A Study of Achievement & Attitude Change in Seventh Grade Science Students at Sky Haven Elementary School, DeKalb County, Georgia, Using the Lecture-Demonstration-Recitation Method & the Discovery Method of Teaching

Leslie McIntosh
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1977
A STUDY OF ACHIEVEMENT AND ATTITUDE CHANGE IN SEVENTH GRADE SCIENCE STUDENTS AT SKY HAVEN ELEMENTARY SCHOOL, DEKALB COUNTY, GEORGIA, USING THE LECTURE—DEMONSTRATION—RECITATION METHOD AND THE DISCOVERY METHOD OF TEACHING

A Project
Presented to
the Faculty of the Department of Elementary Education
Western Kentucky University
Bowling Green, Kentucky

In Partial Fulfillment
of the Requirements for the Degree
Specialist in Education

by
Leslie Bruner McIntosh
August 1977
A STUDY OF ACHIEVEMENT AND ATTITUDE CHANGE IN SEVENTH GRADE SCIENCE STUDENTS AT SKY HAVEN ELEMENTARY SCHOOL, DEKALB COUNTY, GEORGIA, USING THE LECTURE—DEMONSTRATION—RECITATION METHOD AND THE DISCOVERY METHOD OF TEACHING

Recommended July 7, 1977

James N. Hick
Director of Project

Approved 7-29-77

Dean of the Graduate College
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Leslie B. McIntosh August 1977

Directed by: James W. Hicks, R. A. Otto, and V. J. Christenson

Department of Elementary Western Kentucky University Education

Because of the need for people to be scientifically literate in today's technological world, this researcher questioned whether the seventh grade students at the Sky Haven Elementary School, DeKalb County, Georgia, were learning basic science concepts in the most effective manner.

The purpose of this study was to compare the lecture-demonstration-recitation method (experimental treatment) and the discovery method (control treatment) of teaching science in the seventh grade to determine which method of instruction would result in greater student achievement and improved attitude towards science.

The sample consisted of 42 students of comparable ability (21 in each group) most of whom were black and/or disadvantaged. The period of instruction was eighteen weeks during the 1976-77 school year. Two achievement tests (one standardized and one researcher-prepared and criterion-referenced) and one standardized attitudes survey were used. The t test was chosen to test the
differences between the means of the two groups for three hypotheses and six sub-hypotheses at the .05 level of significance.

The findings indicated that the discovery method was significantly more effective in enhancing student achievement when measured by researcher-prepared criterion-referenced test. However, there were no statistically significant differences between student achievement and student attitudes toward science as measured by standardized instruments.

Although teaching method makes little or no difference on student achievement or attitudes as measured by standardized instruments, both methods did result in higher achievement and attitude scores with the lecture-demonstration-recitation group showing more improvement.

The most statistically significant finding was the sizable gains in achievement for both methods of instruction using the researcher-prepared criterion-referenced test. Both results were significant at greater than the .001 level.

Because of these significant findings, the writer recommends that more study be done in the area of criterion-referenced testing especially with minority and/or disadvantaged children.
CHAPTER I

INTRODUCTION

The elementary schools of the United States have had science as an integral part of the curriculum since the middle of the nineteenth century. However, the scope of the science program was very narrow in the initial stages of development as it focused only on specific topics directly related to the home life of the students.¹

Historically, science has made its greatest developments during periods of national emergency. Science first became a dominant force to be reckoned with during and after World War II. The war years saw science and technology develop sophisticated new war machinery as military scientists contributed to the war effort. This radical and sudden interest in and demand for science affected the quality and quantity of science in high schools and colleges as the demand for trained scientists increased. However, this new interest in science had little effect on the elementary curriculum at that time because of other pressing problems such as the rapidly

increasing population, which was increasing the pupil-teacher ratio at a very fast rate, and the accompanying financial burden. Therefore, elementary science program coordinators focused their resources on maintaining existing programs rather than initiating changes.

During the post-World War II period, much thought and discussion focused on science and its importance in the elementary school curriculum, but relatively little action was taken to effect new programs until the revolutionary phenomenon known as Sputnik occurred in 1957.2 This Russian achievement lighted the scientific fire that has continued to burn to this day and gives no indication that it will be extinguished. Modern man now considers new scientific developments a necessity of life as he becomes more sophisticated, achieves a higher standard of living, and faces a crowded world with its resultant problems of dwindling supplies of natural resources and increasing quantities of waste materials.

To keep up with the demands of the modern world just after Sputnik, curriculum planners and science educators began placing science in the elementary school whether the school was prepared or not. Much confusion existed as the elementary teachers were faced with teaching a subject that was, for the most part, unfamiliar to them. Also, there was confusion as to what scientific topics

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should be taught at the elementary level and when such topics should be presented. Even with all of the current research, these questions have not been answered to the satisfaction of all interested authorities. However, there is general agreement that science programs must be sequential, beginning with kindergarten and continuing through high school.  

Even with the new focus on science, Frankel stated that "In spite of new programs, new materials, and new curricula, science teaching in the elementary schools seems to be one of the most neglected areas of the curriculum." He concluded that this neglect of the science curriculum has resulted from lack of adequate preparation and background, feelings of inadequacy, insufficient science supplies and equipment, lack of a science room, no training in use of science equipment, and laziness.

Most all Georgia elementary schools' science programs seem to suffer from the problems stated by Frankel. Therefore, since some of our schools' science programs...

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5Ibid., p. 343.

6Ibid.
programs are not as advanced and up-to-date as we would like to think, science educators need to continue to publicize how vitally important science and scientific research are to the continuing advancement of our society so that people will support federal funding of science research projects.

Since science is so important in our present age, children need to study and learn scientific principles, applications, and methods in order to live intelligently and effectively. Today, science has surpassed the status of being merely a body of facts; science is a way of thinking and solving problems.7

Because of vast scientific research and writing, the literature in science has increased so rapidly that scientists are unable to keep abreast of all recent developments. In order to deal with the science literature problem in the schools, scientists and educators have been working together to determine the best teaching method that will prepare students for a lifetime of scientific study, not just during the school years. This combined effort has resulted in new teaching methods mainly at the high school level.8


As a result of these new methods of teaching science, one major emphasis has been the earlier introduction of concepts. Concepts once taught in high school are now introduced in junior high school and even in the elementary grades. To meet these new science curriculum demands, the elementary schools have had to revise their science programs. ⁹

As the elementary school science curriculum planners have dealt with the need for science curriculum revision and a sequential order of study, they have planned organized programs stating the various topics and facts that should be learned at each grade level. ¹⁰, ¹¹ Even though the schools have developed sound, well organized programs, none of them will be successful without effective teaching.

Effective teaching requires effective teachers. An effective teacher is usually thought of as a person with effective teaching-technique skills, a thorough knowledge of the subject area, and considerable patience.

⁹ Drenchko, p. 3.


and fortitude. However, Cronbach\textsuperscript{12} stated that no teacher can possibly have all the answers to science problems, but he must have an understanding of the way in which scientists work.

Generally, the scientist functions in the following manner. He formulates a problem, studies the facts that are known, makes a guess (hypothesis) as to the solution of the problem, and, finally, tests the hypothesis. If the hypothesis fails to be acceptable, the scientist must start all over again. This procedure is the common method by which anyone solves a problem. However, VanDeventer\textsuperscript{13} stated that the scientist adds an extra step which is to determine whether or not the accepted solution also applies in similar situations.

According to Drenchko\textsuperscript{14}, teachers use different methods of teaching in the various subject areas with laboratory work best suited for scientific studies. Today, elementary school science is taught in a variety


\textsuperscript{14}Drenchko, pp. 4-6.
of ways. Some of the most common methods of teaching are:

1. Reading: Science teaching utilizing the reading method consists of the students reading an assigned number of pages and answering questions about what they have read. This procedure is usually utilized by poorly prepared teachers or those that provide little time for science instruction. If the reading is well motivated, the student can learn needed information, but the techniques of problem solving are not taught and, hence, not learned by the students.

2. Lecture-demonstration: This type of teaching is teacher dominated as he does most of the active participation except for the reading of assignments and note taking. In class, the teacher lectures and the students take notes. When the teacher feels that demonstrations are useful, he performs them and has class discussion about the results.

3. Recitation-demonstration: Recitation includes oral questions and answers, demonstrations, and considerable class discussion. The demonstrations are performed by both the teacher and students. Demonstrations are useful to introduce a principle or to determine where and how the principle applies after the students have
discussed it. Demonstration provides the advantage of taking less time than discussion to obtain the same results.  

4. Activity: In the activity method, the students are physically, as well as mentally, involved in the learning experience. The students perform the demonstrations and experiments and report results to the class as a whole.

5. Class project and experiment: This method of teaching involves the entire class in working for the solution to a project or experiment. In the participation, the students may be involved in different parts of the whole group class project or they may do the same thing as in performing the same experiment. Whatever the type of participation involved, each student is participating in the problem solving process.

6. Independent study: Branley stated that independent study can occur whenever experiments are used for which the student does not know the answer.

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15Ibid.


17Drenchko.

18Franklyn M. Branley, "Experiments and Demonstrations," Grade Teacher 78 (October 1960): 53, 125+.  

This type of instruction requires much teacher planning. Each student must be able to choose problems and work toward satisfactory conclusions with minimal teacher help. The teacher should serve as a resource person.

Huffmire\textsuperscript{19} identified certain tactics and methods that could be used in any independent study:

The planned investigation, reflective thinking, inspiration, the "educated guess," trial-and-error, accidental discovery, reference to authority, developing new concepts and problems, using a logbook (and) making a final written report.

7. Problem solving (Discovery): Babikian\textsuperscript{20} stated that science is no longer considered a body of factual knowledge by science educators; instead, they think of it as a dynamic process of inquiry. However, according to Hetland,\textsuperscript{21} students are often taught science concepts in an isolated fashion. This results in much student confusion, and the student is unable to effectively apply the concepts when needed to solve a problem.


Therefore, according to Babikian and Dawson, students should be taught the cognitive skills which are essential for the independent application of the scientific method. This shift in emphasis has led to the innovation of the problem solving or discovery method of instruction. Also, Dawson stated that problem solving stimulates student motivation to study and learn because it offers a challenge to the students. Then, when solutions are found, the students sense a feeling of competence which stimulates interest in further study and learning.

Statement of the Problem

From the above discussion of the most common methods used to teach science, it is obvious that elementary science teachers have several options available to them, and that they should be knowledgeable of the available research so that they can make intelligent choices.

In an effort to determine whether the seventh grade science program at the Sky Haven Elementary School, DeKalb County, Georgia, which utilizes the discovery method, is effective, this researcher conducted a study comparing two methods of teaching science.

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22 Babikian.

Purpose of the Study

The purpose of this study was to compare the lecture-demonstration-recitation method and the discovery method of teaching science in the seventh grade in order to determine which method of instruction would result in greater student achievement and attitude towards science.

Definitions

1. A problem was considered as a motivator for finding solutions that were more involved than simply copying answers readily out of a book.24

2. Problem solving involved both the cognitive and affective domains as the students learned the techniques involved in finding solutions to problems and developed an independence in their learning.25

3. Lecture-demonstration-recitation was that method in which the students were assigned specific reading assignments which they were questioned over by the teacher in the class situation. Open class discussions followed in which the students were encouraged to participate, but the teacher was always in charge. The demonstrations were performed by the teacher or specifically chosen students to demonstrate or explain specific principles studied in the reading assignment.26 Most all learning experiences were centered in the classroom with some teacher lecturing.

24 Drenchko, p. 8.


26 Drenchko, p. 9.
4. Discovery was that method in which the student, with the teacher's guidance, made a series of inductive investigations in a laboratory environment. These investigations were individual, small group, and large group oriented. By studying each investigation's set of related facts and experiences, the student derived a concept. A sequential series of related concepts yielded a generalization. The student spent most of his class time in the laboratory learning from real experiences. Certain amounts of non-laboratory time were spent discussing and summarizing class data.

Assumptions

1. The students were sufficiently mature to handle the various learning experiences in a departmentalized situation.

2. The students were able to handle the equipment necessary for the various investigations and experiments.

3. Both the lecture-demonstration-recitation method and the discovery method could be handled in an equally efficient manner by the average elementary teacher.

This teacher (researcher) had not had special training in science other than the required science courses for his undergraduate degree in elementary education from Western Kentucky University. Therefore, he should be considered an average elementary teacher for the purpose of this study.

4. The seventh grade students were typical of those found in similar communities.

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28 Drenchko, p. 10.
5. Since the lecture—demonstration—recitation method and the discovery method are different teaching methods, the two methods should have had different effects on student achievement and attitude towards science.

6. Based on the method of assigning students in the two groups, there should have been no differences in student achievement and attitude towards science according to the sex of the student.

7. Based on the method of assigning students in the two groups, there should have been no differences in student achievement and attitude towards science according to the intelligence of the student.

Hypotheses

The research hypothesis for this study was that the discovery method of teaching science will result in higher student achievement and improved attitude towards science than will the lecture—demonstration—recitation method of teaching science in the seventh grade.

Based on the research hypothesis, the following null hypotheses were tested:

1. There is no statistically significant difference between the lecture—demonstration—recitation method and the discovery method of teaching science in the seventh grade with respect to student achievement as indicated by a standardized science achievement test.

2. There is no statistically significant difference between the lecture—demonstration—recitation method and the discovery method of teaching science in the seventh grade with respect to student achievement as indicated by a researcher—prepared criterion—referenced science achievement test.
3. There is no statistically significant difference between the lecture-demonstration-recitation method and the discovery method of teaching science in the seventh grade with respect to student attitude towards science as indicated by a standardized attitudes survey.

In addition, the following null sub-hypotheses were tested:

1. There is no statistically significant difference between pre- and posttest scores on a standardized science achievement test using the lecture-demonstration-recitation method.

2. There is no statistically significant difference between pre- and posttest scores on a researcher-prepared criterion-referenced science achievement test using the lecture-demonstration-recitation method.

3. There is no statistically significant difference between pre- and posttest scores on a standardized science achievement test using the discovery method.

4. There is no statistically significant difference between pre- and posttest scores on a researcher-prepared criterion-referenced science achievement test using the discovery method.

5. There is no statistically significant difference between pre- and posttest scores on a standardized attitudes survey using the lecture-demonstration-recitation method.

6. There is no statistically significant difference between pre- and posttest scores on a standardized attitudes survey using the discovery method.
CHAPTER II

REVIEW OF RELATED LITERATURE

Science instruction is receiving a major emphasis in the modern elementary school curriculum because of the need for each child to learn the techniques of scientific problem solving. Therefore, the Sky Haven Elementary School and this researcher are vitally concerned about the school's present seventh grade discovery oriented science program. The primary purpose of this study has been to determine the effectiveness of the present program with respect to student achievement and attitude towards science.

To determine the success of various science teaching methods in improving achievement and attitude levels as recorded in research for the seventh grade or grades with close similarity, few articles of research were relevant and worthy of inclusion in this review. A review of relevant research follows.

Norton\textsuperscript{29} conducted a study with seventh and eighth grade students to determine the difference in

\textsuperscript{29}Norton.
teaching methods and their effects on the student. He found that junior high students tended to have an extremely high interest in science, but that the interest was extremely low by the time they reached ninth grade. Norton attributed this reversal in interest to the students having been taught by the lecture-recitation method of teaching. He stated that interest would remain high if the students were permitted to actively perform within the class.

Carpenter ³⁰ confirmed Norton's findings in a study of fourth graders. He compared the effectiveness of the reading-recitation method and the problem solving method involving experimentation and demonstrations. Both groups of students were taught the same topics for the same length of time. Carpenter even reversed the groups on some of the topics. In all cases, the groups taught by the problem solving method tested significantly higher on mean scores using the t test. In breaking the data down to compare the high and low intelligence students, Carpenter found that students in the top quarter of the class achieved more in the problem solving method, but the difference was not enough to be statistically significant. However, the bottom quarter of the group

in the problem solving method was extremely statistically significant.

Babikian\textsuperscript{31} conducted a study of 216 eighth graders to determine the relative effectiveness of discovery, laboratory, and expository methods of teaching science concepts. He found that both the expository and laboratory methods were significantly more effective than the discovery method. In addition, irrespective of the method used, high intelligence students achieved significantly better than the low intelligence students, and the boys achieved significantly better than the girls.

Babikian cautioned that the superiority of the expository method over the discovery method might have been due to the particular expository lesson plan used and to the lack of experience of the subjects in the discovery method. However, the investigation provided enough evidence to recognize the importance of the expository method in science education.

Pitt\textsuperscript{32} compared the guided discovery method and the lecture-recitation method of teaching science in effecting mental process development in 314 seventh

\begin{flushright}
\textsuperscript{31}Babikian.
\end{flushright}

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and eighth grade students. The data revealed that the students taught by the guided discovery method performed in a superior way when required to use the higher mental processes of analysis, synthesis, and evaluation. Both groups were equal in performance when required to use lower mental processes of remembering, recalling, comprehending, and applying knowledge.

Benson's\textsuperscript{33} study compared the achievement and attitudes toward science of fifth graders taught by the lecture-demonstration method and the discovery (pupil-investigation) method. The students were from two different schools in Oklahoma. Each school had one experimental group and one control group. By using a $t$ test, he found that the two teaching methods produced no significant differences in content achievement. A Mann-Whitney U statistic revealed that differences in attitude toward science were significant in one school, but were not significant in the second school. Benson concluded his study by stating that available evidence indicated that, when taught by the same teacher, the discovery (pupil-investigation) approach was at least as effective as the lecture-demonstration approach to teaching fifth grade science.

James conducted a study of 60 seventh grade students to compare the differences of achievement and interest when taught by the individualized approach and the group approach. The results revealed that there was no significant difference in achievement between the two treatments, thus supporting the hypothesis that students in the individualized treatment are able to assume responsibility for their learning and profit from an environment which was judged by observers as being chaotic. No significant difference between the two treatments in respect to students' interest was discovered. In addition, the results did not provide evidence that poorer students would be more apt to profit from individualized instruction.

Partin's study compared the effectiveness of the process method and the textbook method upon the achievement and interest in science for selected fourth grade students. Factorial analysis of variance revealed that there was no significant difference in achievement for the two treatments. The boys scored significantly

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greater gains than did the girls. However, factorial analysis of variance revealed that students in the process method scored significantly higher in interest than did those students taught by the textbook method. The boys demonstrated significantly higher interest than did the girls.

Downs\textsuperscript{36} studied the effect of constructional activities upon the science and mathematics achievement of 360 fifth grade students. There were three teaching approaches: Method A, an experimental approach in which the students constructed a bird house designed to enrich the unit of science being studied; Method B, an experimental approach designed to enrich the curricular areas of social studies and mathematics in which the students constructed such objects as giant rulers, circular fractions, number lines, place value boxes, abaci, serving trays, and geometric figures; and Method C, the traditional approach which did not employ a constructional experience to enrich fifth grade curricular areas. The results revealed that the achievement scores of students in Group A were significantly higher, regardless of ability level, than for Groups B and C.

In conclusion, it is apparent that much more relevant research in science teaching methods is needed in order to guide elementary schools toward better and more efficient teaching. Therefore, it was intended that this research project would result in significant conclusions that would help improve the seventh grade science program at the Sky Haven Elementary School, as well as provide useful guidelines for other similar elementary schools that are interested in continued evaluation and improvement of their science programs.
CHAPTER III

DESIGN OF THE STUDY

Purpose

In an effort to determine whether the seventh grade science program at the Sky Haven Elementary School, DeKalb County, Georgia, (utilizing the discovery method), was effective, this researcher conducted a study comparing two methods of teaching science. The purpose of this study was to compare the lecture-demonstration-recitation method and the discovery method to determine which method of instruction would result in greater student achievement and better attitude towards science. The study was conducted for eighteen weeks of classroom instruction during the winter and spring quarters of the 1976-77 school year.

The research hypothesis for this study was that the discovery method of teaching science will result in higher student achievement and improved attitude towards science than will the lecture-demonstration-recitation method of teaching science in the seventh grade.

Based on the research hypothesis, the following null hypotheses were tested:
1. There is no statistically significant difference between the lecture-demonstration-recitation method and the discovery method of teaching science in the seventh grade with respect to student achievement as indicated by a standardized science achievement test.

2. There is no statistically significant difference between the lecture-demonstration-recitation method and the discovery method of teaching science in the seventh grade with respect to student achievement as indicated by a researcher-prepared criterion-referenced science achievement test.

3. There is no statistically significant difference between the lecture-demonstration-recitation method and the discovery method of teaching science in the seventh grade with respect to student attitude towards science as indicated by a standardized attitudes survey.

In addition, the following null sub-hypotheses were tested:

1. There is no statistically significant difference between pre- and posttest scores on a standardized science achievement test using the lecture-demonstration-recitation method.

2. There is no statistically significant difference between pre- and posttest scores on a researcher-prepared criterion-referenced science achievement test using the lecture-demonstration-recitation method.

3. There is no statistically significant difference between pre- and posttest scores on a standardized science achievement test using the discovery method.

4. There is no statistically significant difference between pre- and posttest scores on a researcher-prepared criterion-referenced science achievement test using the discovery method.

5. There is no statistically significant difference between pre- and posttest scores on a standardized attitudes survey using the lecture-demonstration-recitation method.
6. There is no statistically significant difference between pre- and posttest scores on a standardized attitudes survey using the discovery method.

Sample

Sky Haven Elementary School is a large, predominantly black, suburban K-7 continuous progress elementary school of approximately 900 students. A majority of the students come from economically and socially disadvantaged homes.

There were 42 seventh grade students (35 black students and 7 white students) involved in this study (21 students in each of the two groups). Due to present Sky Haven School policy, the students were grouped in a homogenous fashion according to math achievement level. Two groups of comparable ability and achievement were selected to use in this study. All students in the two groups were in either math level 19 or 20 (seventh grade equivalent levels were 19-21).

Procedure

The experimental group, which was composed of 21 students in math level 19, was taught by the lecture-demonstration-recitation method. The control group, which was composed of 21 students (13 students in math level 19 and 8 students in math level 20), was taught by the discovery method utilizing DeKalb County's regular science program (explained below). Both
teaching methods are defined in Chapter I on pages 11 and 12. The researcher taught both groups and remained with these groups for the duration of the study.

The research design is illustrated below:

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C & \quad 0_1 \quad X \quad 0_2
\end{align*}
\]

DeKalb County and Sky Haven Elementary School's basic science program at the seventh grade level is *Ideas and Investigations in Science: Life Science* (IIS) developed by Wong, Bernstein, and Shevick.\(^{37}\) The IIS program was utilized as the control treatment in this study. The IIS materials served as a resource for the experimental treatment. However, both groups studied the same topics and took the same teacher-made tests at the end of each of the three Ideas of study (explained below).

According to Wong, Bernstein, and Shevick,\(^{38}\) IIS is a program of inductive-discovery learning experiences stressing those few major science concepts that should be known by every person in order to be scientifically literate. In addition, IIS emphasizes the ways or processes by which scientists form ideas, make discoveries, and contribute to the advancement of society. In this program, the student is involved in

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\(^{38}\) Ibid., *Teachers Manual*, p. 16.
daily activities from which he discovers scientific truths about his world for himself.

IIS's teaching strategy involves the student in conducting investigations with the teacher's guidance. Each investigation leads the student to discover one concept. A series of sequential concepts forms a scientific idea. "The concepts and processes have been chosen with the students' intellectual, social, motivational, and educational maturity as determining criteria." 39

The total IIS program is composed of twelve Ideas (appendix 1, pages 63-76). The eighteen weeks of instruction for this study focused on Idea 4, (Energy), "All Living Things Must Obtain Energy"; Idea 5, (Metabolism), "All Living Things Use Energy"; and Idea 6, (Life Activities), "All Living Things Have Common Life Activities." 40

The following supplemental texts were available for use by the researcher and students:


39 Ibid.

40 Ibid., pp. 4-15.
Instrument

Three instruments were used in this study. The first instrument was the 1964 edition of the Stanford Science Test, Advanced Level. Form X of the test was administered as the pre-test and Form W of the test was administered as the post-test. Comparisons were made to determine growth in achievement.

Of the various standardized science tests available, the Stanford enjoys as good a recommendation as any of the others. According to Mallinson, Hastings and Stake, Kambly and Goolsby, the Stanford Science Test is as good a measurement, if not one of the best, of students' scientific knowledge as any such tests available to the researcher today.

The Stanford Science Test has a relatively high reliability coefficient of .88 and a standard error of measurement of 9.0 which lends credence to the


reliability of the test. However, the validity of the test falls markedly because only one-fourth of the test items are related to the contents of study in this life science project. The researcher was unable to procure a standardized science achievement test with a higher level of validity.

Because of test confidentiality, the publisher of the Stanford Science Test refused to grant permission to include a copy of the test in this project report (see appendix 2, pages 77-78).

The second instrument used in this study was a researcher-prepared criterion-referenced science achievement test (appendix 3, pages 79-93). Criterion-referenced testing was necessitated by the poor validity of the Stanford Science Test for my project sample. In addition, Sky Haven Elementary School has discontinued norm-referenced testing as the new focus in DeKalb County has centered on criterion-referenced testing. The researcher-prepared criterion-referenced test was administered as both the pretest and the posttest. Comparisons were made to determine growth in achievement.

Several writers such as Glaser, Brazziel, Dziuban and Vickery, Drew, Elsner and Ebel have defined criterion-referenced tests and offered supportive statements for use of this type of individualized testing.

Brazziel's definition and supportive statements of the criterion-referenced test are most noteworthy in reference to my particular teaching situation in a predominantly black school. According to Brazziel, criterion-referenced tests measure student progress toward explicit objectives as defined by the school enterprise. They are measures of degree of mastery of material taught and learned in a specific time frame. They have a high degree of individual relevance and validity; the major intent is to measure individual progress and identify needed additional experiences to assure mastery of instructional objectives. Criterion-referenced tests afford teachers and children the opportunity to


focus on mastery of material enabling pupils to progress to a higher level of study.  

In recommending use of criterion-referenced tests over norm-referenced tests, Brazziell stated that the norm-referenced test which measures children in relation to each other is really not an accurate measurement of learning objectives. This is because norm-referenced tests are standardized according to the comparisons made on a norm group. In addition, half of the children must be below the median. This type of testing is self-defeating as the bottom half always loses, whereas in criterion-referenced testing, it is possible for all of the children to succeed.

To further reinforce the problems that norm-referenced tests present to the minority child, Drew cautioned that norm-referenced tests are still culturally biased even after the many promises to develop culturally fair tests. Therefore, it seems fair to assume that the groups of students used to standardize the Stanford Science Test and all other norm-referenced tests may be totally unlike the socioeconomic and cultural levels of a given local testing.

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52 Brazziell, p. 52.
53 Ibid.
54 Drew, p. 324.
situation such as Sky Haven Elementary School, which is predominantly black and has many students from low income families.

The recently published DeKalb County Upper Elementary Course Guide lists the concepts, subconcepts, and learning objectives of the seventh grade Life Science program which served as the basis for instruction and testing in this project. Ideas 4, 5, and 6, which were the focus of this study, are outlined in appendix 4, pages 94-101.

The third instrument used in this study was the Survey of School Attitudes, Form A, intermediate level (science section). The Survey of School Attitudes (SSA), a standardized attitudes survey, was used to compare the students' attitudes toward science.

The results of the SSA are made meaningful by two important characteristics:

The Survey [SSA] asks the student about a variety of activities representing a curricular area rather than asking direct questions about an area such as: "Do you like social studies?" Second, the Likert-type item format used on the Survey requires the student to state an opinion about each activity.

The three Likert-type response options used in the SSA are: "Like," "Dislike," and "Not Sure or Don't Care."^56

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^56 Ibid., p. 13.
The reliability of the SSA is evidenced by the following testing data: half reliability coefficient, corrected by the Spearman-Brown Formula, of .83 and Coefficient Alpha reliability estimate of .82 with 2.4 standard error of measurement.

In developing the SSA, the author was careful not to exclude minority concerns in selection and representation of content. Members of various minority groups are depicted in the artwork and varied aspects of our culture are represented in the items. In addition, minority students were used in the national standardization procedures.

Since Form B of the SSA was unavailable at the time of the study, Form A served as both the pretest and posttest. Comparisons were made to determine individual growth in attitude towards science, as well as to determine which teaching method yielded the greater level of increase in attitudes.

Because of test confidentiality, the publisher of the SSA refused to grant permission to include a copy of the survey in this project report (see

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57 Ibid., p. 8.
58 Ibid., p. 13.
appendix 2, pages 77-78). However, the lack of appropriate attitude surveys and the relatively significant reliability figures listed above for the SSA lend credence to its use in this project.

Treatment of Data

The $t$ test was chosen to test the differences between the means of the two groups for each hypothesis at the .05 level of significance.

Ary, Jacobs, and Razavieh\(^{60}\) stated that the $t$ test is one of the most widely used ways of testing a null hypothesis for significance. It is especially useful to test small samples as in this project. In addition, the $t$ test enables the researcher to compensate for non-independent (or matched) samples, as was used in this project, so as to make the results more representative.

Limitations

1. Although the topics of study were the same for both groups, the various investigations and experiments differed according to teacher direction and/or student interest.

2. The range of investigations and experiments were limited by available resources and equipment.

3. The sample consisted of only 42 students.

4. The Stanford Science Test was not a valid standardized instrument for measuring the achievement growth of the students in the sample.
CHAPTER IV

ANALYSIS OF DATA

The \( t \) test was used for both the in-group processes (nonindependent or correlated) and between group processes (independent).

Within each group, both Experimental (E) and Control (C), the pre- and posttest scores were analyzed using the following formula:\(^{61}\)

\[
\begin{align*}
    t &= \frac{\bar{D}}{\sqrt{\frac{\sum D^2 - (\bar{D})^2}{N(N-1)}}} \\
    \bar{D} &= \text{the mean of the differences} \\
    \sum D^2 &= \text{the sum of the squared difference scores} \\
    N &= \text{the number of pairs}
\end{align*}
\]

Between the groups, E and C, the formula used to test significance was:\(^{62}\)

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\(^{61}\)Ibid., p. 139.

\(^{62}\)Ibid., p. 136-37.
\[ t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt\left( \frac{\frac{\sum x_1^2}{n_1} + \frac{\sum x_2^2}{n_2}}{n_1 + n_2 - 2} \right) \left( \frac{1}{n_1} + \frac{1}{n_2} \right)} \]

where

\( \bar{x}_1 - \bar{x}_2 = \) the observed difference between two means

\[ \sqrt\left( \frac{\sum x_1^2 + \sum x_2^2}{n_1 + n_2} \right) \left( \frac{1}{n_1} + \frac{1}{n_2} \right) = \] The formula for the standard error for the difference between two means is also written as

\( \sigma_{\bar{x}_1 - \bar{x}_2} \)

\( n_1 = \) the number of cases in Group 1 (E Group)

\( n_2 = \) the number of cases in Group 2 (C Group)

\( \sum x_1^2 = \) the sum of the squared deviation scores in the E Group

\( \sum x_2^2 = \) the sum of the squared deviation scores in the C Group

The level of significance is .05, sometimes written as \( \alpha = .05 \) or \( p < .05 \).

Degrees of freedom (d.f.) are:

within groups = 20 \((n-1)\),

\[ \text{value} = 2.086 \text{ at } .05 \text{ level} \]

\[ \text{value} = 2.845 \text{ at } .01 \text{ level} \]

\[ \text{value} = 3.850 \text{ at } .001 \text{ level} \]

between groups = 40 \((n_1 + n_2 - 2)\),

\[ \text{value} = 2.021 \text{ at } .05 \text{ level} \]

\[ \text{value} = 2.704 \text{ at } .01 \text{ level} \]

\[ \text{value} = 3.551 \text{ at } .001 \text{ level} \]

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\(^{63}\) Ibid., pp. 134-35, 360.
**TABLE 1**

**SUMMARY OF NULL HYPOTHESES**

<table>
<thead>
<tr>
<th>Null Hypotheses</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. There is no statistically significant difference between the lecture-demonstration-recitation method and the discovery method of teaching science in the seventh grade with respect to student achievement as indicated by a standardized science achievement test.</td>
<td>*n.s.</td>
</tr>
<tr>
<td>2. There is no statistically significant difference between the lecture-demonstration-recitation method and the discovery method of teaching science in the seventh grade with respect to student achievement as indicated by a researcher-prepared criterion-referenced science achievement test.</td>
<td>p &lt; .05</td>
</tr>
<tr>
<td>3. There is no statistically significant difference between the lecture-demonstration-recitation method and the discovery method of teaching science in the seventh grade with respect to student attitude towards science as indicated by a standardized attitudes survey.</td>
<td>*n.s.</td>
</tr>
</tbody>
</table>

* = not significant
<table>
<thead>
<tr>
<th>Null Sub-Hypotheses</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. There is no statistically significant difference between pre- and posttest scores on a standardized science achievement test using the lecture-demonstration-recitation method.</td>
<td>**p &lt; .05</td>
</tr>
<tr>
<td>2. There is no statistically significant difference between pre- and posttest scores on a researcher-prepared criterion-referenced science achievement test using the lecture-demonstration-recitation method.</td>
<td>***p &lt; .05</td>
</tr>
<tr>
<td>3. There is no statistically significant difference between pre- and posttest scores on a standardized science achievement test using the discovery method.</td>
<td>*n.s.</td>
</tr>
<tr>
<td>4. There is no statistically significant difference between pre- and posttest scores on a researcher-prepared criterion-referenced science achievement test using the discovery method.</td>
<td>***p &lt; .05</td>
</tr>
<tr>
<td>5. There is no statistically significant difference between pre- and posttest scores on a standardized attitudes survey using the lecture-demonstration-recitation method.</td>
<td>**p &lt; .05</td>
</tr>
<tr>
<td>6. There is no statistically significant difference between pre- and posttest scores on a standardized attitudes survey using the discovery method.</td>
<td>*n.s.</td>
</tr>
</tbody>
</table>

* = not significant

** = at p < .01 level

*** = at p < .001 level
### TABLE 3

**ACHIEVEMENT IN SCIENCE USING STANFORD SCIENCE TEST**

<table>
<thead>
<tr>
<th>Number</th>
<th>E Group</th>
<th>C Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>32      +9</td>
<td>43      +18</td>
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<tr>
<td>2</td>
<td>31      +8</td>
<td>41      +15</td>
</tr>
<tr>
<td>3</td>
<td>29      +6</td>
<td>38      +12</td>
</tr>
<tr>
<td>4</td>
<td>28      +5</td>
<td>32      +6</td>
</tr>
<tr>
<td>5</td>
<td>27      +4</td>
<td>31      +5</td>
</tr>
<tr>
<td>6</td>
<td>27      +4</td>
<td>31      +5</td>
</tr>
<tr>
<td>7</td>
<td>26      +3</td>
<td>31      +5</td>
</tr>
<tr>
<td>8</td>
<td>26      +3</td>
<td>30      +4</td>
</tr>
<tr>
<td>9</td>
<td>25      +2</td>
<td>30      +4</td>
</tr>
<tr>
<td>10</td>
<td>25      +2</td>
<td>28      +2</td>
</tr>
<tr>
<td>11</td>
<td>24      +1</td>
<td>26      +0</td>
</tr>
<tr>
<td>12</td>
<td>24      +1</td>
<td>26      +0</td>
</tr>
<tr>
<td>13</td>
<td>23      0</td>
<td>23      -3</td>
</tr>
<tr>
<td>14</td>
<td>22      -1</td>
<td>23      -3</td>
</tr>
<tr>
<td>15</td>
<td>20      -3</td>
<td>21      -5</td>
</tr>
<tr>
<td>16</td>
<td>19      -4</td>
<td>20      -6</td>
</tr>
<tr>
<td>17</td>
<td>18      -5</td>
<td>18      -8</td>
</tr>
<tr>
<td>18</td>
<td>18      -5</td>
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<tr>
<td>19</td>
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<td>20</td>
<td>16      -7</td>
<td>15      -11</td>
</tr>
<tr>
<td>21</td>
<td>12      -11</td>
<td>11      -15</td>
</tr>
</tbody>
</table>

\[ \bar{X}_1 = 23.3 \ (23) \quad \bar{X}_2 = 26.3 \ (26) \]

\[ t \text{ value} = 1.40 \]

**NOTE:** See appendix 5, pages 103-104, for complete table and calculations.
Calculated value of 1.40 does not exceed the critical value of 2.021. Therefore, the null hypothesis that there is no statistically significant difference in the means of the two groups with respect to student achievement using a standardized science achievement test (Stanford Science Test) is accepted.

**Conclusion:**

Teaching method makes little or no statistically significant difference on student achievement in science as measured by a standardized instrument. Both methods alone can cause a gain in scores. However, the lecture-demonstration-recitation method appears to offer more evidence for this approach with this particular sample (see table 6, pages 45-46, and table 7, pages 49-50).
### TABLE 4

**ACHIEVEMENT IN SCIENCE USING RESEARCHER-PREPARED CRITERION-REFERENCED TEST**

<table>
<thead>
<tr>
<th>E Group</th>
<th></th>
<th></th>
<th></th>
<th>C Group</th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Number</td>
<td>$X_1$</td>
<td>$X_1$</td>
<td>$X_1^2$</td>
<td>Number</td>
<td>$X_2$</td>
<td>$X_2$</td>
<td>$X_2^2$</td>
</tr>
<tr>
<td>1</td>
<td>78</td>
<td>+17</td>
<td>289</td>
<td>1</td>
<td>78</td>
<td>+10</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>77</td>
<td>+16</td>
<td>256</td>
<td>2</td>
<td>78</td>
<td>+10</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>74</td>
<td>+13</td>
<td>169</td>
<td>3</td>
<td>78</td>
<td>+10</td>
<td>100</td>
</tr>
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<td>4</td>
<td>74</td>
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<td>77</td>
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<td>81</td>
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<tr>
<td>5</td>
<td>71</td>
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<td>75</td>
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<td>49</td>
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<td>6</td>
<td>67</td>
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<td>36</td>
<td>6</td>
<td>73</td>
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<td>25</td>
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<td>7</td>
<td>66</td>
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<td>7</td>
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</tr>
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<td>14</td>
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<td>4</td>
<td>14</td>
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<td>21</td>
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<td>-30</td>
<td>900</td>
</tr>
</tbody>
</table>

\[ \bar{X}_1 = \frac{1,279}{10} = 127.9 \]  \[ \bar{X}_2 = \frac{1,428}{10} = 142.8 \]  \[ \bar{X}_1^2 = 2,797 \]  \[ \bar{X}_2^2 = 1,950 \]  

**t value = 2.14**

**NOTE:** See appendix 5, pages 105-106, for complete table and calculations.
Calculated value of 2.14 exceeds the critical value of 2.021. Therefore, the null hypothesis that there is no statistically significant difference in the means of the two groups with respect to student achievement in science using a researcher-prepared criterion-referenced science achievement test is rejected.

Conclusion:

The statistically significant difference in scores between the two groups would occur in chance only 5% of the time. The discovery method appears to be more effective as a teaching style for enhancing achievement in science as supported by the results of a researcher-prepared criterion-referenced instrument. It is speculated that the instrument itself which has only face validity is a variable, though not measured. The instrument may just be much more relevant to the needs of the students in this sample.
## TABLE 5
ATTITUDES TOWARD SCIENCE USING SURVEY OF SCHOOL ATTITUDES

<table>
<thead>
<tr>
<th>Number</th>
<th>$X_1$</th>
<th>$x_1$</th>
<th>$x_1^2$</th>
<th>Number</th>
<th>$X_2$</th>
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<tbody>
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<td>81</td>
<td>21</td>
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<td>-11</td>
<td>121</td>
</tr>
</tbody>
</table>

\[ \sum x_1 = 445 \quad \sum x_1^2 = 472 \quad \sum x_2 = 438 \quad \sum x_2^2 = 459 \]

\[ \bar{x}_1 = 21.2 \ (21) \quad \bar{x}_2 = 20.9 \ (21) \]

\[ t \text{ value} = 0.202 \]

NOTE: See appendix 5, pages 107-108, for complete table and calculations.
Calculated value of 0.202 does not exceed the critical value of 2.021. Therefore, the null hypothesis that there is no statistically significant difference in the means of the two groups with respect to student attitude towards science using a standardized attitudes survey (Survey of School Attitudes) is accepted.

Conclusion:

Teaching method makes little or no statistically significant difference on student attitude towards science as measured by a standardized attitudes instrument. In terms of improving attitudes, the lecture-demonstration-recitation method showed the greater support in terms of an increase (see table 10, pages 53-54, and table 11, pages 55-56).
<table>
<thead>
<tr>
<th>Subject Number</th>
<th>Pretest</th>
<th>Posttest</th>
<th>D</th>
<th>( D^2 )</th>
</tr>
</thead>
<tbody>
<tr>
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<td>23</td>
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<td>64</td>
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<td>22</td>
<td>26</td>
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</tr>
<tr>
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<td>19</td>
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<td>21</td>
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<td>12</td>
<td>-2</td>
<td>4</td>
</tr>
</tbody>
</table>

\[ \sum D = 90 \quad \sum D^2 = 938 \]

\( t \) value = 3.75

NOTE: See appendix 5, pages 109-110, for complete table and calculations.
Calculated value of 3.75 exceeds the critical value of 2.086. Therefore, the null hypothesis that there is no statistically significant difference in pre- and posttest scores on a standardized science achievement test (Stanford Science Test) using the lecture-demonstration-recitation method is rejected.

Conclusion:

The gain in scores on the Stanford Science Test would occur in chance only 5%* of the time and was the result of the lecture-demonstration-recitation method which improved the scores. Actual means were 19.0 (pretest) and 23.3 (posttest).

*Results are significant at greater than $p < .01$ since this critical value is 2.845.
<table>
<thead>
<tr>
<th>Subject Number</th>
<th>Pretest</th>
<th>Posttest</th>
<th>D</th>
<th>D²</th>
</tr>
</thead>
<tbody>
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<tr>
<td>2</td>
<td>19</td>
<td>36</td>
<td>+17</td>
<td>289</td>
</tr>
<tr>
<td>3</td>
<td>28</td>
<td>61</td>
<td>+33</td>
<td>1,089</td>
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<tr>
<td>4</td>
<td>24</td>
<td>59</td>
<td>+35</td>
<td>1,225</td>
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<tr>
<td>5</td>
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<td>77</td>
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<td>1,521</td>
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<tr>
<td>8</td>
<td>36</td>
<td>78</td>
<td>+42</td>
<td>1,764</td>
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<tr>
<td>9</td>
<td>38</td>
<td>66</td>
<td>+28</td>
<td>784</td>
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<tr>
<td>10</td>
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<td>1,764</td>
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<td>196</td>
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<td>18</td>
<td>71</td>
<td>+53</td>
<td>2,809</td>
</tr>
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<td>22</td>
<td>57</td>
<td>+35</td>
<td>1,225</td>
</tr>
<tr>
<td>17</td>
<td>27</td>
<td>74</td>
<td>+47</td>
<td>2,209</td>
</tr>
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<td>361</td>
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<td>63</td>
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<td>1,936</td>
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<td>21</td>
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<td>56</td>
<td>+41</td>
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</table>

\[ D = 717 \quad \Sigma D^2 = 26,371 \]

\[ t \text{ value} = 16.03 \]

**NOTE:** See appendix 5, pages 111-112, for complete table and calculations.
Calculated value of 16.03 exceeds the critical value of 2.086. Therefore, the null hypothesis that there is no statistically significant difference between the pre- and posttest scores on the researcher-prepared criterion-referenced science achievement test using the lecture-demonstration-recitation method is rejected.

Conclusion:

The sizable gain in scores would occur in chance only 5%* of the time and is really attributable to the method of testing which used a researcher-prepared criterion-referenced test. Actual means were 26.9 (pretest) and 61.1 (posttest).

*Results are significant at greater than p < .001 since this critical value is 3.850.
TABLE 8

C GROUP--DISCOVERY METHOD: ACHIEVEMENT IN SCIENCE ON STANFORD SCIENCE TEST

<table>
<thead>
<tr>
<th>Subject Number</th>
<th>Pretest</th>
<th>Posttest</th>
<th>D</th>
<th>D²</th>
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</thead>
<tbody>
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<td>1</td>
<td>23</td>
<td>26</td>
<td>+3</td>
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</tr>
<tr>
<td>2</td>
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<td>-5</td>
<td>25</td>
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<td>0</td>
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<tr>
<td>4</td>
<td>21</td>
<td>26</td>
<td>+5</td>
<td>25</td>
</tr>
<tr>
<td>5</td>
<td>34</td>
<td>41</td>
<td>+7</td>
<td>49</td>
</tr>
<tr>
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<td>1</td>
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<td>81</td>
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<td>81</td>
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<td>16</td>
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<td>1</td>
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<tr>
<td>21</td>
<td>22</td>
<td>30</td>
<td>+8</td>
<td>64</td>
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</tbody>
</table>

\[ t \text{ value} = 2.07 \]

\[ \sum D = 44 \quad \sum D^2 = 520 \]

NOTE: See appendix 5, pages 113-114, for complete table and calculations.
Calculated value of 2.07 does not exceed the critical value of 2.086. Therefore, the null hypothesis that there is no statistically significant difference between the pre- and posttest scores on a standardized science achievement test (Stanford Science Test) using the discovery method is accepted.

Conclusion:

The gain in scores could occur by chance at least 5% of the time and is not caused by the discovery method of instruction. Actual means were 24.2 (pretest) and 26.3 (posttest).
### TABLE 9

C GROUP—DISCOVERY METHOD: ACHIEVEMENT IN SCIENCE ON RESEARCHER-PREPARED CRITERION-REFERENCED SCIENCE TEST

<table>
<thead>
<tr>
<th>Subject Number</th>
<th>Pretest</th>
<th>Posttest</th>
<th>D</th>
<th>D²</th>
</tr>
</thead>
<tbody>
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<td>28</td>
<td>72</td>
<td>+44</td>
<td>1,936</td>
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<td>29</td>
<td>68</td>
<td>+39</td>
<td>1,521</td>
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<tr>
<td>4</td>
<td>38</td>
<td>78</td>
<td>+40</td>
<td>1,600</td>
</tr>
<tr>
<td>5</td>
<td>46</td>
<td>75</td>
<td>+29</td>
<td>841</td>
</tr>
<tr>
<td>6</td>
<td>30</td>
<td>77</td>
<td>+47</td>
<td>2,209</td>
</tr>
<tr>
<td>7</td>
<td>33</td>
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<tr>
<td>8</td>
<td>35</td>
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<td>+43</td>
<td>1,849</td>
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<td>484</td>
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<td>25</td>
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<td>1,369</td>
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<td>73</td>
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<td>72</td>
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</table>

\[
\sum D = 746 \quad \sum D^2 = 28,074
\]

\[
t = 18.39
\]

**NOTE:** See appendix 5, pages 115-116, for complete table and calculations.
Calculated value of 18.39 exceeds the critical value of 2.086. Therefore, the null hypothesis that there is no statistically significant difference between the pre- and posttest scores on the researcher-prepared criterion-referenced science achievement test using the discovery method is rejected.

**Conclusion:**

The sizable gain in scores would occur in chance only 5%* of the time. It is probably attributable to the discovery method of teaching science when measured by a locally-prepared criterion-referenced science achievement test. Actual means were 32.7 (pretest) and 67.8 (posttest).

*Results are significant at greater than $p < .001$ since this critical value is 3.850.
### TABLE 10

**E GROUP--LECTURE-DEMONSTRATION-RECITATION METHOD:**
**SURVEY OF SCHOOL ATTITUDES**

<table>
<thead>
<tr>
<th>Subject Number</th>
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<th>Posttest</th>
<th>D</th>
<th>D^2</th>
</tr>
</thead>
<tbody>
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<td>+6</td>
<td>36</td>
</tr>
<tr>
<td>21</td>
<td>15</td>
<td>21</td>
<td>+6</td>
<td>36</td>
</tr>
</tbody>
</table>

$\bar{D} = 55$  $\bar{D^2} = 467$

$t$ value = 2.96

**NOTE:** See appendix 5, pages 117-118, for complete table and calculations.
Calculated value of 2.96 exceeds the critical value of 2.086. Therefore, the null hypothesis that there is no statistically significant difference between the pre- and posttest scores on a standardized attitudes survey (Survey of School Attitudes) using the lecture-demonstration-recitation method is rejected.

Conclusion:

The gain in scores would occur in chance only 5%* of the time. The lecture-demonstration-recitation method was effective in improving students' attitudes toward science. Actual means were 18.6 (pretest) and 21.2 (posttest).

*Results are significant at greater than $p < .01$ since this critical value is 2.845.
TABLE 11
C GROUP—DISCOVERY METHOD: SURVEY OF SCHOOL ATTITUDES

<table>
<thead>
<tr>
<th>Subject Number</th>
<th>Pretest</th>
<th>Posttest</th>
<th>D</th>
<th>$D^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25</td>
<td>21</td>
<td>-4</td>
<td>16</td>
</tr>
<tr>
<td>2</td>
<td>29</td>
<td>30</td>
<td>+1</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>11</td>
<td>+1</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>18</td>
<td>21</td>
<td>+3</td>
<td>9</td>
</tr>
<tr>
<td>5</td>
<td>26</td>
<td>23</td>
<td>-3</td>
<td>9</td>
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<tr>
<td>6</td>
<td>20</td>
<td>26</td>
<td>+6</td>
<td>36</td>
</tr>
<tr>
<td>7</td>
<td>21</td>
<td>24</td>
<td>+3</td>
<td>9</td>
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<tr>
<td>8</td>
<td>22</td>
<td>17</td>
<td>-5</td>
<td>25</td>
</tr>
<tr>
<td>9</td>
<td>22</td>
<td>19</td>
<td>-3</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td>22</td>
<td>23</td>
<td>+1</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>8</td>
<td>10</td>
<td>+2</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td>22</td>
<td>22</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>13</td>
<td>16</td>
<td>20</td>
<td>+4</td>
<td>16</td>
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<tr>
<td>14</td>
<td>14</td>
<td>16</td>
<td>+2</td>
<td>4</td>
</tr>
<tr>
<td>15</td>
<td>18</td>
<td>25</td>
<td>+7</td>
<td>49</td>
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<tr>
<td>16</td>
<td>20</td>
<td>20</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>17</td>
<td>23</td>
<td>22</td>
<td>-1</td>
<td>1</td>
</tr>
<tr>
<td>18</td>
<td>18</td>
<td>18</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>19</td>
<td>20</td>
<td>27</td>
<td>+7</td>
<td>49</td>
</tr>
<tr>
<td>20</td>
<td>21</td>
<td>23</td>
<td>+2</td>
<td>4</td>
</tr>
<tr>
<td>21</td>
<td>22</td>
<td>20</td>
<td>-2</td>
<td>4</td>
</tr>
</tbody>
</table>

$\sum D = 21 \quad \sum D^2 = 245$

$t$ value = 1.36

NOTE: See appendix 5, pages 119-120, for complete table and calculations.
Calculated value of 1.36 does not exceed the critical value of 2.086. Therefore, the null hypothesis that there is no statistically significant difference between the pre- and posttest scores on a standardized attitudes survey (Survey of School Attitudes) using the discovery method is accepted.

**Conclusion:**

Use of the discovery method may not change a student's attitude towards science to any degree of significance. Actual means were 19.9 (pretest) and 20.9 (posttest).
CHAPTER V

SUMMARY AND CONCLUSIONS

Purpose

Billions of dollars have been spent to educate future scientists to lead our country in the race for technological supremacy. However, a great number of Americans seem confused by science and are reluctant to make inquiry into the basic scientific facts that affect their lives every day.

Because of the need for people to be scientifically literate in today's technological world, this researcher questioned whether the seventh grade students at the Sky Haven Elementary School, DeKalb County, Georgia, were learning basic science concepts in the most effective manner.

This study was concerned with the comparison of two extreme teaching methods and how they affected student achievement and attitude. The purpose of this study was to compare the lecture-demonstration-recitation method and the discovery method of teaching science in the seventh grade to determine which method of instruction would result in higher student achievement and improved attitude towards science.
Procedure

The sample, consisting of 42 seventh grade students at the Sky Haven Elementary School, was divided into two equal groups. The control group was taught using the discovery method, whereas the experimental group was taught using the lecture-demonstration-recitation method. The instruction time of eighteen weeks occurred during the winter and spring quarters of the 1976-77 school year. Two instruments, one standardized and one researcher-prepared and criterion-referenced, were administered to compare achievement. One standardized instrument was administered to compare student attitudes. The t test was chosen to test the statistical difference between the means of the two groups for each hypothesis at the .05 level of significance.

Findings

The major findings of this study have indicated that the discovery method is the more effective teaching method for enhancing student achievement in seventh grade science when measured by the researcher-prepared criterion-referenced test. However, there were no statistically significant differences between student achievement and student attitude towards science as measured by standardized instruments.

Therefore, the null hypotheses that there are no statistically significant differences between the
demonstration-recitation method and the discovery method of teaching science in the seventh grade with respect to student achievement and student attitudes toward science as indicated by standardized tests were accepted. The null hypothesis that there is no statistically significant difference between the lecture-demonstration-recitation method and the discovery method of teaching science in the seventh grade with respect to student achievement as indicated by a researcher-prepared criterion-referenced science achievement test was rejected, and the alternative hypothesis that the discovery method would result in greater student achievement when measured by a researcher-prepared criterion-referenced test was accepted.

Although teaching method makes little or no statistically significant difference on student achievement in science or attitudes toward science as measured by standardized instruments, both methods did result in higher achievement and attitude scores with the lecture-demonstration-recitation group showing more improvement.

The most significant finding was the sizable gains in achievement for both methods when using the researcher-prepared criterion-referenced science achievement test. On an eighty question test, the lecture-demonstration-recitation group's actual means were 26.9 (pretest) and 61.1 (posttest). The discovery group's actual means were 32.7 (pretest) and 67.8
Both results were statistically significant at greater than the .001 level.

**Conclusions**

The following conclusions are based upon the data analyzed in this study:

1. The research hypothesis was supported partially. No statistically significant difference was found using either the lecture-demonstration-recitation method or the discovery method when using standardized tests for achievement or attitudes. Only the researcher-prepared criterion-referenced science achievement test revealed any statistically significant difference.

2. The first null hypothesis on student achievement was accepted when using the standardized science achievement test.

3. The second null hypothesis on student achievement was rejected when using the researcher-prepared criterion-referenced science achievement test.

4. The third null hypothesis on student attitudes toward science was accepted with respect to no statistically significant difference when using either the lecture-demonstration-recitation method or the discovery method of teaching.

5. Statistical significance was found in improvement of posttest scores in achievement and attitude using the lecture-demonstration-recitation method of teaching as measured by both the standardized and researcher-prepared criterion-referenced instruments.

6. Improvement in posttest scores was statistically significant for both the lecture-demonstration-recitation method and the discovery method of teaching when measured by the researcher-prepared criterion-referenced science achievement test.
Implications

The following implications are based upon the data analyzed in this study:

1. Neither the lecture-demonstration-recitation method nor the discovery method of teaching is preferred in improving achievement or attitudinal scores in science.

2. The researcher-prepared criterion-referenced science achievement test appears more promising as a measurement tool.

3. Gains may be made in either method of instruction if the proper measurement instrument (criterion-referenced) is used.

4. Gains are made easier in achievement than in attitude.

5. More gains were made using the lecture-demonstration-recitation method. This may have occurred because of the sample's need for a more structured program of instruction.

Recommendations

The following recommendations for further research are based upon the findings, conclusions, and implications derived from this study:

1. Due to the small sample, this study should be replicated using a larger sample. Perhaps a larger sample would increase results for one of the two teaching methods.

2. This study should be replicated in another area of the country (non-south) to determine regional differences.

3. More research should be conducted in regards to the use of criterion-referenced achievement tests especially with minority and/or disadvantaged students.
APPENDIXES

1. **Ideas and Investigations in Science (IIS): Life Science**--Twelve Ideas of Study ........ 63
2. Letter--The Psychological Corporation's Denial of Permission to Include Copies of Stanford Science Test and Survey of School Attitudes in Project Report ............ 77
3. Researcher-Prepared Criterion-Referenced Science Achievement Test ................. 79
5. Statistics for Tables 3-11 ............... 102
APPENDIX 1

IDEAS AND INVESTIGATIONS IN SCIENCE (IIS):
LIFE SCIENCE—TWELVE IDEAS OF STUDY
The structure of the IIS program is based on the following set of Ideas:

IDEA 1 (Inquiry) Man uses the methods of science to discover more about his natural world.

IDEA 2 (Characteristics) There are certain characteristics basic to life.

IDEA 3 (Cells) Living things are composed of cells.

IDEA 4 (Energy) All living things must obtain energy.

IDEA 5 (Metabolism) All living things use energy.

IDEA 6 (Life Activities) All living things have common life activities.

IDEA 7 (Reproduction) All Living things must reproduce to continue their own kind.

IDEA 8 (Environment) The environment is the total of the physical and biological factors around an organism.

IDEA 9 (Habitat) Groups of organisms find a place to live in the environment.

IDEA 10 (Adaptation) An organism must adjust to all the environmental factors.

IDEA 11 (Relationships) Living things interact in many ways with other living things.

IDEA 12 (Balance) Living things must live in balance with their environment.

The development of each of the Ideas is summarized on the following pages. Note how each Idea is developed through a sequential series of concepts.
<table>
<thead>
<tr>
<th>INVESTIGATION</th>
<th>CONCEPT DEVELOPED</th>
<th>NATURE OF THE ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Try It; You'll Like It</td>
<td>Careful Observations Help Solve Problems</td>
<td>Observing Liquid that Changes Color; Observing Playing Cards; Playing “Crossed or Uncrossed”</td>
</tr>
<tr>
<td>2. Love, A Little More of It this Year</td>
<td>Accurate Measurements Help Solve Problems</td>
<td>Learning Metric Measurements of Length; Mealworm Race</td>
</tr>
<tr>
<td>3. Keep The Faith, Baby</td>
<td>Predictions Are Possible Answers to Problems</td>
<td>Learning Metric Weights and Use of Balance</td>
</tr>
<tr>
<td>4. The Dawning of the Age of Asparagus</td>
<td>A Controlled Experiment Is Used to Test a Prediction</td>
<td>Learning Metric Measurement of Volume and Use of Graduated Cylinder; Experimenting with Elodea</td>
</tr>
<tr>
<td>5. I Know I Put It Somewhere</td>
<td>Data Tables Are Used to Organize Results from an Experiment</td>
<td>Placing Data in a Table; Strength of Finger</td>
</tr>
<tr>
<td>6. What's Your Game Plan?</td>
<td>Science Is a Way of Solving Problems</td>
<td>Learning How to Read a Thermometer; Solving a Temperature Problem</td>
</tr>
<tr>
<td>INVESTIGATION</td>
<td>CONCEPT DEVELOPED</td>
<td>NATURE OF THE ACTIVITY</td>
</tr>
<tr>
<td>---------------------------------------------------</td>
<td>----------------------------------------------------------</td>
<td>------------------------------------------------------------</td>
</tr>
<tr>
<td>1. Are You In Shape?</td>
<td>Each Kind of Living Thing Has a Certain Size and Shape</td>
<td>Observing Living and Non-Living Things</td>
</tr>
<tr>
<td>2. Growing for a Change</td>
<td>Living Things Grow and Change</td>
<td>Measuring Height and Weight; Judging Tree Rings; Observing Peas and Pea Seedlings</td>
</tr>
<tr>
<td>3. Do You Hear Those New Sensations?</td>
<td>Living Things Respond to a Stimulus</td>
<td>Mealworm Response; Pupil Response of Eye; Plant Response to Light</td>
</tr>
<tr>
<td>4. Don't Let Me Dry Out</td>
<td>Living Things Take in and Give off Water</td>
<td>Water Absorption by Seeds and Pebbles; Cobalt Chloride Tests of Body Water</td>
</tr>
<tr>
<td>5. Take a Deep Breath</td>
<td>Living Things Take in and Give off Air</td>
<td>Breathing Rates; Gas Production by Yeast</td>
</tr>
<tr>
<td>6. Where's the Menu?</td>
<td>Living Things Take in Food</td>
<td>Sugar Intake by Yeast; Recording Food Intake by Students</td>
</tr>
</tbody>
</table>
# IIS LIFE SCIENCE: IDEA 3 (Cells)

## Living Things Are Composed of Cells

<table>
<thead>
<tr>
<th>INVESTIGATION</th>
<th>CONCEPT DEVELOPED</th>
<th>NATURE OF THE ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. To See or Not to See . . . That is the Mystery</td>
<td>The Microscope Is a Tool Used to Magnify Small Objects</td>
<td>Fingerprint Activity; Learning to Use the Microscope</td>
</tr>
<tr>
<td>2. The Beast from the Barrel</td>
<td>The Microscope Is a Tool Used to Study Cells</td>
<td>Examining Pond Water: Examining Cork Cells</td>
</tr>
<tr>
<td>3. They Come in Many Shapes and Sizes</td>
<td>The Shape of a Cell Is Related to Its Job</td>
<td>Pictures of Different Plant and Animal Cells; Study of Cheek Cells; Study of Onion Skin Cells</td>
</tr>
<tr>
<td>4. This Is Where It's At</td>
<td>The Life Activities of a Cell Take Place Within the Cytoplasm</td>
<td>Study of Cell Parts in Onion Skin and Elodea; Plasmolysis of Elodea Cells</td>
</tr>
<tr>
<td>5. The Wonderful World of the Cell</td>
<td>The Life of a Cell Depends Upon the Ability of Dissolved Materials to Enter and Leave the Cell</td>
<td>Comparing Normal and Plasmolyzed Elodea Cells; Deplasmolysis of Elodea Cells</td>
</tr>
<tr>
<td>6. You Can't Blow Your Nose with This Tissue</td>
<td>Cells Are Organized into Tissues, Tissues into Organs, and Organs into Systems</td>
<td>Bone Puzzle; Arm Model; Systems Puzzle</td>
</tr>
</tbody>
</table>

---

# NATURE OF THE ACTIVITY

- Fingerprint Activity; Learning to Use the Microscope
- Examining Pond Water: Examining Cork Cells
- Pictures of Different Plant and Animal Cells; Study of Cheek Cells; Study of Onion Skin Cells
- Study of Cell Parts in Onion Skin and Elodea; Plasmolysis of Elodea Cells
- Comparing Normal and Plasmolyzed Elodea Cells; Deplasmolysis of Elodea Cells
- Bone Puzzle; Arm Model; Systems Puzzle
# IIS LIFE SCIENCE: IDEA 4 (Energy)

**All Living Things Must Obtain Energy**

<table>
<thead>
<tr>
<th>INVESTIGATION</th>
<th>CONCEPT DEVELOPED</th>
<th>NATURE OF THE ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The Root of the Problem</td>
<td>Plant Roots Take in Water</td>
<td>Root Cross-Section Study; Studying Liquid Transport in Celery</td>
</tr>
<tr>
<td>2. Look Ma, No Teeth</td>
<td>The Stomates in Plant Leaves Take in Carbon Dioxide</td>
<td>CO₂ Removal from Bramthymol Yellow; Locating Stomates; Coating Plant Leaves with Petroleum Jelly</td>
</tr>
<tr>
<td>3. The Wildest Recipe of All</td>
<td>During Photosynthesis, Plants Make Carbohydrates from Raw Materials</td>
<td>Testing for Starch; Removing Chlorophyll from Leaf</td>
</tr>
<tr>
<td>4. Green Power</td>
<td>Plants Need Chlorophyll to Make Starch</td>
<td>Study of Variegated Plant Leaf; Testing Leaf for Area of Starch Production</td>
</tr>
<tr>
<td>5. Let's Throw Some Light on the Subject</td>
<td>Plants Need Light Energy to Make Starch</td>
<td>Observing the Fluorescence of Chlorophyll; Covering Plant Leaves</td>
</tr>
<tr>
<td>6. The Bush that Made It</td>
<td>Plants Use Food for Energy</td>
<td>Rise of Water in Capillary Tubes; Burning Peanut for Energy</td>
</tr>
</tbody>
</table>
## IIS Life Science: Idea 5 (Metabolism)

### All Living Things Use Energy

<table>
<thead>
<tr>
<th>Investigation</th>
<th>Concept Developed</th>
<th>Nature of the Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I Tried It and I Nearly Died</td>
<td>Living Things Need Water and Oxygen</td>
<td>Interacting Beans and Steel Wool with Air and Water</td>
</tr>
<tr>
<td>2. It's a Real Gasser</td>
<td>Living Things Produce Carbon Dioxide</td>
<td>Reacting Beans with Bromthymol Blue</td>
</tr>
<tr>
<td>3. Sounds Fishy to Me</td>
<td>Living Things Take in Oxygen and Produce Carbon Dioxide</td>
<td>Detecting Oxygen Uptake and Carbon Dioxide Production in Fish</td>
</tr>
<tr>
<td>4. You'll Get a Rise out of This</td>
<td>Living Things Produce Carbon Dioxide from Sugar</td>
<td>Reacting Yeast with Sugar to Give Off Carbon Dioxide</td>
</tr>
<tr>
<td>5. Let's Break It Apart</td>
<td>When Living Things Break Apart Sugar, Carbon Dioxide Is Released</td>
<td>Detecting Sugar in Foods; Breaking Bread and Sugar Apart</td>
</tr>
<tr>
<td>6. The Little Old Heatmaker, Me</td>
<td>When Living Things Break Apart, Sugar, Energy Is Released</td>
<td>Measuring Heat Energy Production in Yeast; Skin Temperature; Burning Marshmallows to Produce Heat</td>
</tr>
</tbody>
</table>
## IIS LIFE SCIENCE: IDEA 6 (Life Activities)

### All Living Things Have Common Life Activities

<table>
<thead>
<tr>
<th>INVESTIGATION</th>
<th>CONCEPT DEVELOPED</th>
<th>NATURE OF THE ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. You'll Wind Up Broke, Every Time</td>
<td>Digestion Breaks down Food into Smaller Particles</td>
<td>Digesting Various Foods with Enzymes</td>
</tr>
<tr>
<td>2. Getting It Through to You</td>
<td>Diffusion Is the Way in Which Materials Enter and Leave Cells</td>
<td>Imbibition in a Raisin; Diffusion Through a Plastic Bag; IIS Diffusion Kit</td>
</tr>
<tr>
<td>3. It Gets It All Around</td>
<td>The Circulatory System Transports Materials to All Parts of the Body</td>
<td>Tracing Blood Flow; Listening to Pulse; Alcohol</td>
</tr>
<tr>
<td>5. The Ameba and the Osmond Brothers</td>
<td>Hormones Regulate the Life Activities of Living Things</td>
<td>Plant Hormone and Pea Growth</td>
</tr>
<tr>
<td>6. The Debbi Made Me Do It</td>
<td>The Brain Coordinates the Life Activities of Living Things</td>
<td>Determining Coordination and Manual Dexterity; The Numbers Game</td>
</tr>
<tr>
<td>7. Get Really Stoned</td>
<td>Drugs Disrupt the Brain's Ability to Coordinate</td>
<td>Burning Artificial Marijuana; Rapping; Assorted Aesthetic Turn-Ons</td>
</tr>
</tbody>
</table>
## IIS LIFE SCIENCE: IDEA 7 (Reproduction)

**All Living Things Must Reproduce to Continue Their Own Kind**

<table>
<thead>
<tr>
<th>INVESTIGATION</th>
<th>CONCEPT DEVELOPED</th>
<th>NATURE OF THE ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Come Look At My Goose Tree</td>
<td>All Living Things Come from Other Living Things</td>
<td>Redi’s Experiment Using Fruit Flies and Banana</td>
</tr>
<tr>
<td>2. This Will Break You Up</td>
<td>Reproduction May Begin with the Splitting of a Cell</td>
<td>Budding in Yeast; Binary Fission in Paramecium and Ameba</td>
</tr>
<tr>
<td>3. Let’s Get Together</td>
<td>Reproduction May Begin with the Joining of Two Cells</td>
<td>Conjugation in Spirogyra; Fertilization in Fish</td>
</tr>
<tr>
<td>3A. Spread the Word, Not the Germ</td>
<td>Venereal Disease Is a Serious Problem</td>
<td>Reading About Venereal Disease</td>
</tr>
<tr>
<td>4. You Can’t Buy Parts For It</td>
<td>Some Organisms Can Reproduce New Parts</td>
<td>Regeneration of Pellicle in Blepharisma; Sponge and Starfish Regeneration</td>
</tr>
<tr>
<td>5. The World’s Full Court Press</td>
<td>The Number of Organisms in a Group Can Pressure the Group</td>
<td>Serial Dilution in Culture of Serratia Marcescens; Overpopulation in Rats</td>
</tr>
</tbody>
</table>
## IIS LIFE SCIENCE: IDEA 8 (Environment)

### The Environment Is the Total of the Physical and Biological Factors Around an Organism

<table>
<thead>
<tr>
<th>INVESTIGATION</th>
<th>CONCEPT DEVELOPED</th>
<th>NATURE OF THE ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The Drip of Life</td>
<td>Living Things Must Obtain Water from Their Environment</td>
<td>Mold Growth; Seed Growth</td>
</tr>
<tr>
<td>2. When You’re Hot, You’re Hot</td>
<td>Living Things Are Affected by Temperature Changes in the Environment</td>
<td>Fish Respiration; Temperature Effect on Yeast Cells</td>
</tr>
<tr>
<td>3. You’ve Got to See the Light</td>
<td>Living Things Are Affected by Light Conditions in the Environment</td>
<td>Radish Seed Growth; Elodea Activity in Light</td>
</tr>
<tr>
<td>4. Soul Food Special</td>
<td>The Food Supply Influences the Size of a Population</td>
<td>Bacteria and Mold Growth; Protein Tests</td>
</tr>
<tr>
<td>5. Change Is the Name of the Game</td>
<td>The Environment Is Constantly Changing</td>
<td>Determining Rainfall and Temperature Changes</td>
</tr>
<tr>
<td>6. Where on Earth Is Life?</td>
<td>Most Life Exists near the Middle of the Biosphere</td>
<td>Changing the Environment of Pond Water; Identifying the Biosphere</td>
</tr>
</tbody>
</table>
### IIS LIFE SCIENCE: IDEA 9 (Habitat)

**Groups of Organisms Find a Place to Live in the Environment**

<table>
<thead>
<tr>
<th>INVESTIGATION</th>
<th>CONCEPT DEVELOPED</th>
<th>NATURE OF THE ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. An Ocean of Life</td>
<td>Many Organisms Live in Water</td>
<td>The Water Game; Making a Depression Slide to Observe Pond Water Organisms</td>
</tr>
<tr>
<td>2. Don't Bug Me</td>
<td>Many Organisms Live in the Soil</td>
<td>Studying Forest Litter; Examining Soil for Worms</td>
</tr>
<tr>
<td>3. It Pays to Have a Backbone</td>
<td>Vertebrates Live in Many Habitats</td>
<td>Photo Essay Showing Diversity of Vertebrate Habitats</td>
</tr>
<tr>
<td>4. Stick with Me</td>
<td>Organisms Live Where They Do Because of Dispersal</td>
<td>Dropping Squares to Show Dispersal; Seed Dispersal by Wind and Animals</td>
</tr>
<tr>
<td>5. Two Can Live Better than One</td>
<td>Where an Organism Lives Depends Upon Other Organisms</td>
<td>Relationships Between Vertebrates; Study of Lichens</td>
</tr>
<tr>
<td>6. It's Not Hard to Find</td>
<td>Organisms Live Where They Can Get Energy</td>
<td>Effect of Food Shortage on Yeast</td>
</tr>
</tbody>
</table>
## IIS LIFE SCIENCE: IDEA 10 (Adaptation)

### An Organism Must Adjust to All the Environmental Factors

<table>
<thead>
<tr>
<th>INVESTIGATION</th>
<th>CONCEPT DEVELOPED</th>
<th>NATURE OF THE ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Things Change</td>
<td>Organisms Respond to Changes in the Environment</td>
<td>Brine Shrimp and Light</td>
</tr>
<tr>
<td>2. Stay Cool, Brother</td>
<td>Some Organisms Keep a Steady Inside Environment When the Outside Environment Changes</td>
<td>Comparing Internal and External Temperature</td>
</tr>
<tr>
<td>3. Seeing Is Believing</td>
<td>Some Organisms Change Their Inside Environment When the Outside Environment Changes</td>
<td>Heartbeat in Daphnia; Effect of Drugs on Heartbeat Rate</td>
</tr>
<tr>
<td>4. It Came from Outer the Sink</td>
<td>Living Things Can Change in Size and Appearance Over Millions of Years</td>
<td>Preserving Meat in Ice; Embedding Insect Models in Resin; Horse Evolution</td>
</tr>
<tr>
<td>5. Make It or Forget It</td>
<td>Organisms that Cannot Adapt May Become Extinct</td>
<td>Study of the Evolution of the Longer-eared Rabbit</td>
</tr>
</tbody>
</table>
## I15 Life Science: Idea 11 (Relationships)

Living Things Interact in Many Ways with Other Living Things

<table>
<thead>
<tr>
<th>Investigation</th>
<th>Concept Developed</th>
<th>Nature of the Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Stop Hassling Me</td>
<td>A Population is the Number of One Kind of Organism Living in an Area</td>
<td>Counting Various Populations; Overpopulation and Stress</td>
</tr>
<tr>
<td>2. Life in the Yellow Pages</td>
<td>A Community is a Group of Populations Living in an Area</td>
<td>Observing Various Communities; Determining Nature of a Community from a Telephone Book</td>
</tr>
<tr>
<td>3. Hawks Don't Eat Zucchinis</td>
<td>Living Things May Eat Other Living Things in a Predator-Prey Relationship</td>
<td>Observing Hydra Eating Daphnia; Simulation Game of Two Populations in an Area</td>
</tr>
<tr>
<td>4. It's Finger-Lickin' Good</td>
<td>A Food Chain Shows How Living Things Are Related to Each Other by What They Eat</td>
<td>Completing Food Chains; Food Chain Card Game</td>
</tr>
<tr>
<td>5. Spin, Spin Your Tangled Web</td>
<td>A Food Web Shows the Food Relationships in a Community</td>
<td>Making, Constructing, and Drawing Food Webs</td>
</tr>
<tr>
<td>6. This Is My World</td>
<td>Living Things Must Live Together with Other Living Things in a Community</td>
<td>Community Game</td>
</tr>
</tbody>
</table>
**IIS LIFE SCIENCE: IDEA 12 (Balance)**

**Living Things Must Live in Balance with Their Environment**

<table>
<thead>
<tr>
<th>INVESTIGATION</th>
<th>CONCEPT DEVELOPED</th>
<th>NATURE OF THE ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. We Have to Be Together</td>
<td>All Living and Non-Living Things Interact with Each Other in an Ecosystem</td>
<td>Observing Various Ecosystems</td>
</tr>
<tr>
<td>2. The Greatest Invention Since the Wheel</td>
<td>Water on the Earth Goes Around in a Cycle</td>
<td>Determining Plant Transpiration; Observing Evaporation</td>
</tr>
<tr>
<td>3. We’re Still Going Around and Around</td>
<td>Nutrients Go Around in a Cycle</td>
<td>Decomposition of Bread by Bacteria in Cheese</td>
</tr>
<tr>
<td>4. Don’t Get All Tapped Out</td>
<td>Carbon Dioxide and Oxygen Go Around in a Cycle</td>
<td>Keeping a Snail and Plant Alive in a Sealed Tube</td>
</tr>
<tr>
<td>5. Live Dangerously—Take a Deep Breath</td>
<td>Man Can Pollute the Air</td>
<td>Collecting Air Particles</td>
</tr>
<tr>
<td>6. All It Needs Is a Little Love</td>
<td>Man’s Greatest Resource Is Man Himself</td>
<td>Open-Ended Creative Activity on the Beauty of Man</td>
</tr>
</tbody>
</table>


APPENDIX 2

LETTER--THE PSYCHOLOGICAL CORPORATION'S DENIAL OF PERMISSION TO INCLUDE COPIES OF STANFORD SCIENCE TEST AND SURVEY OF SCHOOL ATTITUDES IN PROJECT REPORT
February 2, 1977

Ms. Leslie B. McIntosh
2929 Panthersville Road, Apt. R-15
Decatur, Georgia 30034

Dear Ms. McIntosh:

This is in reply to your letter of January 31 requesting permission to include copies of the Stanford Science Test, Advanced, and the Survey of School Attitudes, Intermediate Level, in your dissertation.

I am sorry but we must turn down your request as it is our standard policy not to allow our instruments to be used in documents which are often filed in areas open to the general public. I know you will understand our concern for the security of our tests.

If you have any questions, please do not hesitate to call on us.

Sincerely,

Irene Neuvelt
Supervisor
Rights and Permissions
APPENDIX 3

RESEARCHER-PREPARED CRITERION-REFERENCED SCIENCE ACHIEVEMENT TEST
Multiple choice: choose the one best answer.

1. Plants take in water through the _______.
   A. roots
   B. stomates
   C. conducting tubes
   D. stems

2. What percentage of the air is oxygen?
   A. 10%
   B. 20%
   C. 30%
   D. 40%

3. When a drop of iodine is placed on a substance and a blue-black color results, we know that _______ is present.
   A. sugar
   B. protein
   C. fat
   D. starch

4. Both roots and plant stems have _______ which guide water throughout the plant's stems and leaves.
   A. stomates
   B. conducting tubes
   C. mouths
   D. hairs

5. If oxygen is removed from the environment, _______.
   A. cell growth will occur
   B. cell growth will not occur
   C. all living things will die
   D. none of the above
   E. (B) and (C) only

6. The substances in the body that break food down into smaller particles are called _______.
   A. saliva
   B. digestive juices
   C. blood
   D. sweat
7. A plant's conducting tubes _______.
   A. have a round shape
   B. conduct water upward throughout the plant
   C. permit water to reach the stem and leaves of the plant
   D. all of the above
   E. (A) and (C) only

8. The two principal substances that animals need in order to live are _______.
   A. water and carbon dioxide
   B. water and nitrogen
   C. water and oxygen
   D. water and helium

9. Breaking food down into smaller parts is called _______.
   A. digestion
   B. respiration
   C. photosynthesis
   D. energy

10. The pores on a plant leaf that take in carbon dioxide are called _______.
    A. mouths
    B. holes
    C. stomates
    D. gills

11. Animals produce and give off the gas _______.
    A. oxygen
    B. carbon monoxide
    C. nitrogen
    D. carbon dioxide

12. The body's food tube runs from _______.
    A. the mouth to the esophagus
    B. the mouth to the stomach
    C. the mouth to the small intestine
    D. the mouth to the large intestine

13. Generally, a plant's stomates are located on _______.
    A. the top surface of a leaf
    B. the bottom surface of a leaf
    C. both the top and bottom surfaces of a leaf
    D. none of the above
14. The gas breathed in by animals is ________.
   A. oxygen
   B. carbon monoxide
   C. carbon dioxide
   D. nitrogen

15. The major organs of the body’s food tube are ________.
   A. mouth and esophagus
   B. mouth, stomach, and small intestine
   C. mouth, esophagus, stomach, small intestine, and large intestine
   D. esophagus, stomach, small intestine, and large intestine

16. Guard cells regulate ________.
   A. the evaporation of water from plant leaves
   B. the opening and closing of the stomates
   C. the exchange of gases in the plant
   D. all of the above
   E. none of the above

17. When using the Winkler test to test for oxygen, the presence of a dark brown solid means ________.
   A. a lot of oxygen is present
   B. a little oxygen is present
   C. no oxygen is present
   D. none of the above

18. The small finger-like projections on the wall of the small intestine through which digested food is absorbed out into the bloodstream are the ________.
   A. cells
   B. villi
   C. membranes
   D. particles

19. During photosynthesis, plants ________.
   A. take in oxygen and give off carbon dioxide
   B. take in carbon dioxide and give off oxygen
   C. take in water and give off (or evaporate) water
   D. take in carbon dioxide and give off nitrogen
20. When using bromthymol blue to test for carbon dioxide, the bromthymol blue turns ______ if carbon dioxide is present.
   A. brown
   B. red
   C. blue
   D. yellow

21. The process of food passing through a membrane is called ________.
   A. digestion
   B. respiration
   C. photosynthesis
   D. diffusion

22. Plants use the following raw material(s) to make food: ________.
   A. stomates
   B. water
   C. carbon dioxide
   D. oxygen
   E. (B) and (C) only

23. Plants are able to develop energy through the process of ________.
   A. photosynthesis
   B. oxygen detection
   C. carbon dioxide detection
   D. respiration

24. The circulation of blood in the body is kept in motion mainly by the pumping action of the ________.
   A. blood
   B. veins
   C. heart
   D. arteries

25. Food-making takes place in a plant's ________.
   A. roots
   B. stems
   C. leaves
   D. conducting tubes
26. A living thing releases energy through the process known as ________.
   A. photosynthesis
   B. oxygen detection
   C. carbon dioxide detection
   D. respiration

27. The main artery that branches into smaller arteries in carrying blood to the body is the ________.
   A. aorta
   B. vein
   C. pulmonary artery
   D. capillary

28. The process of food-making in plants is called ________.
   A. chlorophyll
   B. carbohydrates
   C. energy
   D. photosynthesis

29. The end products of respiration in animals are ________.
   A. energy and carbon dioxide
   B. energy and oxygen
   C. energy and hydrogen
   D. oxygen and hydrogen

30. The main artery that carries blood to the lungs to exchange carbon dioxide for oxygen is the ________.
   A. aorta
   B. vein
   C. pulmonary artery
   D. capillary

31. The foods made by plants are called ________.
   A. photosynthesis
   B. raw materials
   C. carbohydrates
   D. chlorophyll

32. Living things produce and release carbon dioxide when ________ is broken apart.
   A. water
   B. sunlight
   C. sugar
   D. yeast cells
33. The heart is divided into four chambers called the ________.
   A. left aorta, right aorta, left ventricle, right ventricle
   B. left atrium, right atrium, left ventricle, right ventricle
   C. left artery, right artery, left vein, right vein
   D. left atrium, right atrium, left aorta, right aorta

34. The iodine test for starch in plants is an example of ________.
   A. a qualitative indicator
   B. a quantitative indicator
   C. photosynthesis
   D. respiration

35. The products of photosynthesis which contain stored energy necessary for sustaining life are ________.
   A. water
   B. starches
   C. proteins
   D. all of the above

36. Blood flows through the heart in one direction only: ________.
   A. from atrium to ventricle
   B. from aorta to vein
   C. from ventricle to atrium
   D. from vein to aorta

37. The material that gives leaves their green color is ________.
   A. oxygen
   B. chlorophyll
   C. carbon dioxide
   D. water

38. Starch is many ________ joined together.
   A. carbohydrates
   B. fats
   C. sugars
   D. proteins
39. Gases and materials are exchanged by diffusion between the cells and blood in the _______.
   A. lungs  
   B. ventricles  
   C. atria  
   D. capillaries

40. The only portion of a leaf that contains starch is that portion which contains _______.
   A. oxygen  
   B. chlorophyll  
   C. carbon dioxide  
   D. water

41. Examples of foods containing fats are _______.
   A. crackers, bread, potatoes  
   B. green beans, cabbage, lettuce  
   C. milk, cheese, ice cream  
   D. oil, butter, meat fat

42. The blood vessels that carry blood back to the heart from the body are called _______.
   A. veins  
   B. arteries  
   C. atria  
   D. ventricles

43. The role of chlorophyll in photosynthesis is to help the plant make _______ out of raw materials.
   A. starch  
   B. water  
   C. carbon dioxide  
   D. oxygen

44. Examples of foods containing carbohydrates are _______.
   A. crackers, bread, potatoes  
   B. green beans, cabbage, lettuce  
   C. milk, cheese, ice cream  
   D. oil, butter, meat fat

45. The instrument used to determine a person's heart beat rate is the _______.
   A. microscope  
   B. gyroscope  
   C. stethoscope  
   D. telescope
46. Plants receive their energy supply for photosynthesis from ________.
   A. water  
   B. air  
   C. food  
   D. light

47. Starches are broken down into sugars by ________.
   A. water  
   B. acids  
   C. sunlight  
   D. oxygen

48. When a person exercises, his/her heart beats ________.
   A. increase  
   B. decrease  
   C. stay the same  
   D. none of the above

49. The kind of energy that plants need to make starch is ________.
   A. light energy  
   B. chlorophyll  
   C. dark energy  
   D. air

50. The chemical acid in the mouth that breaks starches into sugars is ________.
   A. gastric acid  
   B. pyruvic acid  
   C. citric acid  
   D. saliva

51. Alcohol can be a harmful drug to the body because ________.
   A. alcohol is not digested by the stomach or small intestine  
   B. alcohol gets into the bloodstream very fast  
   C. alcohol in the blood can cause the body to be less able to function properly  
   D. all of the above
52. Plants grown with light ________.
   A. can make starch
   B. can not make starch
   C. can receive enough light energy to make starch
   D. can not receive enough light energy to make starch
   E. (A) and (C) only

53. Carbon dioxide is released when ________.
   A. acid breaks sugar apart
   B. sugar is dissolved in water
   C. starch is dissolved in water
   D. water breaks sugar apart

54. After food has been digested and diffused from the small intestine into the bloodstream, it is carried to all parts of the body by the ________.
   A. stomach
   B. heart
   C. circulatory system
   D. villi

55. Plants need light energy to make ________.
   A. light
   B. food
   C. water
   D. chlorophyll

56. When animals break apart sugar, ________.
   A. carbon dioxide is released
   B. energy is released
   C. oxygen is released
   D. (A) and (B) only

57. The wind pipe, lungs, and air sacs make up the ________.
   A. digestive system
   B. respiratory system
   C. circulatory system
   D. reproductive system
58. In order for materials to move through a plant, the plant needs _______.
   A. energy  
   B. water  
   C. food  
   D. chlorophyll

59. The constant exchange of gases between the outside air and the body is called _______.
   A. respiration  
   B. diffusion  
   C. breathing  
   D. circulation

60. Foods that are stored by plants for later use contain _______.
   A. light energy  
   B. food energy  
   C. potential energy  
   D. chemical energy

61. A person’s body can not work unless the body generates or produces _______.
   A. potential energy  
   B. chemical energy  
   C. heat energy  
   D. light energy

62. The two gases that must be exchanged for cells to stay alive are _______.
   A. carbon dioxide and nitrogen  
   B. oxygen and nitrogen  
   C. oxygen and hydrogen  
   D. carbon dioxide and oxygen

63. When a plant breaks down stored foods to meet an increase in energy requirement, the energy that has been at rest is changed into _______.
   A. light energy  
   B. food energy  
   C. potential energy  
   D. chemical energy
64. Smoking affects respiration by _______.
   A. increasing the amount of air that can be exchanged in the body
   B. decreasing the amount of air that can be exchanged in the body
   C. There is no change in the amount of air that can be exchanged in the body after smoking.
   D. none of the above

65. Plants get their energy from _______.
   A. the sun
   B. the rain
   C. eating food
   D. chlorophyll

66. The chemicals produced by glands that regulate digestion, circulation, respiration, and diffusion in the body are called _______.
   A. regulators
   B. chemicals
   C. hormones
   D. liquids

67. The process by which liquids travel up through plant tubes is called _______.
   A. transpiration
   B. photosynthesis
   C. respiration
   D. chlorophyll

68. Animals get their energy from _______.
   A. the sun
   B. the rain
   C. eating food
   D. chlorophyll

69. Plant hormones are produced in the _______.
   A. growing tips of plants
   B. plant's roots
   C. plant's leaves
   D. plant's stem
70. Since animals obtain energy from the foods they eat, they are called _______.

A. producers  
B. consumers  
C. workers  
D. leeches

71. The unit of heat used for measuring the energy supplied by food is _______.

A. energy  
B. calorie  
C. work  
D. sugar

72. Two major hormone producing glands in the body are the _______.

A. pituitary and stomach  
B. pancreas and liver  
C. adrenal and salivary gland  
D. thyroid and pancreas

73. Since green plants possess the ability to absorb light energy from the sun and to use this energy to convert carbon dioxide and water into carbohydrates, these plants are called _______.

A. producers  
B. consumers  
C. workers  
D. leeches

74. Metabolism involves _______.

A. the changing of food into living tissue  
B. the changing of food into energy  
C. the breaking down of worn-out tissue  
D. all of the above

75. The ability to do things from experience and memory is called _______.

A. learning  
B. coordination  
C. practice  
D. control
76. Green plants are the primary source of food energy for all organisms because _______.
   A. green plants are consumers
   B. green plants are producers
   C. green plants provide food energy for consumers
   D. (A) and (C) only
   E. (B) and (C) only

77. The function of the brain is to _______.
   A. regulate the life activities of the body
   B. diffuse food materials between the small intestine and the cells of the body
   C. exchange carbon dioxide and oxygen between the outside air and the body
   D. coordinate the activities of the body

78. In order to survive, all living things must obtain _______.
   A. sunlight
   B. chlorophyll
   C. energy
   D. carbon dioxide

79. Any substance, other than food, which has an effect on the body is called a _______.
   A. stimulant
   B. depressant
   C. drug
   D. hallucinogen

80. Drug abuse may lead to _______.
   A. the need for a larger dose of the same drug to get turned on
   B. the need for stronger drugs to get turned on
   C. poor physical and mental health
   D. all of the above
### Answer Key

**Pre-Test and Post-Test**

*H.S. Life Science, Ideas 4,5,6*

1. A  
2.  
3. D  
4. B  
5. E  
6. B  
7. D  
8. C  
9. A  
10. C  
11. D  
12. D  
13. B  
14. A  
15. C  
16. D  
17. A  
18. B  
19. B  
20. D  
21. D  
22. E  
23. A  
24. C  
25. C  
26. D  
27. A  
28. D  
29. A  
30. C  
31. C  
32. C  
33. B  
34. A  
35. B  
36. A  
37. B  
38. C  
39. D  
40. B  
41. D  
42. A  
43. A  
44. A  
45. C  
46. D  
47. B  
48. A  
49. A  
50. D  
51. D  
52. E  
53. A  
54. C  
55. B  
56. D  
57. B  
58. A  
59. A  
60. C  
61. C  
62. D  
63. D  
64. B  
65. A  
66. C  
67. A  
68. C  
69. A  
70. B  
71. B  
72. D  
73. A  
74. D  
75. B  
76. E  
77. D  
78. C  
79. C  
80. D
APPENDIX 4

DEKALB COUNTY UPPER ELEMENTARY COURSE GUIDE—
SCIENCE CONCEPTS, SUBCONCEPTS, AND LEARNING
OBJECTIVES FOR ITS IDEAS 4, 5, AND 6
Concepts and Subconcepts

All living things must obtain energy.

Plant roots take in water.

The stomates in plant leaves take in carbon dioxide.

Plants make carbohydrates from raw materials during photosynthesis.

Learning Objectives

Given necessary and appropriate experiences the pupil will:

- demonstrate intake and conduction of water by roots.
- relate the function of roots.
- explain that conducting tubes in the plant stem are continuous with those in the root.
- infer that plants take in water.

Given necessary and appropriate experiences the pupil will:

- identify and locate stomates.
- demonstrate that green plants take in carbon dioxide.
- explain the regulatory function of guard cells.
- compare gas exchange during respiration and photosynthesis.
- conclude that carbon dioxide is taken in by the stomates in the plant leaves.

Given necessary and appropriate experiences the pupil will:

- list raw materials taken in by plants and used to make food.
<table>
<thead>
<tr>
<th>Concepts and Subconcepts</th>
<th>Learning Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Describe photosynthesis.</td>
<td></td>
</tr>
<tr>
<td>Specify where food-making in green plants takes place.</td>
<td></td>
</tr>
<tr>
<td>Specify what food a plant makes and how it can be identified.</td>
<td></td>
</tr>
<tr>
<td>Discuss indicators - quantitative and qualitative - and their importance.</td>
<td></td>
</tr>
<tr>
<td>Test for starch in plants.</td>
<td></td>
</tr>
<tr>
<td>Conclude that during photosynthesis plants make carbohydrates from raw materials.</td>
<td></td>
</tr>
</tbody>
</table>

**Plants need chlorophyll to make starch.**

Given necessary and appropriate experiences the pupil will:

- Determine that green leaves contain chlorophyll.
- Determine what portion of a leaf contains starch.
- List carbon dioxide and water as raw materials needed by plants to synthesize carbohydrates.
- Explain the role of chlorophyll in photosynthesis.

**Plants need light energy to make starch.**

Given necessary and appropriate experiences the pupil will:

- Compare plants grown with and without light.
- Determine the energy supply for photosynthesis.
- Explain plants' need of energy.

**Plants use food for energy.**

Given necessary and appropriate experiences the pupil will:
**Concepts and Subconcepts**

All living things use energy (metabolism).

Living things need water and oxygen.

Living things produce carbon dioxide.

Living things take in oxygen and produce carbon dioxide.

**Learning Objectives**

discuss potential and chemical energy in relation to plants.

explain plants' need of energy.

explain transpiration in plants.

define producers and consumers.

explain how green plants are the primary source of food energy for all organisms.

Given necessary and appropriate experiences the pupil will:

relate the nature and composition of air.

experiment to test the effect of oxygen on cell growth.

demonstrate the need for water by living things.

tell what gas is needed by living things.

Given necessary and appropriate experiences the pupil will:

test for presence of carbon dioxide.

explain and demonstrate that living things produce carbon dioxide.

Given necessary and appropriate experiences the pupil will:

demonstrate that living things take in oxygen and produce carbon dioxide.
Concepts and Subconcepts

Living things produce carbon dioxide from sugar.

When living things break sugar apart, carbon dioxide is released.

Learning Objectives

describe cellular respiration.

Given necessary and appropriate experiences the pupil will:

- illustrate the concept of respiration.
- relate the importance of photosynthesis and respiration.
- demonstrate that living things, using sugar as a source of food, produce carbon dioxide.

When living things break sugar apart, energy is released.

Given necessary and appropriate experiences the pupil will:

- identify carbohydrates as products of photosynthesis which contain stored energy necessary for sustaining life.
- relate the difference between starches and sugars.
- relate the difference between carbohydrates, fats, and proteins.
- identify some simple and complex carbohydrates.
- test various foods to determine the presence of sugar.
- demonstrate that starches can be broken apart to produce carbon dioxide.
- relate how digestive enzymes work.
- tell how carbon dioxide comes from sugar.
All living things have common life activities.

Digestion breaks down food into smaller particles. Given necessary and appropriate experiences the pupil will:

- test, given various foods and digestive juices, foods for starch, sugar, protein, and fat.
- describe what digestive juices do to food.
- state that digestion is the breaking down of food.
- name the parts of the digestive system.

Diffusion is the way in which materials enter and leave cells. Given necessary and appropriate experiences the pupil will:

- define and describe the function of the villi.
- construct a device to illustrate increased surface area due to folding and relate this to the small intestine.
- define diffusion.

Concepts and Subconcepts

Learning Objectives

define work.
tell where plants get their energy.
tell where animals get their energy.
measure and record data depicting the release of energy.
relate how living things get energy from food.
discuss metabolism.
relate the meaning of calories in food.
<table>
<thead>
<tr>
<th>Concepts and Subconcepts</th>
<th>Learning Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>The circulatory system transports materials to all parts of the body.</td>
<td>Given necessary and appropriate experiences the pupil will:</td>
</tr>
<tr>
<td></td>
<td>name the parts of the circulatory system and describe their function.</td>
</tr>
<tr>
<td></td>
<td>demonstrate the proper use and function of the stethoscope.</td>
</tr>
<tr>
<td></td>
<td>relate data about the effects of drinking on driving to the diffusion of alcohol directly into the bloodstream.</td>
</tr>
<tr>
<td></td>
<td>relate the relationship between digestion, diffusion, and circulation.</td>
</tr>
<tr>
<td></td>
<td>trace the flow of blood in diagrams of the heart and circulatory.</td>
</tr>
<tr>
<td>Respiration is the constant exchange of gases.</td>
<td>Given necessary and appropriate experiences the pupil will:</td>
</tr>
<tr>
<td></td>
<td>name and diagram the parts of the respiratory system.</td>
</tr>
<tr>
<td></td>
<td>define respiration.</td>
</tr>
<tr>
<td></td>
<td>distinguish between breathing and respiration.</td>
</tr>
<tr>
<td></td>
<td>name the two gases that must be exchanged for cells to stay alive.</td>
</tr>
<tr>
<td></td>
<td>explain how smoking affects respiration.</td>
</tr>
<tr>
<td></td>
<td>infer that respiration is the constant exchange of gases.</td>
</tr>
<tr>
<td>Hormones regulate the life activities of living things.</td>
<td>Given necessary and appropriate experiences the pupil will:</td>
</tr>
<tr>
<td></td>
<td>define hormones.</td>
</tr>
</tbody>
</table>
|                          | observe, record, and describe the effect hormones
Learning Objectives

1. Discuss alternations to drugs.
2. Recognize the problems associated with drug abuse.

Drugs disrupt the brain's ability to coordinate.

The brain coordinates the life activities of the body.

Drugs disrupt the brain's ability to coordinate.

The brain coordinates the life activities of the body.

Drug objectives and subconcepts

1. Have on plants.

2. State where plant hormones are produced.

3. Name the four major glands which produce hormones.

4. Infer that hormones are regulators of the following body activities - digestion, circulation, respiration, and diffusion.

5. Relate how the body might be helped to overcome a problem of coordination.

6. Define coordination.

7. Define drug.

8. Recognize the problems associated with drug abuse.

9. Discuss alternatives to drug use.

Given necessary and appropriate experiences, the pupil will:

Given necessary and appropriate experiences, the pupil will:

- Define coordination.
- Define drug.
- Recognize the problems associated with drug abuse.
- Discuss alternatives to drug use.

Relate how the body might be helped to overcome a problem of coordination.

In animals:

- Infer that hormones are regulators of the following body activities - digestion, circulation, respiration, and diffusion.

- Name the four major glands which produce hormones.

- State where plant hormones are produced.

- Have on plants.
APPENDIX 5

STATISTICS FOR TABLES 3-11
### TABLE 3

**ACHIEVEMENT IN SCIENCE USING STANFORD SCIENCE TEST**

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<tr>
<th>Number</th>
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\[
\sum X_1 = 489 \quad \sum X_1^2 = 548 \quad \sum X_2 = 553 \quad \sum X_2^2 = 1,474
\]

\[
\bar{X}_1 = 23.3 \ (23) \quad \bar{X}_2 = 26.3 \ (26)
\]

**t value = 1.40**

**NOTE:** See page 104 for calculations.
\[ t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{\hat{x}_1^2 + \hat{x}_2^2}{n_1 + n_2 - 2} \left( \frac{1}{n_1} + \frac{1}{n_2} \right)}} \]

\[ t = \frac{23.3 - 26.3}{\sqrt{\frac{548 + 1,474}{21 + 21 - 2} \left( \frac{1}{21} + \frac{1}{21} \right)}} \]

\[ t = \frac{-3.0}{\sqrt{\frac{2,022}{40} \left( \frac{2}{21} \right)}} \]

\[ t = \frac{-3.0}{\sqrt{50.55 (.09)}} \]

\[ t = \frac{-3.0}{\sqrt{4.54}} = \frac{-3.0}{2.13} \]

\[ t = 1.40 \]
### Table 4

**Achievement in Science Using Researcher-Prepared Criterion-Referenced Test**

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</table>

$\bar{X}_1 = 60.9 \ (61)$  \hspace{1cm}  $\bar{X}_2 = 67.8 \ (68)$

**Calculation of t-value:**

$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$

Where $s_1^2 = 2,797$ and $s_2^2 = 1,950$.

$t = \frac{60.9 - 67.8}{\sqrt{\frac{2,797}{61} + \frac{1,950}{68}}} = \frac{-6.9}{\sqrt{45.87 + 28.36}} = \frac{-6.9}{7.14} = -0.97$

**Conclusion:**

The t-value of -0.97 is not significant at the 0.05 level of significance. There is no significant difference between the two groups in terms of achievement in science using the criterion-referenced test.

**NOTE:** See page 106 for calculations.
\[
t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\left(\frac{\xi x_1^2 + \xi x_2^2}{n_1 + n_2 - 2}\right) \left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}
\]

\[
t = \frac{61 - 68}{\sqrt{\left(\frac{2,797 + 1,950}{21 + 21 - 2}\right) \left(\frac{1}{21} + \frac{1}{21}\right)}}
\]

\[
t = \frac{-7}{\sqrt{\frac{4,747}{40} \left(\frac{2}{21}\right)}}
\]

\[
t = \frac{-7}{\sqrt{118 (.09)}}
\]

\[
t = \frac{-7}{\sqrt{10.68}} = \frac{-7}{3.26}
\]

\[
t = 2.14
\]
### TABLE 5
ATTITUDES TOWARD SCIENCE USING SURVEY OF SCHOOL ATTITUDES

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\[ \sum x_1 = 445 \quad \sum x_1^2 = 472 \]
\[ \sum x_2 = 438 \quad \sum x_2^2 = 459 \]

\[ \bar{x}_1 = 21.2 \ (21) \]
\[ \bar{x}_2 = 20.9 \ (21) \]

\[ t \text{ value} = 0.202 \]

**NOTE:** See page 108 for calculations.
\[
t = \frac{\overline{x}_1 - \overline{x}_2}{\sqrt{\left(\frac{\overline{\xi}_1^2 + \overline{\xi}_2^2}{n_1 + n_2 - 2}\right) \left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}
\]

\[
t = \frac{21.2 - 20.9}{\sqrt{\left(\frac{472 + 459}{21 + 21 - 2}\right) \left(\frac{1}{21} + \frac{1}{21}\right)}}
\]

\[
t = \frac{0.3}{\sqrt{\frac{931}{40} \left(\frac{2}{21}\right)}}
\]

\[
t = \frac{0.3}{\sqrt{23.3 (0.9)}}
\]

\[
t = \frac{0.3}{\sqrt{2.2}} = \frac{0.3}{1.48}
\]

\[
t = 0.202
\]
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$\sum D = 90$  $\sum D^2 = 938$

$t$ value = 3.75

NOTE: See page 110 for calculations.
\[
t = \frac{D}{\sqrt{\frac{\varepsilon D^2 - (\varepsilon D)^2}{N \over N (N-1)}}}
\]
\[
t = \frac{90}{21} \sqrt{\frac{938 - (90)^2}{21 \over 21 (21-1)}}
\]
\[
t = 4.28 \sqrt{\frac{938 - 385.7}{420}}
\]
\[
t = 4.28 \sqrt{\frac{552.3}{420}}
\]
\[
t = \frac{4.28}{\sqrt{1.31}} = \frac{4.28}{1.14}
\]
\[
t = 3.75
\]
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$f_D = 717$  \( fD^2 = 26,371 \)

$t$ value $= 16.03$

NOTE: See page 112 for calculations.
\[
t = \frac{\overline{D}}{\sqrt{\frac{\varepsilon D^2 - (\varepsilon D)^2}{N}}}
\]
\[
t = \frac{717}{21}
\]
\[
t = \frac{34}{\sqrt{26,371 - \frac{514,089}{21}}}
\]
\[
t = \frac{34}{\sqrt{26,371 - 24,480}}
\]
\[
t = \frac{34}{\sqrt{1,891}}
\]
\[
t = \frac{34}{\sqrt{4.5}}
\]
\[
t = \frac{34}{2.12}
\]
\[
t = 16.03
\]
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$\sum D = 44$  $\sum D^2 = 520$

$t$ value $= 2.07$

NOTE: See page 114 for calculations.
\[
t = \frac{\bar{D}}{\sqrt{\frac{\xi D^2 - (\xi D)^2}{N}}} \sqrt{\frac{N}{N(N-1)}}
\]

\[
t = \frac{44}{21}
\]

\[
t = \sqrt{\frac{520 - \frac{(44)^2}{21}}{21 \cdot (21-1)}}
\]

\[
t = \frac{2.09}{\sqrt{\frac{520 - 92.1}{420}}}
\]

\[
t = \frac{2.09}{\sqrt{\frac{427.9}{420}}}
\]

\[
t = \frac{2.09}{\sqrt{\frac{1.018}{1.009}}} = \frac{2.09}{1.009}
\]

\[
t = 2.07
\]
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\[ \sum D = 746 \quad \sum D^2 = 28,074 \]

\[ t \text{ value} = 18.39 \]

**NOTE:** See page 116 for calculations.
\[ t = \frac{D}{\sqrt{\frac{eD^2 - \frac{(eD)^2}{N}}{N (N-1)}}} \]

\[ t = \frac{746}{21} \]

\[ t = \frac{35.5}{\sqrt{\frac{28,074 - \frac{(746)^2}{21}}{21 (21-1)}}} \]

\[ t = \frac{35.5}{\sqrt{\frac{28,074 - 556,516}{21}}\sqrt{\frac{28,074 - 26,500}{420}}} \]

\[ t = \frac{35.5}{\sqrt{1,574}} \]

\[ t = \frac{35.5}{\sqrt{3.74}} = \frac{35.5}{1.93} \]

\[ t = 18.39 \]
TABLE 10
E GROUP--LECTURE--DEMONSTRATION--RECITATION METHOD:
SURVEY OF SCHOOL ATTITUDES

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\[ \bar{\Delta} = 55 \quad \bar{\Delta^2} = 467 \]

\[ t \text{ value} = 2.96 \]

NOTE: See page 118 for calculations.
\[ t = \sqrt{\frac{\overline{D}}{N (N-1)}} \]
\[ t = \sqrt{\frac{\frac{55}{21} - \frac{(55)^2}{21}}{21 (21-1)}} \]
\[ t = \sqrt{\frac{467 - \frac{3,025}{21}}{21 (20)}} \]
\[ t = \sqrt{\frac{467 - 144}{420}} \]
\[ t = \sqrt{\frac{323}{420}} \]
\[ t = \sqrt{\frac{2.6}{.769}} = \frac{2.6}{.876} \]
\[ t = 2.96 \]
### TABLE 11
C GROUP—DISCOVERY METHOD: SURVEY OF SCHOOL ATTITUDES

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\[ \sum D = 21 \]
\[ \sum D^2 = 245 \]

\[ t \text{ value} = 1.36 \]

**NOTE:** See page 120 for calculations.
\[ t = \frac{D}{\sqrt{\frac{\xi D^2 - (\xi D)\xi}{N}}} \]
\[ = \frac{21}{\sqrt{\frac{245 - (21)^2}{21}}} \]
\[ = \frac{1}{\sqrt{\frac{245 - 441}{21}}} \]
\[ = \frac{1}{\sqrt{\frac{224}{420}}} \]
\[ = \frac{1}{\sqrt{.533}} = \frac{1}{.730} \]
\[ t = 1.36 \]
BIBLIOGRAPHY


Branley, Franklyn M. "Experiments and Demonstrations." Grade Teacher 78 (October 1960): 53, 125+.


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