment were not affected in terms of achievement, however, there were negative effects on classroom discipline.
Conversely, many of the students in the low enthusiasm group "exhibited boredom" (McKinney, et. al., 1983). The conclusion reached as a result of the study was that, at the fourth grade level, moderate teacher enthusiasm seemed to improve instruction, and ultimately achievement. Levels of enthusiasm consistent with that found to be exhibited by effective teachers of adolescent and young adults caused problems in classroom management at this level. On the other hand, the levels of enthusiasm suggested for younger children seemed to cause boredom in the students at the fourth grade level. In sum, the different teacher behaviors which were effective at lower and higher grade levels were not effective at this grade level.

In their review, Good and Brophy (cited in Ornstein, 1984) specifically list the teacher behaviors (processes) shown to be responsible for student achievement (products). These are:

- variety in the use of teaching methods and media;
- "with-it'ness", awareness of what is going on, alert in monitoring classroom activities; "overlapping", i.e. sustaining an activity while doing something else at the same time; "smoothness", or sustaining proper lesson pacing and group momentum;
- not dwelling too much on minor points or wasting time dealing with individuals, rather than focusing on the classroom of students; holding students accountable for learning; realistic expectations in line with student abilities and behaviors;
realistic praise, not praise for praise's sake; enthusiasm; flexibility in planning and adopting classroom activities; businesslike behavior; indirectness (similar to Flanders' concept); student opportunity to learn what is being tested; and comments that help structure learning of knowledge and concepts for students. (p. 112)

Again, it must be remembered that not all teacher behaviors shown to be effective with one group of students are necessarily so with another. In order to be effective, a teacher needs to take the findings of research and apply them knowingly to the students with whom he/she works, being flexible when necessary (Medley, cited in Ornstein, 1984).

Teacher Attitudes

According to Benninga, Guskey and Thornburg (1981), many studies relating to teacher behavior in fact measure teacher attitudes and perceptions. The reason for this becomes clear when one considers "labels associated with certain behavioral characteristics such as honest, aggressive, authoritarian, destructive, democratic, etc." (p. 66). One soon discovers that these very same terms are used to describe both attitudes and personality characteristics, and can thereby draw the conclusion that attitudes, perceptions, and behaviors are one and the same.
In contemplating this relationship, it can be said that one behaves in a manner consistent with that which one believes is true. The behaviors of a teacher, too, reflect his/her attitudes and perceptions. In order to measure a teacher's attitude then, one simply needs to examine the behaviors in which these attitudes are clearly evident.

Several studies have attempted to explore the relationship between teacher attitude and behavior in terms of interactions with students. Ryan (cited in Benninga, Guskey & Thornburg, 1981) found that those teachers receiving the highest rater assessments displayed three major patterns of teacher classroom behavior - stimulating versus dull, responsive versus evading, warm versus aloof. In addition, the high group had more positive opinions of students, were more likely to utilize democratic type procedures in the classroom and, as represented by a "mean inventory response" were suggesting of "a superior emotional adjustment". In other words, because the high group had more affirmative attitudes, they were more positive in their behavior towards students.

In a study designed to establish the interaction of teacher attitudes and student perceptions, Benninga, et al., determined that students, too, could perceive the association between teacher behavior attitude. Furthermore, it was established that teachers who felt a greater need to exercise control and held themselves less accountable for the learning outcomes of their students were regarded more negatively by the students with whom they worked.
On the contrary, those teachers who felt less need to control their students and more personal responsibility for their learning, were perceived more positively.

In reviewing a large body of research related to student evaluations of instruction, Haak, Kleiber and Peck (cited in Benninga, et. al., 1981) discovered much agreement in student perceptions of their teachers. Generally, those "warm and friendly" teachers highly regarded by students consistently turned out to be a "mature adult whose focus is outwardly directed toward children and, furthermore, a person who views the children in a very positive kind of light". Those teachers who received poor ratings by students appeared to be "thoroughly ego-centric, concerned with him/herself, interpreting the students' actions as personally directed toward his/her own discomfort, and disposed to impugn the motives of others". Once again, this shows that demonstration of a positive attitude on the part of the teacher being displayed through behavior results in affirmative student perceptions.

Benninga, et. al., discuss the research on parenting styles and suggest that they have parallel implications in the classroom setting. For example, Baldwin (cited in Benninga, et. al., 1981) found that parents who behaved in a highly democratic manner typically had children who were bossy, physically vigorous, active and highly socially involved. In contrast, those parents who displayed highly controlling behavior had children who were obedient, suggestible, fearful, and lacking in tenacity.
Feshbach (cited in Benninga, et. al., 1981) found that "highly controlling parents concerned with maintaining authority and who value obedience for its own sake" have been found to have children lacking in empathy. Coopersmith (cited in Benninga, et. al., 1981) extended these findings, adding that such children were also typically low in self-esteem. Hoffman and Saltzstein (cited in Benninga, et. al., 1981) further concluded that the children of highly controlling parents also had difficulty in applying learned moral standards to their own lives, and Baumrind (cited in Benninga, et. al., 1981) suggested these children, in addition to frequently being sad and withdrawn, lack a sense of independence. Baumrind went on to discover that "when parents imposed fairly high demands on their children, while at the same time encouraging verbal give and take in their explanations of, and rationales for, desired behavior, their children were more independent and socially responsible".

In extending the above findings to the classroom setting, it could be said that students of those teachers who behave in a highly democratic manner might be expected to behave more independently and boisterously. On the other hand, those students of teachers who display more controlling behavior might be expected to behave in just the opposite way. It seems to be that the attitudes and behaviors of the parent/teacher being perceived by the child/student in turn dictate his/her behavior.

Weber, Brookover and Lezotte, and Rutter, et. al., (cited in Benningen, et. al., 1981) stated that:
teachers who feel a greater sense of responsibility for positive learning outcomes may foster in their students a desire to perform at higher levels, with more positive classroom interactions (interactive style) resulting as a by-product of these attitudes (p. 72)

In this, it seems highly plausible that those teachers who have positive attitudes towards their students (and behave in accordance with these attitudes) may indirectly cause their students to make greater gains in achievement than those students of teachers who have negative attitudes.

Witty (cited in Taddeo, 1977) conducted a study dealing with the personality traits of effective teachers. The following age groups were represented in the study: below nine, 9-14, 14 and up as, "over a period of time, children were asked to write a letter on: 'The Teacher Who Has Helped Me Most'" (p. 10). Once the rank of traits were formulated, it was found that all qualities which students found aidant were linked with teacher attitudes and related behaviors. Out of 12 characteristics, 11 were listed as more important than the ability of a teacher to teach his/her particular subject matter. Specifically, the rank of traits were:

1) Cooperative, democratic attitudes
2) Kindliness and consideration for the individual
3) Patience
4) Wide interests
5) Personal appearance and pleasing manner
6) Fairness and impartiality
7) Sense of humor
8) Good disposition and consistent behavior
9) Interest in pupils' problems
10) Flexibility
11) Use of recognition and praise
12) Unusual proficiency in teaching a particular subject (p. 10)

Teacher attitudes are displayed through teacher behavior. It is clear that these attitudes can be perceived by and have an effect on students. This point can be further illustrated when contemplating the subject area of science.

Like all points of view, attitudes towards science are acquired. They are positive or negative feelings which serve as a "convenient summary of a wide variety of beliefs about science" (Koballa & Crawley, 1985, p. 231). Washton (cited in Koballa, Jr., et. al., 1985) determined that teachers' attitudes towards science have a definite influence on their students' attitudes.

As has been noted, teacher attitude is reflected in many teacher behaviors. The time the teacher spends teaching science as well as the manner in which it is taught (teacher behavior) dictate to students the teacher's attitudes about the subject area of science. Although the amount of time that elementary educators spend teaching science varies considerably, it has been estimated that, by the
time they reach third grade, many students do not feel happy in
their science classes (Rakow, 1984).

Shrigley (cited in Koballa, Jr., et. al., 1985) found that
the science classes of many teachers were marked by
lengthy consecutive seatwork assignments, characterized
by students reading textbook chapters and completing
worksheets, and have been found to have an unfavorable
impact on "time on task" and do little to enhance
positive attitude development among elementary and
secondary students. (p. 229)

In studies designed to determine the prevalent feelings of elementary
students and their teachers regarding science, the National Assess-
ment of Educational Progress (NAEP) identified many aspects of
attitudes and instruction by which science is taught and learned.

Nearly half of the teachers at the elementary level admitted
to not knowing the answers to questions asked by students. Only
a third of elementary school students felt that their teachers
enjoy science. Despite these characteristics of elementary school
teachers, they "make science exciting" (Yager & Bonnstetter, 1984,
p. 409) according to over two-thirds of their students.

Two-thirds of the elementary school teachers encouraged their
students to show their ideas regarding science-related experience.
For 60% of elementary school students, science class was described
as being "fun". Of the elementary students, 85% felt that their
science classes were "interesting". According to the studies,
science classes "rarely made elementary school students feel 'uncomfortable'"; and nearly 60% of this elementary population reported that their science classes made them feel "successful". Finally, 93% of all elementary students in the study felt that the science which they study will somehow be useful to them in the future (Yager, et. al., 1984).

Interestingly, in comparing these results to perceptions of junior and senior high school students and adults, researchers discerned that junior high, senior high students and finally adults seemed to be respectively more negative in all categories concerning their perceptions of science teachers, classes, and course content (with adults being the most adverse). When considering these findings, it seems that something needs to be done in order to help foster and maintain positive science attitudes among students as student attitudes will affect behavior, and student behavior will ultimately affect achievement. Inappropriate attitudes, then, like inappropriate behavior, need to be changed before achievement can be made.

Teacher attitudes are not restricted to content areas of the curriculum, such as science and math. Attitudes can be, and many times are, associated with students. Perhaps some of the most stigmatizing teacher attitudes are those related to expectations.

**Teacher Expectations**

Teachers typically expect certain students to behave in certain ways; there are certain attitudes and perceptions by which teachers
view the capabilities and performance of students. Because of these expectations, teachers behave differently towards different students.

Over time, students' self-concepts, levels of aspiration, and achievement motivation will be affected. Given more time, these areas (which all affect achievement) will be more permanently shaped. In sum, students' achievement and behavior will parallel teacher expectations and behaviors: high expectation students will be led to achieve at high levels, and the achievement of students' of low expectation will regress (Good, 1981).

Perhaps the single most contributing factor to the knowledge we have today regarding the effects of teacher expectation on student achievement is a 1968 study conducted by Robert Rosenthal and Lenore Jacobson. Their investigation, entitled, Pygmalion in the Classroom, captured national attention and demonstrated that the expectations which teachers hold regarding individual student performance does indeed affect outcome.

In the study, teachers were told that several students in their classroom, based on a written examination, had shown an impressive potential for academic growth. These students had actually been chosen at random. Eight months later, an intelligence test revealed that students for whom teachers held fictitiously high expectations showed greater gains in IQ than other students in their school for whom these expectations were not held (Cooper & Tom, 1984; Good, 1981; Good, 1982).
Since the findings of Rosenthal and Jacobson, 19 years ago, much subsequent research in the area of teacher expectation has been conducted. In addition, extensive research literature has been produced, describing just how teacher expectations influence student performance. The research further supports the original findings of Rosenthal and Jacobson that, along with the many and complicated factors that influence student performance, teacher expectations do play a role in the quality and quantity of students' achievement (Cooper & Tom, 1984).

Teachers develop prejudices about student ability levels prior to ever meeting the student. There are various reasons for this. First, the teacher may rationalize, either consciously or unconsciously, that the gains previously made by an older sibling are indicative of potential achievement of a younger brother or sister. "I had your older sister (or brother). She (He) was excellent in Math" is an example of a comment which is suggestive of the expectation which a teacher places on a present student who is the sister (or brother) of a past student (Arganbright, 1983).

Expectations are developed on the basis of the family income and other such factors of which the student is a part. According to Leigh (cited in Arganbright, 1983), teachers "know that working class children rarely are high achievers in the educational system, know that there is little point in expecting high achievement from them, and teach accordingly" (p. 94). While underestimating the
ability of children of working class parents, teachers tend to overestimate that of middle class children.

Prejudices and expectations are also developed by reviewing formal test scores and other information found in/on permanent records. Although these serve as essential sources of data when properly used, teachers tend to develop opinions such as "I cannot expect much from this student based on these scores" (Arganbright, 1983) as a result of previewing records. Again, this is a type of teacher expectation.

Previous teachers of a student and their opinions of that student help to form preconceived notions of a student's ability or lack of ability. Although not intentional, a flippant comment about a student from one teacher to another can serve as an influential piece of information regarding an unknown student's ability (Arganbright, 1983).

Finally, ability grouping can alter teacher expectations. Placement of a child in the "low group" does little else than classify a student as a low achiever in the minds of the student, his/her classmates, and the teacher (Arganbright, 1983). Furthermore, because of placement in a "low group" in one academic area, teachers very well may have a tendency to automatically transfer that low expectation of a student to other academic areas.

According to Cooper (1984), there are two general kinds of effects that teacher expectations may have on student achievement. The first is called the self-fulfilling prophecy. Merton (cited in Cooper, et. al., 1984) describes the self-fulfilling prophecy
as occurring when "a false definition of the situation evokes a new behavior which makes the original false conception come true" (p. 78). The kinds of expectations which create self-fulfilling prophecies are those inconsistencies which naturally occur between a teacher's belief regarding a student's achievement and that student's test scores. The certainty which a teacher feels regarding the improvement of a student might also be expected to create self-fulfilling prophecies.

The second type of expectation effect is called a sustaining expectation effect. This occurs when, because of teacher expectations, a student continuously achieves at pre-existing levels. Cooper and Good (cited in Cooper & Tom, 1984) explain the occurrence of sustaining expectation effects when "teachers respond on the basis of their existing expectations for students rather than to changes in student performance caused by sources other than the teacher" (pp. 78-79).

In a study designed to examine the effects of various special education labels on teachers' expectations regarding future academic performance, Rolison and Medway found that classroom teachers either raise or lower their expectations and thereby their behavior (Rosenthal, cited in Cooper & Tom, 1984) according to a student's previous special education label and past performance. In accordance with research demonstrating the negative influence of the label of mental retardation (Foster & Ysseldyke; Salvia, Clark & Ysseldyke, cited in Rolison & Medway, 1985), the study found that, although the learning disabled (LD) label is more "stigmatizing" than no label,
it is not as "stigmatizing" as the Educable Mentally Retarded (EMR)
label (Rolison & Medway, 1985).

It has been found that students who are labeled as being slow
may receive fewer opportunities to learn new materials than those
students labeled as bright (Beez, cited in Cooper & Tom, 1984).
In addition, when new material is introduced to classes, teachers
tend to discuss this material with their brighter students rather
than their slower students (Cornbleth, Davis & Button, cited in
Cooper & Tom 1984). As a result, slow students also have less
difficult material taught to them.

Research has shown that teacher behaviors resulting from these
low expectations cause slower students to become less willing to
take risks in the classroom. For various reasons, low expectation
students are discouraged from volunteering answers and seeking
out the teacher's assistance. Rather than learn the academic content
for which they are responsible (and will eventually be tested on),
the student who has been convinced that he/she cannot achieve may
spend the majority of his/her time and energy pleasing the teacher
in ways he/she can achieve (offering to help around the room, take
down bulletin boards in the hall, run errands, etc.). Without
sufficient contact with students of low expectation, the teacher
becomes virtually unable to appropriate attitude changes within
him/herself or the student. Thus, expectations are not changed
and student achievement is not made.

The research seems to indicate that teacher expectation effects
are most likely to occur in those achievement domains for which
the greatest variation in instructional styles are allowed. For example, teacher expectations seem to have a much stronger impact on reading achievement than math achievement or IQ (Smith, cited in Cooper & Tom, 1984).

Expectation effects seem to involve "causal direction". Most research evidence seems to indicate that, just as teacher expectation can cause student achievement, student achievement can cause teacher expectation. For example, a student who is a high achiever is more likely to cause a teacher to have high expectations for him/her than is a student who is considered to be a low achiever (West & Anderson, cited in Cooper & Tom, 1984). In this, teacher-student relationships are said to be bi-directional, a type of "cyclical process of mutual influence" (p. 79).

As has been determined, attitudes or expectations about a student which a teacher believes to be true will cause differences in teacher behavior. This, in turn, will affect student achievement. Rosenthal (cited in Cooper & Tom, 1984) has summarized four behaviors found to be associated with teacher expectations and, therefore, student achievement. These factors are socioemotional climate, verbal input, verbal output, and feedback.

Socioemotional Climate

Socioemotional climate, or the social and emotional atmosphere of a classroom, is regarded as one of the most important variables
affecting student achievement (Harris & Rosenthal; Rosenthal, cited in Harris, Rosenthal and Snodgrass, 1986). Many nonverbal behaviors associated with positive emotional feelings are displayed most frequently by teachers in interactions with students believed to be bright, or for whom teachers have high expectations. It has been documented in a number of different studies that teachers who believed they were interacting with highly capable students behaved differently by smiling and nodding their heads more often than those working with slower students. In addition, teachers leaned toward and looked more frequently into the eyes of those students perceived as bright (Chaikin, Iglar & Derlega, cited in Cooper & Tom, 1984).

**Verbal Input**

In terms of the types and frequencies of verbal attention given to students or verbal input, Good and Brophy (cited in Cooper & Tom, 1984) found that some teachers tended to stay with high expectation students longer after they had failed to answer a question. While there, they proceeded to help the high achiever by giving more clues, repeating themselves, and rephrasing questions asked. This is in direct contrast to the behaviors of these same teachers in similar situations with low expectation students.

According to the findings of Rothbart, Dalfen and Barrett (cited in Cooper & Tom, 1984), teachers tended to pay closer attention to the responses of children that had been labeled as "gifted". In research conducted by Rowe (cited in Cooper & Tom, 1984), it
was found that some teachers appeared to allow bright students more time to respond to questions before redirecting the unanswered questions to other class members. In contrast, these teachers, in dealing with students whose past performances indicated that they had little chance of correctly answering the same question, gave up more quickly.

Verbal Output

One of the best researched behavior areas related to achievement expectations is the frequency of teacher-student academic interactions, or verbal output. Brophy and Good (cited in Cooper & Tom, 1984) have conducted over 20 studies in this area. Most of these studies indicate that teachers more frequently participate in "academic contacts" with high, rather than low, expectation students. When studying the frequency of student-initiated interactions with the teacher, it is probably not surprising to most that high expectation students initiate many more academic contacts than those students of low teacher expectation. In terms of whether teachers equal or accentuate this difference through their own initiation, studies find conflicting results. In this, each of the following conclusions are supported: teachers initiate more contact with high expectation students; they initiate more contacts with lows; they do not show any initiation difference whatsoever.

What has been found (Good, Cooper & Blakey, cited in Cooper & Tom, 1984) is that teachers, in public or group settings, were more likely to call on high expectation students and, in private
or individual settings, were more likely to have interactions with slower students. In light of this determination, it seems that, although expectations can influence how often a teacher initiates contacts, the point of this influence depends on the setting (Cooper & Tom, 1984).

Feedback

Feedback is a final area determined by Rosenthal to be affected by teacher expectation. In turn, teacher behavior in this area also affects student achievement. Much research in this area deals with the teachers' use of praise and criticism.

Traditionally, the use of praise has been encouraged as a constructive means of demonstrating appreciation, recognizing one for excellence, and encouraging further achievement. Often, educators have expressed their unyielding belief in the value of praise. Frequently, throughout the course of their training, prospective teachers are reminded of the importance of focusing on the positive rather than dwelling on the negative aspects of students' work and behavior. Adamson (cited in Fever, Broockman & Myrick, 1979) has suggested that giving praise may even be "therapeutic" to the teacher giving it, as well as to the student receiving it.

Teacher praise has received close attention in a large number of educational studies (Flanders, 1970; Rosenshine, 1971; Brophy & Evertson, 1974; Dunkin & Biddle, 1974; Stallings & Kaskowitz, 1974; Soar & Soar, 1979, cited in Morine-Dershimer, 1982). This
research has tended to focus on the use of praise by teachers, and has shown that the use of teacher praise is not an accurate predictor of teacher effectiveness (Brophy, cited in Morine-Dershimer, 1982).

In an attempt to explain these findings, Brophy (cited in Morine-Dershimer, 1982) has suggested that praise does not always function as a reinforcer for good academic performance. Instead, it is sometimes used by teachers for other reasons and serves different purposes with students of different abilities. Brophy has noted the need to take into account the varied meaning that teacher praise may have for students (Morine-Dershimer, 1982).

Graham (1984), in an attempt to address the issue of teacher feelings regarding students and this influence on student thought and behavior, found that praise, as other "well-intentioned teacher behaviors" may, at times, have unexpected or even negative consequences on the students to whom they are directed. While it is unlikely that any teacher would intentionally say to a student that they thought he/she were low in ability, the information may be unintentionally conveyed by the teacher (as has been demonstrated).

For instance, sympathy from a teacher can indirectly communicate a low ability message to a student. There is evidence (Meyer, Bachmann, Biermann, Hempelmann, Ploger & Spiller, cited in Graham, 1984) that praise for success at easy tasks (and no criticism for failure at these tasks) can indicate low ability to a student. Similarly, students who receive help from a teacher are perceived
by others, and themselves, as being low in ability (Weinstein &
Middlestadt, 1979; Meyer, 1982; Weiner, Graham, Taylor & Meyer,

Cooper and Baron (cited in Cooper & Tom, 1984) found a fairly
consistent pattern of results with regards to teachers' use of
academic praise and criticism. That is that teachers tend to praise
high expectation students more, while low expectation students
are criticized more.

Brophy and Good (cited in Heller & Parsons, 1981) reported
that, in the classroom, sex and achievement level interact to influence
the type of evaluative teacher feedback. In general, high achieving
boys receive the most praise; higher than either low achieving
boys or high and low achieving girls. Most of the criticism directed
at boys has to do with non-academic matters, or non-intellectual
aspects of their work (messy papers, careless mistakes, incomplete
work, etc.). In contrast, girls of all achievement levels are
treated more similarly. The majority of criticism seems to be
directed at the quality or correctness of their work; praise is
not directed toward work, but seems to be related to non-academic
matters.

Summary of Expectation Research

Brophy and Good (cited in Good, 1982; Good, 1981) have compiled
a list of research findings which indicates the specific types
of differential teacher behaviors exhibited toward high and low
achieving students. This summary of research is as follows:
1) Seating lows farther away from the teacher or in a group, making it harder to monitor low achieving students or treat them as individuals (Rist, cited in Good, 1981; Good, 1982).


4) Less eye contact and non-verbal communication of attention and responsiveness (leaning forward, positive head nodding) in interaction with lows (Chaikin, Sigler & Derlega, 1974, cited in Good, 1981; Good, 1982).

5) Calling on lows less often to respond to questions (Davis & Levine, 1970; Mendoza, Good & Brophy, 1972; Rubovits & Maehr, 1971, cited in Good, 1982; Good, 1981).


7) Not staying with lows in failure situations; providing clues, asking follow up questions. Less use of effective but time consuming instructional methods with lows when time is limited (Sylvann & Snyder, 1980, cited in Good, 1982; Good, 1981).

9) Give lows the answer or call on someone else rather than trying to improve their responses by giving clues or repeating or rephrasing a question (Brophy & Good, 1970b; Jeter & Davis, 1973, cited in Good, 1982; Good, 1981).


12) Briefer and less informative feedback to lows' questions (Cooper, 1979; Cornbleth & Davis, 1972, cited in Good, 1982; Good, 1981).


14) Differential administration or grading of tests or assignments in which highs, but not lows, are given the benefit of the doubt in borderline cases (Cahen, 1966; Finn, 1972; Heapy & Seiss, 1970, cited in Good, 1982; Good, 1981).
15) Teachers interact with lows more privately than publicly, and monitor and structure their activities more closely (Brophy & Good, cited in Good, 1982; Good, 1981).

16) Demanding less from lows (Beez, Brophy & Good, cited in Good, 1982; Good, 1981).

17) Inappropriate reinforcement: rewarding lows' inappropriate behavior or incorrect answers (Amato, Fernandez, Espinosa & Donbusch; Kleinfield; Kleinfield; Rowe; Weinstein; Taylor, cited in Good, 1982; Good, 1981).

It is important to point out that expectation effects do not occur in every case. This is because not all teachers are prone to produce these expectation effects; not all teachers demonstrate a consistent pattern of sharply differentiated behavior between high and low potential students (Brophy & Good, cited in Cooper & Tom, 1984; Good, 1982).

Good and Brophy (cited in Good, 1982) have suggested that teachers act according to their expectations in one of three ways. About one-third of teachers who were observed in the variety of studies dealing with teacher expectation seemed to exaggerate the deficiencies of low achievers, actually causing the students to decline in achievement by providing them with fewer educational opportunities and by teaching them less. This type of teacher is known as overreactive. According to Brophy & Good, teachers overreacting to the learning deficiencies of lows cause the opportunity and motivational levels for and of this group of students to be reduced.
A second group of teachers, described as reactive, allowed
high expectation students to dominate the class, but not to the
extent that the overreactive teachers did. High students did receive
more opportunities, but this was because they sought out the teacher
more frequently (by raising their hands more often, etc.).

Thirdly, there are the teachers labeled proactive. These
teachers did the most to provide for low achieving students. Their
expectations did not interfere with their effort to give low achievers
increased time and attention without ignoring the instructional
needs of the other students in the class. These teachers seemed
to anticipate the needs of the different students in the room,
and planned in such a way that all the diversified needs would
be met.

As can be seen, some teachers are more or less intolerant
of students whom they expect to achieve little, criticizing them
and/or not providing adequate opportunity for interaction. Others
are overprotective of students they perceive as being less capable,
rewarding marginal or even incorrect answers. In both cases, in-
adequate feedback is being given students. Without sufficient
teacher feedback, the student cannot know how he/she is doing.
This, in turn, makes achievement difficult, if not impossible.

Studies on Written Feedback

Good (1981) has indicated that positive but appropriate teacher
expectations and feedback are associated with high achievement.
In light of the findings regarding teacher expectation, it seems that the amount and nature of feedback provided to students would make a difference in achievement.

Studies dealing with reinforcement indicated that "right only feedback" (indicating to students whether a test response is correct) increased the amount of material remembered on a later test date (Anderson, Kulhavy & Andre, 1971; Gilman, 1969; Meyer, cited in Bloom & Bourdon, 1980). However, in a comprehensive review of research dealing with teacher feedback, Barringer and Gholson (1979) report that "wrong only feedback (indicating to students whether a test item response is incorrect) produces faster acquisition of and better chance at remembering information than right only feedback. Studies which employ combinations of feedback (for both correct and incorrect responses) are inconsistent in terms of results (Bloom & Bourdon, 1980).

Following incorrect responses, giving corrective feedback has been found to be more effective than right only feedback (Mims & Gholson, 1977; Travers, VanWagene, Haygood & McCormick, 1975). In his review of feedback, Kulhavy (1977) states that:

In terms of test yield, supplying feedback after an error is probably far more important than providing confirmation...however, when an error is produced, the object is not only to eliminate the wrong answer, but also to substitute correct information in its place (p. 221).
Kuhlavy confirms that the corrective function of feedback is probably the most consequential extent that feedback has with regard to student achievement.

Bloom and Bourdon (1980) conducted a study to determine the written feedback techniques commonly employed by classroom teachers. The authors requested that the 183 elementary school teachers used in the study grade a fictional student's mathematics paper "as you usually grade your students' math papers". In examining the strategies used, the authors differentiated between the following seven feedback categories:

1) Right only - correct responses were identified by checks, circles, stars, etc.; no other feedback was given.

2) Wrong only - incorrect responses were identified by checks or circles; no other feedback was given.

3) Right/Wrong - both correct and incorrect responses were identified; no other feedback was given.

4) Redo - incorrect responses were identified and the pupil was requested to redo all missed problems; no further information or assistance was proferred.

5) Corrective feedback - incorrect responses were identified and correct answer was written by the teacher.

6) Teacher assistance - correct, incorrect, or both responses were identified and the teacher requested the pupil come to him or her for assistance.
7) Diagnostic-prescriptive feedback - errors were identified, analyzed (8 facts, possible sign error) and conveyed to the pupil; corrective material was written on the paper and the pupil was requested to redo the missed items with the assistance of teacher-proferred instructional aids. (p. 14)

In analyzing the teacher strategies on the feedback tasks, the authors found that "no type of feedback has very wide use, and that teacher feedback does not reflect what the research indicates about the effectiveness of various types of feedback; that, although corrective feedback has been proven more effective than noncorrective feedback, the latter was employed nearly three times as often" (pp. 14-15).

In a research study designed to find the most effective method of correcting free-writing assignments of German students, Semke (1984) determined that "student progress is enhanced by writing practice alone" (p. 195). The 141 college German students (enrolled in the third quarter of the first year) were divided into four groups. The methods of which their weekly free-writing in a journal were "treated" varied. With Group 1, no errors were marked. Students instead received comments and questions related to the content and the writing. Grades were based solely on the amount of understandable German incorporated in the writing.
The assignments of Group 2 were corrected with correct forms written in. Group 3 was treated with a combination of the previous methods: corrections were made and comments (with regard to the content) were written. Group 4 was required to correct their errors, identified by the teacher by means of a symbolic code, and the entry was then to be rewritten.

The results of the study support the theory that correction does not improve students' writing skills. Neither does it increase total competency in the language. Group 1, which received only comments, showed more progress than the other Groups which received correction. In evaluating an attitude questionnaire, it became evident that those students in Group 1 (comment only) believed that "there should have been some kind of correction of errors on their work: (p. 200). However, they were also the Group which most enjoyed the assignment, according to the same attitude questionnaire.

It appears that giving supportive, meaningful comments in place of corrections has a positive effect on student attitudes toward writing. The results of achievement and attitude measures show that comment alone is equal to or superior to correction with comment. Finally, students do not achieve when forced to correct their own mistakes. The findings of Semke's study indicate that forced correction, in terms of both attitude and achievement, is least effective (Semke, 1984).

In light of these two varied studies concerned with written teacher feedback, it appears that the type of correction which
is most effective has to do with the particular assignment, the subject area, and the grade level for which the assignment is being corrected.

Clearly, certain teacher behaviors have an effect on student achievement. Research has shown that the attitudes and expectations by which a teacher regards a student can and many times does dictate his/her behavior toward that student. Furthermore, it has been demonstrated that varied teacher behaviors in the areas of socio-emotional climate, verbal input, verbal output, and teacher feedback affect student achievement.

Research has helped to identify some of the behavioral characteristics of the "effective teacher". Conversely, certain teacher behaviors have been shown to hinder student achievement. The research will continue in this area as there are many specific teacher behaviors whose effects on student achievement have not yet been studied. By understanding the many times far-reaching effects of their behaviors, teachers can and will be better able to control their behaviors and, in turn, facilitate the intricate process of student achievement.
CHAPTER THREE

DESIGN OF THE STUDY
Purpose

Feedback is one teacher behavior associated with student achievement (Rosenthal, cited in Cooper & Tom, 1984). The purpose of this study is to determine whether written teacher feedback will produce a statistically significant difference in student achievement in the content area of science at the fifth grade level.

Design

The study will be a statistical split half design. Independent t-tests will be the means of statistical analysis utilized to answer the specific questions posed by the study. This design was chosen because it allows for comparisons between the groups of students as well as comparisons within the groups themselves.

Hypotheses

It is expected that achievement will be made from pre- to post-test, both with and without consistent and meaningful written teacher feedback. It is probable that more progress will be made by Groups receiving written teacher feedback (although the difference may not be significant). Within Groups, it seems likely that each Group will show more improvement from pre to post score for the Unit in which consistent written teacher feedback was given. Conversely, it is probable that each Group will show less improvement from pre to post score for the Unit in which consistent written teacher feedback was not given.
Methodology

The sample consisted of students in two fifth grade classes in one urban school in Rochester, New York. The population of this school is relatively homogeneous, racially and socioeconomically; a large percentage of students are from white, middle class families. It is the practice in this school (at which the study was conducted) that, on a yearly basis, students are divided into homerooms (for the following year) as equally as possible in terms of academic achievement, sex, and (potential) behavior problems. At the end of the previous year, fourth grade students were divided in this way by their fourth grade teachers for placement into fifth grade homerooms. From these fifth grade homerooms, two groups (Group A and Group B) of twenty-three students were randomly selected to be utilized in the study.

Following separate pretests designed to establish equivalence between Groups with regard to material to be taught, two separate units in the curriculum (Unit #1 dealing with the earth's composition and pollution, and Unit #2 dealing with the study of the earth's atmosphere and space) were similarly presented to both Group A and Group B.

For the first Unit, all work done by Group A was completely graded. The grade did not show only what (item) was wrong, but hopefully, through use of written teacher comment, why it was incorrect. Papers were returned, complete with grade and written comment, the following day at the beginning of class. Conversely, minimal
correcting of work completed by Group B was done. The efforts of this Group were sporadically returned. Post-test data was collected at the culmination of the Unit in order to make a comparison of the two Groups.

Similar presentation of Unit #2 to Group A and Group B followed. In this Unit, the work of Group A was minimally corrected and occasionally returned. On the other hand, the work of Group B was corrected, complete with written teacher comments, and returned. At the end of the Unit, a post-test was given to determine whether or not there was a statistically significant difference between the achievement of Group A and Group B. In addition, the anticipated achievement of Group A and Group B from Unit #1 to Unit #2 was studied to determine what, if any, effect written teacher commentary has on student achievement in science at the fifth grade level.

Statistical Analysis

The significance of the difference between two independent group means (Group A and Group B) was tested using independent t-tests. All testing was done in the null form at the 95% confidence level (2 = .05).

The experimental hypotheses tested in this study were as follows:

1) In Unit #1, will there be a statistically significant difference between the mean pretest of Group A and the mean pretest of Group B?
2) In Unit #1, will there be a statistically significant difference between the mean post-test score of Group A (consistent and meaningful written teacher feedback) and the mean post-test score of Group B (no consistent and meaningful written teacher feedback)?

3) In Unit #2, will there be a statistically significant difference between the mean pretest of Group A and the mean pretest of Group B?

4) In Unit #2, will there be a statistically significant difference between the mean post-test of Group A (no consistent and meaningful written teacher feedback) and the mean post-test score of Group B (consistent and meaningful written teacher feedback)?

5) For Group A, will there be a statistically significant difference between the mean pretest for Unit #1 ($A_1$) and the mean pretest for Unit #2 ($A_2$)?

6) For Group A, will there be a statistically significant difference between the mean post-test for Unit #1 ($A_1$ - consistent and meaningful written teacher feedback) and the mean post-test for Unit #2 ($A_2$ - no consistent and meaningful written teacher feedback)?

7) For Group B, will there be a statistically significant difference between the mean pretest for Unit #1 ($B_1$) and the mean pretest for Unit #2 ($B_2$)?
8) For Group B, will there be a statistically significant difference between the mean post-test for Unit #1 (B1 - no consistent and meaningful written teacher feedback) and the mean post-test for Unit #2 (B2 - consistent and meaningful written teacher feedback)?
CHAPTER FOUR

STATISTICAL ANALYSIS
Purpose

The purpose of this investigation was to ascertain whether or not written teacher commentary would produce a statistically significant difference in achievement among fifth grade science students. Using independent t-tests, the difference between two independent group means (Group A and Group B) were calculated. All testing was done in the null form at the 95% confidence level ($\alpha = .05$).

Findings

The specific null hypotheses tested in this study were as follows:

1) In Unit #1, there will be no statistically significant difference between the mean pretest of Group A and the mean pretest of Group B.

2) In Unit #1, there will be no statistically significant difference between the mean post-test score of Group A (consistent written teacher feedback) and the mean post-test score of Group B (no consistent written teacher feedback).

3) In Unit #2, there will be no statistically significant difference between the mean pretest of Group A and the mean pretest of Group B.

4) In Unit #2, there will be no statistically significant difference between the mean post-test of Group A (no consistent written teacher feedback) and the mean post-test score of Group B (consistent written teacher feedback).
5) For Group A, there will be no statistically significant difference between the mean pretest for Unit #1 ($A_1$) and the mean pretest for Unit #2 ($A_2$).

6) For Group A, there will be no statistically significant difference between the mean post-test for Unit #1 ($A_1$ - consistent written teacher feedback) and the mean post-test for Unit #2 ($A_2$ - no consistent written teacher feedback).

7) For Group B, there will be no statistically significant difference between the mean pretest for Unit #1 ($B_1$) and the mean pretest for Unit #2 ($B_2$).

8) For Group B, there will be no statistically significant difference between the mean post-test for Unit #1 ($B_1$ - no consistent written teacher feedback) and the mean post-test for Unit #2 ($B_2$ - consistent written teacher feedback).
**TABLE #1**

UNIT #1 PRETEST

INITIAL DATA

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## Results

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<tr>
<td>s = 11.330</td>
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<tr>
<td>sk = -0.058</td>
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### Calculations

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<td>sk = $3 \times \frac{(x - md)}{s}$</td>
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<td>sk = -0.058</td>
<td>sk = 0.588</td>
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</table>

## Findings and Conclusions

Skewness calculated to be -0.058 indicates that Distribution #1 is within the limits of normality.

Skewness calculated to be 0.588 indicates that Distribution #2 is within the limits of normality as well.

Since both Distributions are normal, the study can be continued.
TABLE #2
PRETEST A₁ VS. PRETEST B₁

Experimental Hypothesis - Testing at the 95% confidence level, there will be no statistically significant difference between the mean pretest score for Group A₁ and the mean pretest score for Group B₁. This will be tested in the null form.

<table>
<thead>
<tr>
<th>SUBJECT</th>
<th>PRETEST A₁</th>
<th>SUBJECT</th>
<th>PRETEST B₁</th>
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Results

Pretest $A_1$

$n = 23$
$ar{A}_1 = 39.783$
$s = 11.330$
$s_{A_1} = 2.362$
$2 \Delta = .05$
$t = 2.074$
allowance = 4.900
maximum = 45
minimum = 35

Pretest $B_1$

$n = 23$
$ar{B}_1 = 41.739$
$s = 8.869$
$s_{B_1} = 1.849$
$2 \Delta = .05$
$t = 2.074$
allowance = 3.835
maximum = 46
minimum = 38

Calculations

$t_{obt} = \frac{\bar{A} - \bar{B}}{\sqrt{\frac{(n_A - 1) \cdot s_{A_1}^2 + (n_B - 1) \cdot s_{B_1}^2}{n_A + n_B - 2}} \cdot \frac{1}{n_A} + \frac{1}{n_B}}$

$t_{obt} = 39.783 - 41.739$

$t_{obt} = \sqrt{\frac{(23 - 1) \cdot 11.330^2 + 8.869^2 \cdot \frac{1}{23 + 23 - 2}}{23 + 23 - 2} \cdot \frac{1}{23}}$

$t_{obt} = -0.652$

Findings and Conclusions

Since the $t$ required for 44 degrees of freedom, unbiased at the 95% confidence level is $\pm 2.010$ and since the $t$ obtained in this study was $-0.652$, we must retain the null hypothesis and conclude that there is no statistically significant difference between the mean pretest
of Group $A_1$ and the mean pretest of Group $B_1$. This establishes the initial equivalence of Group $A_1$ and Group $B_1$ with regard to the particular subject matter to be taught in Unit #1.
**TABLE #3**

**PRETEST A₁ VS. POST-TEST A₁**

**Experimental Hypothesis** - There will be a statistically significant difference between the mean pretest score and the mean post-test score for Group A₁ (consistent teacher feedback). The post-test mean will be significantly higher than the pretest mean when tested at the 95% confidence level.

<table>
<thead>
<tr>
<th>SUBJECT</th>
<th>PRETEST A₁</th>
<th>POST-TEST A₁</th>
<th>D</th>
<th>D²</th>
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Results

<table>
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<tr>
<th>Pretest $A_1$</th>
<th>Post-test $A_1$</th>
<th>$D$</th>
<th>$D^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\bar{A}_1 = 39.783$</td>
<td>$\bar{A}_1 = 80.783$</td>
<td>$\xi D = 943$</td>
<td>$\xi D^2 = 43621$</td>
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</tbody>
</table>

Calculations

\[ t_{\text{obt}} = \frac{(\text{pre}) \bar{A}_1 - (\text{post}) \bar{A}_1}{\sqrt{n * (\xi D^2) - (\xi D)^2}} \]

\[ \sqrt{n^2 * (n - 1)} \]

\[ t_{\text{obt}} = 39.783 - 80.783 \]

\[ \sqrt{23 * 43621 - 943^2} \]

\[ 23^2 * (23 - 1) \]

\[ t_{\text{obt}} = -13.099 \]

Findings and Conclusions

Since the $t$ required for 22 degrees of freedom, biased at the 95% confidence level is $\pm 1.717$ and since the $t$ obtained in this study was $-13.099$, we must reject the null hypothesis and conclude that there was a statistically significant improvement in knowledge of science concepts (taught in Unit #1) from pretest to post-test for Group $A_1$. 
**TABLE #4**

**PRETEST B₁ VS. POST-TEST B₁**

**Experimental Hypothesis** - There will be a statistically significant difference between the mean pretest score and the mean post-test score for Group B₁ (no consistent teacher feedback). The post-test mean will be significantly higher than the pretest mean when tested at the 95% confidence level.

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Results

<table>
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<th>Pretest $B_1$</th>
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<td>$\bar{B}_1 = 41.739$</td>
<td>$\bar{B}_1 = 80.826$</td>
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<td>$s = 8.869$</td>
<td>$s = 9.787$</td>
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Calculations

$$t_{obt} = \frac{(pre) \bar{B}_1 - (post) \bar{B}_1}{\sqrt{\frac{n \times (D^2) - (D)^2}{n^2 \times (n - 1)}}}$$

$$t_{obt} = \frac{41.739 - 80.826}{\sqrt{\frac{23 \times 37733 - 899^2}{23^2 \times (23 - 1)}}}$$

$$t_{obt} = -17.265$$

Findings and Conclusions

Since the $t$ required for 22 degrees of freedom, biased at the 95% confidence level is $\pm 1.717$ and since the $t$ obtained in this study was $-17.265$, we must reject the null hypothesis and conclude that there was a statistically significant improvement in the knowledge of science concepts (taught in Unit #1) from pretest to post-test for Group $B_1$. 
**Experimental Hypothesis** - Testing at the 95% confidence level, there will be no statistically significant difference between the mean post-test score from Group A₁ (consistent teacher feedback) and the mean post-test score from Group B₁ (no consistent teacher feedback).

This will be tested in the null form.

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</table>
### Results

**Post-Test A<sub>1</sub>**

- \( n = 23 \)
- \( \bar{A}_1 = 80.783 \)
- \( s = 11.146 \)
- \( s_{A_1} = 2.324 \)
- \( 2 \alpha = 0.05 \)
- \( t = 2.074 \)
- Allowance = 4.820
- Maximum = 86
- Minimum = 76

**Post-Test B<sub>1</sub>**

- \( n = 23 \)
- \( \bar{B}_1 = 80.826 \)
- \( s = 9.787 \)
- \( s_{B_1} = 2.041 \)
- \( 2 \alpha = 0.05 \)
- \( t = 2.074 \)
- Allowance = 4.233
- Maximum = 85
- Minimum = 77

### Calculations

\[
t_{obt} = \frac{\bar{A} - \bar{B}}{ \sqrt{ \frac{(n_A - 1) \cdot s_A^2 + (n_B - 1) \cdot s_B^2 \cdot \left( \frac{1}{n_A} + \frac{1}{n_B} \right)}{n_A + n_B - 2} } }
\]

\[
t_{obt} = 80.783 - 80.826
\]

\[
\sqrt{ \frac{(23 - 1) \cdot 11.146^2 + (23 - 1) \cdot 9.787^2 \cdot \left( \frac{1}{23} + \frac{1}{23} \right)}{23 + 23 - 2} }
\]

\[
t_{obt} = -0.014
\]

### Findings and Conclusions

Since the \( t \) required for 44 degrees of freedom, unbiased at the 95% confidence level is ± 2.010 and since the \( t \) obtained in this study was -0.014, we must retain the null hypothesis and conclude that there is no statistically significant difference between the mean post-test of Group A<sub>1</sub> and the mean post-test of Group B<sub>1</sub>. 
### TABLE #6

**UNIT #2 PRETEST**

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</tbody>
</table>
Results

Distribution #1

- $n = 23$
- $md = 53$
- $\bar{x} = 55.739$
- $s = 13.123$
- $sk = .626$

Distribution #2

- $n = 23$
- $md = 60$
- $\bar{x} = 58.000$
- $s = 13.997$
- $sk = -0.429$

Calculations

Distribution #1

$$sk = \frac{3 \times (55.739 - 53)}{13.123}$$

$$sk = .626$$

Distribution #2

$$sk = \frac{3 \times (58.000 - 60)}{13.997}$$

$$sk = -0.429$$

Findings and Conclusions

Skewness calculated to be .626 indicates that Distribution #1 is within the limits of normality.

Skewness calculated to be -0.429 indicates that Distribution #2 is within the limits of normality as well.

Since both Distributions are normal, the study can be continued from this point.
Experimental Hypothesis - Testing at the 95% confidence level, there will be no statistically significant difference between the mean pretest score for Group A₂ (no consistent teacher feedback) and the mean pretest score for Group B₂ (consistent teacher feedback). This will be tested in the null form.

<table>
<thead>
<tr>
<th>SUBJECT</th>
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<th>SUBJECT</th>
<th>PRETEST B₂</th>
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Results

<table>
<thead>
<tr>
<th>Pretest A_2</th>
<th>Pretest B_2</th>
</tr>
</thead>
<tbody>
<tr>
<td>n = 23</td>
<td>n = 23</td>
</tr>
<tr>
<td>( \bar{A}_2 = 55.739 )</td>
<td>( \bar{B}_2 = 58.000 )</td>
</tr>
<tr>
<td>s = 13.123</td>
<td>s = 13.997</td>
</tr>
<tr>
<td>( s_{A_2} = 2.736 )</td>
<td>( s_{B_2} = 2.919 )</td>
</tr>
<tr>
<td>2d. = .05</td>
<td>2d. = .05</td>
</tr>
<tr>
<td>t = 2.074</td>
<td>t = 2.074</td>
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<tr>
<td>allowance = 5.675</td>
<td>allowance = 6.054</td>
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<tr>
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<td>maximum = 64</td>
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<td>minimum = 50</td>
<td>minimum = 52</td>
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Calculations

\[
t_{obt} = \frac{\bar{A} - \bar{B}}{\sqrt{\frac{(n_A - 1) * s_A^2 + (n_B - 1) * s_B^2 * \frac{1}{n_A} + \frac{1}{n_B}}{n_A + n_B}}}
\]

\[
t_{obt} = \frac{55.739 - 58.000}{\sqrt{\frac{23 - 1) * 13.123^2 + (23 - 1) * 13.997^2 * \frac{1}{23} + \frac{1}{23}}{23 + 23 - 2}}}
\]

\[
t_{obt} = -0.565
\]

Findings and Conclusions

Since the t required for 44 degrees of freedom, unbiased at the 95% confidence level is ± 2.010 and since the t obtained in this study was -0.565, we must retain the null hypothesis and conclude there is no statistically significant difference between the mean pretest of Group A_2 and the mean pretest of Group B_2.
This establishes the initial equivalence of Group A and Group B (with reference to the particular subject matter to be taught in Unit #2).
**TABLE #8**

**PRETEST A2 VS. POST-TEST A2**

**Experimental Hypothesis** - There will be a statistically significant difference between the mean pretest score and the mean post-test score for Group A2 (no consistent teacher feedback). The post-test mean will be significantly higher than the pretest mean when tested at the 95% confidence level.

<table>
<thead>
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<th>SUBJECT</th>
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<th>POST-TEST A2</th>
<th>D</th>
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<td>-8</td>
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Results

<table>
<thead>
<tr>
<th>Pretest $A_2$</th>
<th>Post-test $A_2$</th>
<th>$D$</th>
<th>$D^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\bar{A}_2 = 55.739$</td>
<td>$\bar{A}_2 = 77.522$</td>
<td>$\varepsilon D = -501$</td>
<td>$\varepsilon D^2 = 13429$</td>
</tr>
<tr>
<td>$s = 13.123$</td>
<td>$s = 13.794$</td>
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</tr>
</tbody>
</table>

Calculations

$$t_{obt} = \frac{(pre) \bar{A}_2 - (post) \bar{A}_2}{\sqrt{\frac{n \cdot (\varepsilon D^2) - (\varepsilon D)^2}{n^2 \cdot (n - 1)}}}$$

$$t_{obt} = \frac{55.739 - 77.522}{\sqrt{\frac{23 \cdot (13429) - (501)^2}{23^2 \cdot (23 - 1)}}}$$

$$t_{obt} = -9.471$$

Findings and Conclusions

Since the $t$ required for 22 degrees of freedom, biased at the 95% confidence level is $± 1.717$ and since the $t$ obtained in this study was $-9.471$, we must reject the null hypothesis and conclude that there was a statistically significant improvement in knowledge of science concepts (taught in Unit #2) from pretest to post-test for Group $A_2$. 


TABLE #9
PRETEST B2 VS. POST-TEST B2

**Experimental Hypothesis** - There will be a statistically significant difference between the mean pretest score and the mean post-test score for Group B2 (consistent teacher feedback). The post-test mean will be significantly higher than the pretest mean when tested at the 95% confidence level.

<table>
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Results

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<th>Post-test $B_2$</th>
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<tbody>
<tr>
<td>$B_2 = 58.000$</td>
<td>$B_2 = 81.043$</td>
<td>$\xi_D = -530$</td>
<td>$\xi D^2 = 16840$</td>
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<td>$s = 13.997$</td>
<td>$s = 6.765$</td>
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</table>

Calculations

$$t_{obt} = \frac{(pre) \overline{B}_2 - (post) \overline{B}_2}{\sqrt{\frac{n \cdot (\xi D^2) - (\xi D)^2}{n^2 \cdot (n - 1)}}}$$

$$t_{obt} = \frac{58.000 - 81.043}{\sqrt{\frac{23 \cdot 16840 - 530^2}{23^2 \cdot (23 - 1)}}}$$

$$t_{obt} = -7.623$$

Findings and Conclusions

Since the $t$ required for 22 degrees of freedom, biased at the 95% confidence level is $\pm 1.717$ and since the $t$ obtained in this study was $-7.623$, we must reject the null hypothesis and conclude that there was a statistically significant improvement in knowledge of science concepts (taught in Unit #2) from pretest to post-test for Group $B_2$. 
**Experimental Hypothesis** - Testing at the 95% confidence level, there will be no statistically significant difference between the mean post-test score for Group A₂ (no consistent teacher feedback) and the mean post-test score for Group B₂ (consistent teacher feedback). This will be tested in the null form.

<table>
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<th>POST-TEST B₂</th>
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Results

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<tr>
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<th>Post-test $B_2$</th>
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</thead>
<tbody>
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<td>$n = 23$</td>
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</tr>
<tr>
<td>$\bar{A}_2 = 77.522$</td>
<td>$\bar{B}_2 = 81.043$</td>
</tr>
<tr>
<td>$s = 13.794$</td>
<td>$s = 6.765$</td>
</tr>
<tr>
<td>$s^-_{A_2} = 2.876$</td>
<td>$s^-_{B_2} = 1.411$</td>
</tr>
<tr>
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<td>$2c = .05$</td>
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<tr>
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<tr>
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<tr>
<td>maximum = 84</td>
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<tr>
<td>minimum = 72</td>
<td>minimum = 78</td>
</tr>
</tbody>
</table>

Calculations

\[
t_{obt} = \bar{A} - \bar{B}
\]

\[
= \frac{(n_A - 1) \times s_A^2 + (n_B - 1) \times s_B^2 \times \left(\frac{1}{n_A} + \frac{1}{n_B}\right)}{\sqrt{n_A + n_B - 2}}
\]

\[
t_{obt} = 77.522 - 81.043
\]

\[
= \frac{(23 - 1) \times 13.794^2 + (23 - 1) \times 6.765^2 \times \left(\frac{1}{23} + \frac{1}{23}\right)}{23 + 23 - 2}
\]

\[
t_{obt} = -1.099
\]

Findings and Conclusions

Since the $t$ required for 44 degrees of freedom, unbiased at the 95% confidence level is $\pm 2.010$ and since the $t$ obtained in this study was $-1.099$, we must retain the null hypothesis and conclude that there is no statistically significant difference between the mean post-test of Group $A_2$ and the mean post-test of Group $B_2$. 
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<td>47</td>
</tr>
<tr>
<td>30</td>
<td>47</td>
</tr>
<tr>
<td>30</td>
<td>47</td>
</tr>
<tr>
<td>30</td>
<td>47</td>
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<td>40</td>
</tr>
<tr>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>30</td>
<td>27</td>
</tr>
</tbody>
</table>
Results

Distribution #1

\[ n = 23 \]
\[ \text{md} = 40.000 \]
\[ \bar{x} = 39.783 \]
\[ s = 11.330 \]
\[ \text{sk} = -0.058 \]

Distribution #2

\[ n = 23 \]
\[ \text{md} = 53 \]
\[ \bar{x} = 55.739 \]
\[ s = 13.123 \]
\[ \text{sk} = 0.626 \]

Calculations

Distribution #1

\[ \text{sk} = 3 \times \frac{(x - \text{md})}{s} \]
\[ \text{sk} = 3 \times \frac{(39.783 - 40.000)}{11.330} \]
\[ \text{sk} = -0.058 \]

Distribution #2

\[ \text{sk} = 3 \times \frac{(x - \text{md})}{s} \]
\[ \text{sk} = 3 \times \frac{(55.739 - 53)}{13.123} \]
\[ \text{sk} = 0.626 \]

Findings and Conclusions

Skewness calculated to be \(-0.058\) indicates that Distribution #1 is within the limits of normality.

Skewness calculated to be \(0.626\) indicates that Distribution #2 is within the limits of normality as well.

Since both Distributions are normal, the study can be continued from this point.
**TABLE #12**

**PRETEST A₁ VS. PRETEST A₂**

**Experimental Hypothesis** - Testing at the 95% confidence level, there will be no statistically significant difference between the mean pretest score for Group A₁ and the mean pretest score for Group A₂. This will be tested in the null form.

<table>
<thead>
<tr>
<th>SUBJECT</th>
<th>PRETEST A₁</th>
<th>SUBJECT</th>
<th>PRETEST A₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>60</td>
<td>1</td>
<td>87</td>
</tr>
<tr>
<td>2</td>
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</tr>
<tr>
<td>3</td>
<td>55</td>
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<td>4</td>
<td>67</td>
</tr>
<tr>
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</tr>
<tr>
<td>7</td>
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<td>8</td>
<td>60</td>
</tr>
<tr>
<td>9</td>
<td>45</td>
<td>9</td>
<td>60</td>
</tr>
<tr>
<td>10</td>
<td>45</td>
<td>10</td>
<td>60</td>
</tr>
<tr>
<td>11</td>
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<td>11</td>
<td>60</td>
</tr>
<tr>
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<td>40</td>
<td>12</td>
<td>53</td>
</tr>
<tr>
<td>13</td>
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<td>13</td>
<td>53</td>
</tr>
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<td>14</td>
<td>53</td>
</tr>
<tr>
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<td>15</td>
<td>53</td>
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<td>30</td>
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<td>17</td>
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</tr>
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<td>47</td>
</tr>
<tr>
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<td>47</td>
</tr>
<tr>
<td>20</td>
<td>30</td>
<td>20</td>
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<td>30</td>
<td>21</td>
<td>40</td>
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<td>22</td>
<td>40</td>
</tr>
<tr>
<td>23</td>
<td>15</td>
<td>23</td>
<td>27</td>
</tr>
</tbody>
</table>
### Results

<table>
<thead>
<tr>
<th>Pretest $A_1$</th>
<th>Pretest $A_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$n = 23$</td>
<td>$n = 23$</td>
</tr>
<tr>
<td>$\bar{A}_1 = 39.783$</td>
<td>$\bar{A}_2 = 55.739$</td>
</tr>
<tr>
<td>$s = 11.330$</td>
<td>$s = 13.123$</td>
</tr>
<tr>
<td>$s_{\bar{A}_1} = 2.362$</td>
<td>$s_{\bar{A}_2} = 2.736$</td>
</tr>
<tr>
<td>$2\chi = 0.05$</td>
<td>$2\chi = 0.05$</td>
</tr>
<tr>
<td>$t = 2.074$</td>
<td>$t = 2.704$</td>
</tr>
<tr>
<td>allowance = 4.900</td>
<td>allowance = 5.675</td>
</tr>
<tr>
<td>maximum = 45</td>
<td>maximum = 61</td>
</tr>
<tr>
<td>minimum = 35</td>
<td>minimum = 50</td>
</tr>
</tbody>
</table>

### Calculations

\[
t_{\text{obt}} = \frac{\bar{A}_1 - \bar{A}_2}{\sqrt{\frac{(n_{A_1} - 1) \cdot s_{A_1}^2 + (n_{A_2} - 1) \cdot s_{A_2}^2}{n_{A_1} + n_{A_2} - 2}}}\]

\[
t_{\text{obt}} = 39.783 - 55.739
\]

\[
t_{\text{obt}} = \frac{\sqrt{(23 - 1) \cdot 11.330^2 + (23 - 1) \cdot 13.123^2 \cdot \left(\frac{1}{23} + \frac{1}{23}\right)}}{23 + 23 - 2}
\]

\[
t_{\text{obt}} = -4.414
\]

### Findings and Conclusions

Since the $t$ required for 44 degrees of freedom, unbiased at the 95% confidence level is $\pm 2.010$ and since the $t$ obtained in this study was $-4.414$, we must reject the null hypothesis and conclude that there is a statistically significant difference between the mean pretest of Group $A_1$ and the mean pretest of Group $A_2$ in favor of Group $A_2$. 
**TABLE #13**

**PRETEST A\textsubscript{1} VS. POST-TEST A\textsubscript{1}**

**Experimental Hypothesis** - There will be a statistically significant difference between the mean pretest score and the mean post-test score for Group A\textsubscript{1} (consistent teacher feedback). The post-test mean will be significantly higher than the pretest mean when tested at the 95% confidence level.

<table>
<thead>
<tr>
<th>SUBJECT</th>
<th>PRETEST A\textsubscript{1}</th>
<th>POST-TEST A\textsubscript{1}</th>
<th>D</th>
<th>D\textsuperscript{2}</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>60</td>
<td>68</td>
<td>-8</td>
<td>64</td>
</tr>
<tr>
<td>2</td>
<td>60</td>
<td>96</td>
<td>-36</td>
<td>1296</td>
</tr>
<tr>
<td>3</td>
<td>55</td>
<td>95</td>
<td>-40</td>
<td>1600</td>
</tr>
<tr>
<td>4</td>
<td>50</td>
<td>88</td>
<td>-38</td>
<td>1444</td>
</tr>
<tr>
<td>5</td>
<td>50</td>
<td>87</td>
<td>-37</td>
<td>1369</td>
</tr>
<tr>
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<td>93</td>
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<td>1849</td>
</tr>
<tr>
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<td>45</td>
<td>55</td>
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<td>100</td>
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<td>45</td>
<td>79</td>
<td>-34</td>
<td>1156</td>
</tr>
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<td>45</td>
<td>86</td>
<td>-41</td>
<td>1681</td>
</tr>
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<td>45</td>
<td>61</td>
<td>-16</td>
<td>256</td>
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<td>81</td>
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<td>1681</td>
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<td>83</td>
<td>-43</td>
<td>1849</td>
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<td>2809</td>
</tr>
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<td>81</td>
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<td>2116</td>
</tr>
<tr>
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<td>85</td>
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<td>72</td>
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<td>30</td>
<td>79</td>
<td>-49</td>
<td>2401</td>
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<td>23</td>
<td>15</td>
<td>87</td>
<td>-72</td>
<td>5184</td>
</tr>
</tbody>
</table>
Results

<table>
<thead>
<tr>
<th>Pretest A1</th>
<th>Post-test A1</th>
<th>D</th>
<th>D²</th>
</tr>
</thead>
<tbody>
<tr>
<td>A₁̄ = 39.783</td>
<td>A₁ = 80.783</td>
<td>E_D = 943</td>
<td>E_D² = 43621</td>
</tr>
<tr>
<td>s = 11.330</td>
<td>s = 11.146</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Calculations

\[ t_{\text{obt}} = \frac{(\text{pre} \ A₁) - (\text{post} \ A₁)}{\sqrt{\frac{n^* (E_D²) - (E_D)^2}{n² * (n - 1)}}} \]

\[ t_{\text{obt}} = 39.783 - 80.783 \]

\[ t_{\text{obt}} = \frac{23 * 43621 - 943²}{23² * (23 - 1)} \]

\[ t_{\text{obt}} = -13.099 \]

Findings and Conclusions

Since the t required for 22 degrees of freedom, biased at the 95% confidence level is \(+1.717\) and since the t obtained in this study was \(-13.099\), we must reject the null hypothesis and conclude that there was a statistically significant improvement in knowledge of science concepts (taught in Unit #1) from pretest to post-test for Group A₁.
**TABLE # 14**

**PRETEST A2 VS. POST-TEST A2**

**Experimental Hypothesis** - There will be a statistically significant difference between the mean pretest score and the mean post-test score for Group A2 (no consistent teacher feedback). The post-test score will be significantly higher than the pretest mean when tested at the 95% confidence level.

<table>
<thead>
<tr>
<th>SUBJECT</th>
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<th>POST-TEST A2</th>
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<th>D^2</th>
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<tbody>
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<td>1</td>
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<td>95</td>
<td>-8</td>
<td>64</td>
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<tr>
<td>2</td>
<td>80</td>
<td>98</td>
<td>-18</td>
<td>324</td>
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<td>77</td>
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<td>100</td>
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<td>484</td>
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<td>961</td>
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<td>60</td>
<td>78</td>
<td>-18</td>
<td>324</td>
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<td>83</td>
<td>-23</td>
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<td>729</td>
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<td>66</td>
<td>-13</td>
<td>169</td>
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<td>529</td>
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<td>27</td>
<td>39</td>
<td>-12</td>
<td>144</td>
</tr>
</tbody>
</table>
Results

<table>
<thead>
<tr>
<th>Pretest A₂</th>
<th>Post-test A₂</th>
<th>D</th>
<th>D²</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \bar{A}_2 = 55.739 )</td>
<td>( \bar{A}_2 = 77.522 )</td>
<td>( \bar{D} = -501 )</td>
<td>( \bar{D}^2 = 13429 )</td>
</tr>
<tr>
<td>( s = 13.123 )</td>
<td>2 = 13.794</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Calculations

\[
t_{obt} = \frac{(pre) \ \bar{A}_2 - (post) \ \bar{A}_2}{\sqrt{\frac{n \ast (\bar{D}^2) - (\bar{D})^2}{n^2 \ast (n-1)}}}
\]

\[
t_{obt} = 55.739 - 77.522
\]

\[
t_{obt} = \sqrt{\frac{23 \ast (13429) - (501)^2}{23^2 \ast (23 - 1)}}
\]

\[
t_{obt} = -9.471
\]

Findings and Conclusions

Since the \( t \) required for 22 degrees of freedom, biased at the 95% confidence level is \( \pm 1.717 \) and since the \( t \) obtained in this study was \( -9.471 \), we must reject the null hypothesis and conclude that there was a statistically significant improvement in knowledge of science concepts (taught in Unit #2) from pretest to post-test for Group A₂.
**TABLE #15**

**POST-TEST A₁ VS. POST-TEST A₂**

Experimental Hypothesis - Testing at the 95% confidence level, there will be no statistically significant difference between the mean post-test score for Group A₁ (consistent teacher feedback) and Group A₂ (no consistent teacher feedback). This will be tested in the null form.

<table>
<thead>
<tr>
<th>SUBJECT</th>
<th>POST-TEST A₁</th>
<th>SUBJECT</th>
<th>POST-TEST A₂</th>
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</tr>
<tr>
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<td>55</td>
<td>3</td>
<td>84</td>
</tr>
<tr>
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</tr>
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<td>86</td>
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<td>39</td>
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<td>95</td>
</tr>
<tr>
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<td>95</td>
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<td>98</td>
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<td>21</td>
<td>87</td>
<td>21</td>
<td>77</td>
</tr>
<tr>
<td>22</td>
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<td>63</td>
</tr>
<tr>
<td>23</td>
<td>93</td>
<td>23</td>
<td>81</td>
</tr>
</tbody>
</table>
Results

Post-test A₁

\[ n = 23 \]
\[ \bar{A}_1 = 80.783 \]
\[ s = 11.144 \]
\[ s_{\bar{A}_1} = 2.324 \]
\[ 2L = 0.05 \]
\[ t = 2.074 \]
allowance = 4.820
maximum = 86
minimum = 76

Calculations

\[
t_{\text{obt}} = \frac{(\text{post}) \bar{A}_1 - (\text{post}) \bar{A}_2}{\sqrt{\frac{(n_{A_1} - 1) \cdot s_{A_1}^2 + (n_{A_2} - 1) \cdot s_{A_2}^2}{n_{A_1} + n_{A_2} - 2} \cdot \frac{1}{n_{A_1}} + \frac{1}{n_{A_2}}}}
\]

\[
t_{\text{obt}} = 80.783 - 77.522
\]
\[
t_{\text{obt}} = \sqrt{\frac{(23 - 1) \cdot 11.144^2 + (23 - 1) \cdot 13.794^2}{23 + 23 - 2} \cdot \frac{1}{23} + \frac{1}{23}}
\]
\[
t_{\text{obt}} = .822
\]

Findings and Conclusions

Since the t required for 44 degrees of freedom, unbiased at the 95% confidence level is ± 2.010 and since the t obtained in this study was .822, we must retain the null hypothesis and conclude that there is no statistically significant difference between the mean post-test of Group A₁ and the mean post-test of Group A₂.
# TABLE #16

**GROUP B**

**UNIT #1 and UNIT #2**

**INITIAL DATA**

<table>
<thead>
<tr>
<th>DISTRIBUTION #1</th>
<th>DISTRIBUTION #2</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>60</td>
<td>73</td>
</tr>
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<tr>
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</tr>
</tbody>
</table>
Results

Distribution #1

\[ n = 23 \]
\[ \text{md} = 40.000 \]
\[ \bar{x} = 41.739 \]
\[ s = 8.869 \]
\[ sk = 0.588 \]

Calculations

Distribution #1

\[ sk = 3 \times (\bar{x} - \text{md}) \]
\[ sk = 3 \times (41.739 - 40.000) \]
\[ sk = 0.588 \]

Distribution #2

\[ n = 23 \]
\[ \text{md} = 60 \]
\[ \bar{x} = 58.000 \]
\[ s = 13.997 \]
\[ sk = -0.429 \]

Calculations

Distribution #2

\[ sk = 3 \times (\bar{x} - \text{md}) \]
\[ sk = 3 \times (58.000 - 60) \]
\[ sk = -0.429 \]

Findings and Conclusions

Skewness calculated to be 0.588 indicates that Distribution #1 is within the limits of normality.

Skewness calculated to be -0.429 indicates that Distribution #2 is within the limits of normality as well.

Since both Distributions are normal, the study can be continued from this point.
## TABLE #17

**PRETEST B₁ VS. PRETEST B₂**

**Experimental Hypothesis** - Testing at the 95% confidence level, there will be no statistically significant difference between the mean pretest score for Group B₁ (no consistent teacher feedback) and Group B₂. This will be tested in the null form.

<table>
<thead>
<tr>
<th>SUBJECT</th>
<th>PRETEST B₁</th>
<th>SUBJECT</th>
<th>PRETEST B₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>1</td>
<td>87</td>
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<td>23</td>
<td>35</td>
<td>23</td>
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</tr>
</tbody>
</table>
Results

Pretest $B_1$
n = 23
$\overline{B}_1 = 41.729$
s = 8.869
$s_{B_1} = 1.849$
$2d = .05$
t = 2.074
allowance = 3.835
maximum = 46
minimum = 38

Pretest $B_2$
n = 23
$\overline{B}_2 = 58.000$
s = 13.997
$s_{B_2} = 2.919$
$2d = .05$
t = 2.074
allowance = 6.054
maximum = 64
minimum = 52

Calculations

\[ t_{obt} = \frac{(pre) \overline{B}_1 - (pre) \overline{B}_2}{\sqrt{\frac{(n_{B_1} - 1) * s_{B_1}^2 + (n_{B_2} - 1) * s_{B_2}^2}{n_{B_1} + n_{B_2} - 2} * \left(\frac{1}{n_{B_1}} + \frac{1}{n_{B_2}}\right)}} \]

\[ t_{obt} = 41.739 - 58.000 \]

\[ \sqrt{\frac{(23 - 1) * 8.869^2 + (23 - 1) * 13.997^2}{23 + 23 - 1} * \left(\frac{1}{23} + \frac{1}{23}\right)} \]

\[ t_{obt} = -4.706 \]

Findings and Conclusions

Since the $t$ required for 44 degrees of freedom, unbiased at the 95% confidence level is $\pm 2.010$ and since the $t$ obtained in this study was $-4.706$, we must reject the null hypothesis and conclude that there is a statistically significant difference between the mean pretest of Group $B_1$ (no consistent teacher feedback) and the mean pretest of Group $B_2$ (consistent teacher feedback) in favor of Group $B_2$. 
TABLE #18

PRETEST B₁ VS. POST-TEST B₁

Experimental Hypothesis - There will be a statistically significant difference between the mean pretest score and the mean post-test score for Group B₁ (no consistent teacher feedback). The post-test mean will be significantly higher than the pretest mean when tested at the 95% confidence level.

<table>
<thead>
<tr>
<th>SUBJECT</th>
<th>PRETEST B₁</th>
<th>POST-TEST B₁</th>
<th>D</th>
<th>D²</th>
</tr>
</thead>
<tbody>
<tr>
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</table>
Results

<table>
<thead>
<tr>
<th>Pretest $B_1$</th>
<th>Post-test $B_1$</th>
<th>$D$</th>
<th>$D^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\bar{B}_1 = 41.739$</td>
<td>$\bar{B}_1 = 80.826$</td>
<td>$\varepsilon D = -899$</td>
<td>$\varepsilon D^2 = 37733$</td>
</tr>
<tr>
<td>$s = 8.869$</td>
<td>$s = 9.787$</td>
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</tbody>
</table>

Calculations

\[
t_{obt} = \frac{(pre) \bar{B}_1 - (post) \bar{B}_1}{\sqrt{\frac{n \times \varepsilon D^2 - (\varepsilon D)^2}{n^2 \times (n - 1)}}}
\]

\[
t_{obt} = \frac{41.739 - 80.826}{\sqrt{\frac{23 \times 37733 - 899^2}{23^2 \times (23 - 1)}}}
\]

\[
t_{obt} = -17.265
\]

Findings and Conclusions

Since the $t$ required for 22 degrees of freedom, biased at the 95% confidence level is $\pm 1.717$ and since the $t$ obtained in this study was $-17.265$, we must reject the null hypothesis and conclude that there was a statistically significant improvement in the knowledge of science concepts taught in Unit #1 from pretest to post-test for Group $B_1$. 
**TABLE #19**

**PRETEST B₂ VS. POST-TEST B₂**

*Experimental Hypothesis* - There will be a statistically significant difference between the mean pretest score and the mean post-test score for Group B₂ (consistent teacher feedback). The post-test mean will be significantly higher than the pretest mean when tested at the 95% confidence level.

<table>
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<th>D</th>
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<td>83</td>
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<td>3136</td>
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</tbody>
</table>
Results

<table>
<thead>
<tr>
<th>Pretest B₂</th>
<th>Post-test B₂</th>
<th>D</th>
<th>D²</th>
</tr>
</thead>
<tbody>
<tr>
<td>B₂ = 58.000</td>
<td>B₂ = 81.043</td>
<td>E_D = -530</td>
<td>E_D² = 16840</td>
</tr>
<tr>
<td>s = 13.997</td>
<td>s = 6.765</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Calculations

\[
t_{obt} = \frac{(pre) \overline{B}_2 - (post) \overline{B}_2}{\sqrt{\frac{n \times (E_D^2) - (E_D)^2}{n^2 \times (n - 1)}}}
\]

\[
t_{obt} = \frac{58.000 - 81.043}{\sqrt{\frac{23 \times 16840 - 530^2}{23^2 \times (23 - 1)}}}
\]

\[
t_{obt} = -7.623
\]

Findings and Conclusions

Since the t required for 22 degrees of freedom, biased at the 95% confidence level is ±1.717 and since the t obtained in this study was -7.623, we must reject the null hypothesis and conclude that there was a statistically significant improvement in knowledge of science concepts (taught in Unit #2) from pretest to post-test for Group B₂.
TABLE #20
PRETEST B1 VS. POST-TEST B2

Experimental Hypothesis - Testing at the 95% confidence level, there will be no statistically significant difference between the mean post-test score for Group B1 (no consistent teacher feedback) and Group B2 (consistent teacher feedback). This will be tested in the null form.

<table>
<thead>
<tr>
<th>SUBJECT</th>
<th>POST-TEST B1</th>
<th>SUBJECT</th>
<th>POST-TEST B2</th>
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</thead>
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<td>92</td>
<td>23</td>
<td>80</td>
</tr>
</tbody>
</table>
Results

Post-test $B_1$

\[ \begin{align*}
  n &= 23 \\
  \bar{B}_1 &= 80.826 \\
  s &= 9.787 \\
  s^2_{B_1} &= 2.041 \\
  2 \delta &= 0.05 \\
  t &= 2.074 \\
  \text{allowance} &= 4.233 \\
  \text{maximum} &= 85 \\
  \text{minimum} &= 77
\end{align*} \]

Post-test $B_2$

\[ \begin{align*}
  n &= 23 \\
  \bar{B}_2 &= 81.043 \\
  s &= 6.765 \\
  s^2_{B_2} &= 1.411 \\
  2 \delta &= 0.05 \\
  t &= 2.074 \\
  \text{allowance} &= 2.926 \\
  \text{maximum} &= 84 \\
  \text{minimum} &= 78
\end{align*} \]

Calculations

\[
t_{obt} = \frac{(\text{post} \ \bar{B}_1 - \text{post} \ \bar{B}_2)}{\sqrt{\frac{(n_{B_1} - 1) \cdot s^2_{B_1} + (n_{B_2} - 1) \cdot s^2_{B_2} \cdot (\frac{1}{n_{B_1}} + \frac{1}{n_{B_2}})}{n_{B_1} + n_{B_2} - 2}}}
\]

\[
t_{obt} = \frac{80.826 - 81.043}{\sqrt{\frac{(23 - 1) \cdot 9.787^2 + (23 - 1) \cdot 6.765^2 \cdot (\frac{1}{23} + \frac{1}{23})}{23 + 23 - 2}}}
\]

\[
t_{obt} = -0.087
\]

Findings and Conclusions

Since the $t$ required for 44 degrees of freedom, unbiased at the 95% confidence level is $\pm 2.010$ and since the $t$ obtained in this study was $-0.087$, we must retain the null hypothesis and conclude that there is no statistically significant difference between the mean post-test of Group $B_1$ and the mean post-test of Group $B_2$. 
Summary

The results of testing the null hypotheses are as follows:

1) Failure to reject the null hypothesis indicates that there is no statistically significant difference between the mean pretest of Group A and the mean pretest of Group B for Unit #1.

2) Failure to reject the null hypothesis indicates that there is no statistically significant difference between the mean post-test score of Group A (consistent written teacher feedback) and the mean post-test score of Group B (no consistent written teacher feedback) for Unit #1.

3) Failure to reject the null hypothesis indicates that there is no statistically significant difference between the mean pretest for Group A and the mean pretest of Group B for Unit #2.

4) Failure to reject the null hypothesis indicates that there is no statistically significant difference between the mean post-test of Group A (no consistent written teacher feedback) and the mean post-test score of Group B (consistent written teacher feedback) for Unit #2.

5) Failure to retain the null hypothesis indicates that, for Group A, there is a statistically significant difference between the mean pretest for Unit #1 (A_1) and the mean pretest for Unit #2 (A_2).

6) Failure to reject the null hypothesis indicates that, for Group A, there is no statistically significant difference between the mean post-test for Unit #1 (A_1 - consistent written teacher feedback) and the mean post-test for Unit #2 (A_2 - no consistent written teacher feedback).
7) Failure to retain the null hypothesis indicates that, for Group B, there is a statistically significant difference between the mean pretest for Unit #1 ($B_1$) and the mean pretest for Unit #2 ($B_2$).

8) Failure to reject the null hypothesis indicates that, for Group B, there is no statistically significant difference between the mean post-test for Unit #1 ($B_1$ - no consistent teacher feedback) and the mean post-test for Unit #2 ($B_2$ - consistent written teacher feedback).
CHAPTER FIVE

CONCLUSIONS AND IMPLICATIONS
Purpose

The purpose of this study was to determine what, if any, effect consistent and meaningful written teacher commentary has on the achievement of fifth grade science students. The study was a statistical split half design in nature, utilizing independent t-tests to determine whether there was a statistically significant difference between the achievement levels of students receiving consistent and meaningful written teacher commentary on daily assignments and those students who did not. In addition, the anticipated progress or regression of each Group (as a result of receiving or not receiving consistent and meaningful written teacher commentary) from one Unit to the next was studied.

In this chapter, specific conclusions will be made as results are discussed. In addition, implications for both teachers (specifically teachers of science at the fifth grade level) and further research will be suggested.

Conclusion

Contrary to the hypotheses made by this examiner at the onset of this study, there was no statistically significant difference in achievement between those fifth grade science students who received consistent and meaningful teacher commentary on their daily homework assignments and those who did not. Despite there being no statistically significant differences in achievement, there were other, subtle differences which will be briefly discussed here.
Although all the differences were very slight, both Group A and Group B obtained a higher mean post-test score for the Unit in which they received consistent and meaningful written teacher feedback. Group B consistently had the higher mean scores, despite receiving or not receiving consistent and meaningful teacher commentary on assignments. It is interesting to note, however, that the closest mean score between Group A and Group B was for Unit #1, in which Group A received consistent and meaningful teacher commentary. The difference was a negligible .043 (in favor of Group B) as compared to a difference of 3.521 in favor of Group B for Unit #2 (in which Group B received consistent and meaningful written teacher commentary and Group A did not). The fact remains, however, that no difference was statistically significant.

Perhaps there are explanations for this finding other than the obvious: that consistent and meaningful written teacher commentary on daily homework assignments does not effect student achievement. The first concerns the homework assigned by the teacher used in the study.

In addition to those which were teacher written, assignments were written and suggested sequentially by the text that was being used in science instruction (Silver-Burdett). Perhaps the majority of these assignments did not focus on science concepts tested on the pretest, learned in class, and re-evaluated on the post-test.

According to the authors of the text, the worksheet materials supplied in the Teachers' Edition of the textbook were "designed to meet a variety of instructional needs". Corresponding to each
chapter in the textbook, reproducible copy masters were available, intended to focus on different areas of student achievement.

The teacher used in this study consistently assigned homework from those pages entitled, Vocabulary, Chapter Test, and Skill. According to the Teachers' Edition, the Vocabulary page was designed to reinforce key science terms learned. The purpose of the Chapter Test page was to provide reinforcement of important concepts learned in the chapter. The two Skill pages, however, each had a different purpose stated by the authors: one aimed at developing language arts and reading-related skills through science concepts, the other focused on basic process skills such as observing, inferring, measuring, classifying, sequencing, and predicting (Mallison, 1985). None of these areas were tested on the pre- or post-tests of Unit #1 or Unit #2.

In completing these assignments for homework, perhaps students were not being provided with as much review and reinforcement of science concepts as desired and/or needed. Instead, by focusing on different areas of skill and content, these assignments provided practice in these areas alone. Furthermore, the consistent and meaningful written teacher commentary, although intended toward science concepts which would ideally be learned by students, was, in actuality, directed toward the students' work in the area on which the assignment was focused. This, in providing little or no review of science concepts to be later found on the post-test, would not be likely to cause a difference in achievement as measured by this test.
Another possible explanation of the study's finding is that students did not read or really think about comments and corrections on their papers (so as to not be able to apply them to their learning and future measures of achievement). Although students appeared to be reading/thinking about comments and corrections (during in-class time that was given after corrected papers were redistributed the next day), the results suggest that they did not incorporate them into future work by which achievement was measured.

In addition to written comments and corrections, student assignments had a mark or a grade (depending on the assignment). It is feasible that, instead of attending to the written comments and corrections, students were interested in the overall rating of their work. If this were the case, written comments and corrections would make little or no difference to overall achievement, because they were not being seriously regarded by the students to whom they were directed.

The fact that the written and meaningful teacher commentary was given a day later may have had an effect on the outcome of the study. As suggested in the Introduction, perhaps if students had received immediate feedback as opposed to the day later feedback which was provided, the results would have been different. Day later feedback, for whatever reason, did not make a difference in achievement for these students. Immediate feedback could have very well proven meaningful, thereby causing a significant difference in achievement.
Finally, the word "meaningful" is a highly subjective term. What has meaning or purpose to one is not necessarily significant to another. It is conceivable that the written comments which the teacher used and considered to be meaningful were not, in reality, meaningful to the students who read them. If this were the case, the study would not be truly measuring the effects of consistent and meaningful teacher feedback, as indicated in the title.

**Implications for Further Research**

The nature and findings of this study suggest some interesting topics for further research. Obviously, it would be intriguing to determine whether or not written and meaningful teacher commentary would yield similar or different results in the utilization of subjects from either different grade levels and/or other subject areas. Rather than measure the achievement of students receiving consistent and meaningful written teacher commentary, it would be interesting to somehow measure the difference in attitude of students as a result of this treatment. The effects of different grading techniques on fifth grade students would be a worthwhile investigation, as would the measure of completed and handed-in homework assignments of those students receiving consistent and meaningful written teacher commentary on assignments and those who do not. Finally, a measure of the differences, if any, in achievement and/or attitude between boys and girls receiving consistent and meaningful written teacher commentary on assignments could be investigated as, in other areas, differential treatment (of boys and girls) has been demonstrated by teachers (Stake & Katz, 1982).
Implications for Teachers

This study has raised some interesting implications for teachers of science at the fifth grade level. From the results, it seems safe to assume that, for these teachers, to spend time and energy correcting and writing meaningful comments on student assignments is not as beneficial as providing ongoing, specific, and immediate feedback.

The study also raised an unexpected question related to the objectives of homework and assignments: does the work which teachers routinely assign for homework always accomplish that which is intended? As previously stated, a possible explanation for the results of this study was that the majority of homework assigned did not provide students with sufficient practice work in the specific science areas for which they were responsible. Certainly science is not the only subject area for which this kind of oversight could happen. In light of this, teachers might want to re-evaluate both their reasons for assigning homework as well as the specific assignments which students are required to do in order to determine whether or not their stated objectives are being met.

A final implication for teachers has to do with the advantages of correcting and commenting on students' work on a daily basis. Although time consuming, a teacher has a kind of ongoing dialogue with his/her students by providing this type of written feedback. The affective domain seems to be the area influenced by the teacher consistently writing commentary on student assignments that is not only corrective, but meaningful. A message at the bottom of a paper
in which a student obviously tried, such as "keep up the hard work, Sandi, I can tell you're really trying!" most probably means something special to students when they know that their teacher really is/will be looking; when they know that their teacher really does care. Although not so easily measured as cognitive growth, development of the affective domain can and should also be considered achievement. Commentary from the teacher resulting on increased or sustained effort on the part of the student seems to effect this kind of achievement.

Finally, daily monitoring of students' work allows the teacher to be aware of all students' progress, at all times - not only when reports cards are about to be distributed. All too often, a teacher does not realize that a student has a low average, or is failing a class altogether, until it's really too late to do anything but report the grade. More frequent and thorough monitoring of students' work helps to eliminate this type of occurrence. To strive to provide this written teacher commentary on a daily basis helps to ensure that teachers will be aware of students' progress at all times.

Summary

This study found no statistically significant correlation between consistent and meaningful written teacher commentary and student achievement. Possible explanations, such as homework assignments not corresponding to concepts measured and pre- and post-tests, have been discussed. Some possible topics for further research
to be conducted in this area, such as the effect of consistent and meaningful written teacher commentary on attitude (affective domain), have been proposed. Several implications for teachers have been suggested. Although providing consistent and meaningful written teacher commentary on the assignments of fifth grade science students does not seem to cause any significant difference in achievement, doing so seems to have other advantages, some of which have been considered herein.
References


APPENDIX A

Name__________________________ Science 5

Pretest: Unit #1

Directions:

Read each question and choose the answer that you think is the best. Mark your answer in the space provided.

1. The movement of weathered rock and soil from one place to another is
   a. frost action.
   b. erosion.
   c. sand dunes.
   d. dust storms.

2. Dropping of sediments by moving water, moving ice, and wind is
   a. deposition.
   b. chemical weathering.
   c. erosion.
   d. sedimentation.

3. Daily freezing and melting of water that causes large rocks to break up into small pieces is
   a. deposition.
   b. canyonization.
   c. frost action.
   d. water action.

4. Moving water, moving ice and wind are
   a. causes of pollution.
   b. agents of erosion.
   c. runoff.
   d. physical weathering.

5. Processes that break apart rock by changing its chemical makeup is
   a. deposition.
   b. chemical weathering.
   c. physical weathering.
   d. erosion.

6. A slow moving mass of ice on land is a(n)
   a. sand dune.
   b. river.
   c. iceberg.
   d. glacier.
7. Trees or bushes that block the force of the wind are called
   a. windbreaks.
   b. fault lines.
   c. canyons.
   d. sand dunes.

8. Water that comes from rain and melting snow and flows over the earth's surface is
   a. chemical weathering.
   b. sediments.
   c. agents of erosion.
   d. dust storms.

9. Materials dropped by moving water, moving ice and wind are
   a. sand dunes.
   b. sediments.
   c. agents of erosion.
   d. dust storms.

10. Farmers plant rows of crops around the sides of the hills in order to
    a. water their crops.
    b. collect sediments that enrich the soil.
    c. cause runoff to form small streams.
    d. prevent erosion.

11. Biodegradable materials
    a. are a mixture of smoke and fog.
    b. form acid rain.
    c. are broken down by living things.
    d. are toxic wastes.

12. When magma pushes through the earth's crust
    a. an earthquake forms.
    b. a dome mountain forms.
    c. folded mountains form.
    d. a volcano forms.

13. Earthquake waves are recorded by
    a. barometers.
    b. anemometers.
    c. balloons.
    d. seismographs.

14. Glaciers changed the land over which they moved in all of these ways EXCEPT
    a. scratching rock.
    b. scooping out valleys.
    c. depositing rocky materials.
    d. producing acids that dissolve rock.
15. Which one of these is an example of water pollution?
   a. children in a rowboat on a lake.
   b. fish and water plants on a lake.
   c. sewage in a lake.
   d. smog.

16. A drought is a long period of time during which
   a. many plants die.
   b. winds erode loose, dry topsoil.
   c. runoff erodes topsoil.
   d. both a and b.

17. As fertilizers increase the growth of algae in a lake,
   a. chlorine builds up.
   b. the oxygen supply decreases.
   c. fish begin to take in carbon dioxide.
   d. the oxygen supply increases.

18. Which of these does NOT cause chemical weathering?
   a. mosses.
   b. frost action.
   c. iron oxide.
   d. lichens.

19. Thermal pollution kills certain plant and animals that live in water because
   a. hot water cannot hold as much oxygen as cold water.
   b. the water becomes too acidic.
   c. hot water has too much oxygen in it.
   d. cooling towers in nuclear power plants are no good.

20. Chemical wastes and water vapor in the air combine to form
   a. fossil fuels.
   b. renewable resources.
   c. weak acids.
   d. fog.
APPENDIX B

Name _______________________________ Science 5  

Post-test: Unit #1

Directions:

I. Match the terms in Column A with their answers in Column B.

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>WEATHERING</td>
<td>a. useful material found in or on the earth</td>
</tr>
<tr>
<td>CHEMICAL WEATHERING</td>
<td>b. weak acids falling to the ground as snow or rain</td>
</tr>
<tr>
<td>EROSION</td>
<td>c. substance that helps plants grow</td>
</tr>
<tr>
<td>GLACIERS</td>
<td>d. piles of sand (caused by deposition of wind carried sand)</td>
</tr>
<tr>
<td>SAND DUNES</td>
<td>e. processes that break apart rock into smaller pieces</td>
</tr>
<tr>
<td>NATURAL RESOURCE</td>
<td>f. movement of weathered rock and soil from one place to another</td>
</tr>
<tr>
<td>ACID RAIN</td>
<td>g. poisonous by-products</td>
</tr>
<tr>
<td>FERTILIZER</td>
<td>h. process that breaks apart rock without changing its chemical makeup</td>
</tr>
<tr>
<td>TOXIC WASTES</td>
<td>i. slow moving masses of ice</td>
</tr>
<tr>
<td>PHYSICAL WEATHERING</td>
<td>j. processes that break apart rock by changing its chemical makeup</td>
</tr>
</tbody>
</table>

@ 5 pts. each

II. Fill in the blanks using the terms below. Not all the words will be used.

RENEWABLE RESOURCE
FROST ACTION
AGENTS OF EROSION
WINDBREAK
BIODEGRADABLE
SMOG
RUNOFF
THERMAL POLLUTION
SMOG

1. Water, ice and wind are called the ____________________________.

2. Something that blocks the force of the wind is called a(n) ____________________________.
3. A(n) ________ is a useful material that can be replaced after it is used.

4. Pollution that is a mixture of smoke and fog is called ________.

5. ________ is the dumping of heated materials into the water.

6. Materials that decay or are broken down by living things are ________.

7. The daily freezing and melting of water causes large rocks to break up into smaller pieces. This kind of physical weathering is called ________.

8. ________ is the surface water from rain and melting snow that flows over the earth's surface.

@ 5 pts. each

III. Answer the following questions in the spaces provided. Use complete sentences, and be your neatest, please!

1. In 1884, gold was discovered in a stream at Sutter's Mill in California. Within a year, 80,000 people rushed to California to look for gold. Many of these people simply dipped a pan in a stream and sifted out gold. Where did this gold come from? (Be careful to explain your answer thoroughly!)

2. Why are trees, air, land and water called natural resources?

@ 5 pts. each
APPENDIX C

Pretest: Unit #2

Directions:

Read each question and choose the letter of the best answer. Mark your answer in the space provided.

1. The atmosphere is colder over the poles because the sun's rays
   a. cannot pass through the cloud cover there.
   b. strike the surface there directly.
   c. are too far away to reach these areas.
   d. strike the surface there at a slant.

2. The study of the universe and all the objects in it is called
   a. geology.
   b. astronomy.
   c. ecology.
   d. cardiology.

3. Cumulonimbus clouds are
   a. dark, towering storm clouds.
   b. large, fluffy, fair weather clouds.
   c. thin, wispy clouds.
   d. thick, low, sheetlike clouds.

4. Groups of stars that seem to form patterns are
   a. constellations.
   b. nebulae.
   c. black holes.
   d. neutron stars.

5. Magnitude of a star depends on a star's
   a. distance from the earth.
   b. size.
   c. temperature.
   d. distance from the earth, size, and temperature.

6. To measure distances in space, scientists use
   a. kilometers.
   b. light years.
   c. miles.
   d. fathoms.

7. As heated air expands,
   a. it becomes less dense.
   b. its particles move closer together.
   c. it becomes denser.
   d. its pressure increases.
8. During the day, sea breezes occur because
   a. winds always blow from regions of low pressure to regions of high pressure.
   b. the cooler, higher pressure air over the water blows toward the land.
   c. the amount of water vapor in the air decreases.
   d. the high pressure air over the land blows toward the water.

9. Which color clothing is best to wear on a hot summer day?
   a. dark blue.
   b. brown.
   c. black.
   d. white.

10. Gravitational attraction causes clouds of dust and gas to come together and form a(n)
    a. irregular galaxy.
    b. nebula.
    c. neutron star.
    d. black dwarf str.

11. When a cold air mass moves into a warmer air mass
    a. cirrus clouds appear.
    b. thunderstorms may occur.
    c. the sky clears.
    d. steady, light rain usually falls for several days.

12. A star with no light or heat is called a
    a. white dwarf.
    b. black dwarf.
    c. black hold.
    d. sun.

13. is given off by the sun.
    a. Wind.
    b. Rain.
    c. Solar energy.
    d. Air pressure.

14. The scientist who invented the telescope is
    a. Carsen.
    b. Galileo.
    c. Barnard.
    d. Newton.

15. Another name for stratus clouds near the ground is
    a. fog.
    b. cyclone.
    c. rainstorm.
    d. wind.
APPENDIX D

Name ___________________________ Science 5

Post-test: Unit #2

Directions:

I. Write the letter of the correct answer on the line provided.

1._______ The pressing of air on the earth is known as
   a. a high.
   b. air pressure.
   c. air currents.
   d. global winds.

2._______ The uneven heating of the atmosphere is one reason for
   a. air pressure.
   b. wind.
   c. weather.
   d. the greenhouse effect.

3._______ What is the place called where two air masses meet?
   a. a thunderstorm.
   b. a blizzard.
   c. a cold front.
   d. a front.

4._______ The large, fluffy white clouds often seen during fair weather
   are called
   a. stratus clouds.
   b. cirrus clouds.
   c. cumulus clouds.
   d. cumulonimbus clouds.

5._______ The condition of the atmosphere in a place is
   a. air pressure.
   b. wind.
   c. weather.
   d. climate.

6._______ When air is heated, it
   a. contracts.
   b. expands.
   c. disappears.
   d. is absorbed.

7._______ A large body of air that has the same temperature and moisture
   throughout is
   a. an air mass.
   b. a cloud.
   c. an iceberg.
   d. a planet.
8. Differences in air pressure cause
   a. wind.
   b. air masses.
   c. fronts.
   d. clouds.

9. Weather begins with energy from
   a. the wind.
   b. the sun.
   c. nuclear power plants.
   d. light.

@ 5 pts. each

II. Using the word list, fill in the blanks. Not all terms will be used.

<table>
<thead>
<tr>
<th>MAGNITUDE</th>
<th>BLACK HOLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOVA</td>
<td>CONSTELLATION</td>
</tr>
<tr>
<td>ELLIPTICAL GALAXY</td>
<td>GALAXY</td>
</tr>
<tr>
<td>NEBULA</td>
<td>NEUTRON STAR</td>
</tr>
<tr>
<td>BLACK DWARF</td>
<td>RED GIANT</td>
</tr>
<tr>
<td>UNIVERSE</td>
<td>IRREGULAR GALAXY</td>
</tr>
</tbody>
</table>

1. The measure of the brightness of stars as seen from the earth is known as _________________.

2. A cloud of dust and gas found in space is called a _________________.

3. A star beginning "old age" often swells up to become a _________________.

4. Once most of a star's fuel is gone, it will enter the last stage of its life and become a _________________.

5. An exploding star is also known as a(n) _________________.

6. Stars that explode into supernovas sometimes collapse into very dense stars called _________________.

7. A region in space that was once occupied by a star is a _________________.

8. A large group of stars and other bodies in space is called a _________________.

9. This is like a spiral galaxy, but without the arms. What is it? _________________.

@ 5 pts. each
III. Use the spaces provided to answer the following questions.

1. Photographs of the sun show that it is brighter at the center than at the edges. What conclusion can you draw from this information? Explain your answer.

2. Weather is caused by the uneven heating of the atmosphere. What are three causes of uneven heating of the earth's atmosphere?

@ 5 pts. each