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An Experimental Evaluation of the Use of Instructional Television for Elementary Science

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AN EXPERIMENTAL EVALUATION OF THE USE OF INSTRUCTIONAL TELEVISION FOR ELEMENTARY SCIENCE

by

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LIFE

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CHAPTER I

THE PROBLEM

That television as a mass medium of entertainment, information, and commercial enterprise is here to stay seems fairly clear; that it has a real contribution to make to the education of Americans is not so unanimously accepted. Television as a tool of education has had enthusiastic supporters and violent opponents; it has become a vital part of some school systems, and has been unequivocally rejected by others; it has been seen as a solution to many of our major problems of education, and as just another complication in an already complicated field. In view of the importance of education in our country today, it seems important to weigh these pros and cons with some care; the pressures of the times deny to educators the luxury of making a costly error - either of commission or omission.

During approximately the last fifteen years we have observed rapid growth and development in all phases of educational television. Iowa State College's WOI-TV licensed in 1948 was the first television station owned by an educational institution. In 1952 the Federal Communications Commission allocated 242 channels to non-commercial use. At about this time, many foundations contributed funds toward the development of educational television. Five million dollars was granted by the Fund for the Advancement of Education to assist in educational television station construction and program development.[1]

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[1]William E. Cumming, This is Educational Television, (Ann Arbor, Edwards Brothers, Inc., 1954), p. 5.

By 1960 there were 63 educationally owned television stations on the air, 57 of these holding non-commercial licenses. Twenty-eight more such stations were under construction or in the advanced stages of planning. By the school year 1960-61, a student body, estimated at 3,000,000 in 7,500 secondary and elementary schools, was receiving televised instruction from non-commercial educational television stations, while an additional 1,500,000 were utilizing closed circuit television for the same purposes.[2]

Educational television has been aided by the work of certain organizations which have been interested in the development of television for educational purposes. They have largely been responsible for the expansion of the use of television in the schools.

The National Educational Television and Radio Center was begun in 1953 by a grant from the Fund for the Advancement of Education. The headquarters office for this organization is in New York City, and it serves as the network headquarters for the affiliated non-commercial stations as affiliate outlets, and claims 10,000,000 regular viewers and a potential national audience in excess of 26,000,000 people.[3] The Center serves as a distribution point for the best programs produced by educational television stations. In addition it provides a clearinghouse for information on new developments. The Center also furnishes consultant service, including business advice, to its affiliates.

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[2]Richard B. Hull, "A Note on the History Behind ETV," Educational Television: The Next Ten Years, (Stanford: Institute for Communications Research, 1962), p. 335.

[3]Ibid.

The National Association of Educational Broadcasters has also furnished leadership in extending the use of television for educational purposes. This organization has furnished advisory service at the national, state, and local levels, including information on legal and engineering matters. The group conducts workshops, seminars, and conventions to encourage the exchange of information among established and new stations. Its membership includes:

Educational institutions which own and operate educational television and radio stations
Institutions which produce programs for educational television and radio, or operate closed-circuit installations
Educational institutions or public-service organizations or others interested in promoting educational broadcasting
Firms engaged in the manufacture or sale of broadcast auxiliary equipment wishing to further the advancement of educational broadcasting
Individuals in the educational broadcasting field[4]

As a result of a grant from the Fund for Adult Education of the Ford Foundation, the Joint Committee on Educational Television, which later became the Joint Council on Educational Television, was established in 1951. It is concerned with the preservation and utilization of educational television channels. This organization, a clearinghouse for information concerning television activities, has proven very helpful to educators. It publishes a regular report on the status of educational television and prepares and distributes material on special aspects of its development. The Joint Council on Educational Television is composed of a number of separate organizations:

National Association of State Universities
American Association of Land-Grant Colleges and State Universities
American Association of School Administrators
American Council on Education

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[4]Donald G. Tarbet, Television and Our Schools, (New York: Ronald Press, 1961), pp. 9-10

Council of Chief State School Officers
National Educational Television and Radio Center
National Citizens' Committee for Educational Television
National Congress of Parents and Teachers
National Educational Association of the United States[5]

The National Citizens' Committee for Educational Television was formed about the same time as the Joint Council on Educational Television, and was also financed by a grant from the Fund for Adult Education. Its purpose is to enlist a broad base of citizen support for educational television which in turn makes it possible to share costs and services in order to lighten the load on a community which builds an educational television station. This organization emphasizes informal adult education rather than the formal ed-cational program characteristic of elementary and secondary schools. This policy is based on the concept that television is a means of educating the masses and is a way of building an informed citizenry.

The Office of Education of the United States Department of Health, Education, and Welfare has cooperated with various organizations concerned with educational television. It has sponsored and conducted research in the use of educational or instructional television through Title VII of the National Defense Education Act of 1958. An important service which it provides is that of the dissemination of information concerning the use of television in education, including organizations, finance, course listings, and bibliographies of references on the subject.

It is well to note that to this point we have been considering growth and development in the broad field of educational television. Educational television represents the entire field of programing telecasts which have

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[5]Ibid., p. 11.

as their purpose the conveyance of information or the teaching of skills and techniques. These telecasts have a general cultural value and a general educational interest or appeal for a broad spectrum of our population. Any given telecast might have appeal for a particular segment of this broad spectrum. A more specific aspect of television is that which is intended for in-school use and is referred to as instructional television. Instructional television programing is usually intended for classroom use and most of it is of a regular and continuing nature with explicit learning objectives or outcomes for the viewers. The remainder of this study will be concerned with the utilization of instructional television in our schools.

The growth of instructional television and the related broadcast networks was matched by an even more rapid but less costly development in closed-circuit installations totaling more than 300.[6] This does not include the facilities of the Armed Services. Cable and microwave systems have been widely employed for special laboratory applications, the observation of university lectures and demonstrations, notably in medical schools, and for the formal instruction of regularly enrolled students on all levels. Installations have ranged in size from simple room-to-room one-channel cable connections in a single school building to multiple circuit systems, complete with studios and video tape recording equipment. In Anaheim, California, for instance, an entire city school system was linked together; in Washington County, Maryland, the entire county system; at Ohio State University, the entire campus; and in central Texas, a cluster of institutions with the University of Texas at Austin as the central point.

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[6]Hull, p. 336.

Culminating this period of explosive growth was a new development in a different dimension, the Midwest Program on Airborne Television Instruction. Headquartered at Purdue University, Lafayette, Indiana, the Midwest Program on Airborne Television Instruction (MPATI) was financed by the Ford Foundation and by corporate grants from Westinghouse and other industrial companies. They equipped two DC-6AB transport-cargo planes with Ultra High Frequency (UHF) transmitters and video tape reproduction equipment which serve as airborne television transmitting stations. One of the airplanes serves as the flying transmitter while circling four miles above the town of Montplier, Indiana. The second aircraft is used as a standby in the event of mechanical problems or bad weather conditions. The equipment within the aircraft is used to transmit simultaneously on UHF channels 72 and 76.

The television impulses from the airplane's antenna radiate 200 miles in all directions. Within this telecast area are parts of six states: Illinois, Indiana, Kentucky, Michigan, Ohio and Wisconsin. The region is more than 127,000 square miles in area and contains 17,000 schools and colleges enrolling about seven million students.[7] The growth and development of MPATI has significance not only for its technical accomplishments of airborne transmission, but also for the fact that through one agency such a large number of students and schools could be affected by their programing.

With the rapid increase in the number of stations which are telecasting instructional programs, the rapid increase in the number of televised courses available in any given instructional area, and the growth of television

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[7] This is Airborne, (Lafayette: Midwest Program on Airborne Television Instruction, 1961), p. 12.

organizations with such far reaching implications as the Midwest Program on Airborne Television Instruction, there are still a great many crucial points about which we have little or no information. These are issues which have greatest implication for curriculum and instruction at the local school level.

The first question is concerned with the adaptability of instructional television to the on-going school program. A great deal of criticism has been leveled at the use of television as an added rather than as an integral part of the on-going school program. It is well accepted that a film, or any other learning aid, should be well prepared for and well followed up, and should be used at the educationally right moment. It is clear, however, that what is the right moment in one class is probably not the right moment in another. If both of the classes are using instructional television, then it follows that one of the classes must adapt to the telecast rather than vice versa, since the telecast schedule isn't flexible. The pacing and scheduling of a television course is determined in advance of the school year. It then becomes a general principle that so far as utilization of telecasts is concerned, the classroom must adapt to the telecast rather than the telecast to the classroom.

The next unanswered question is concerned with the adaptability of instructional television to different levels of learning. Guba states "that learning probably takes place at three levels - action, reaction, and interaction."[8]

> At the action level the student learns on his own. At the reaction level the student reacts to the instruction of a teacher (or to a program

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[8] Egon G. Guba, "Evaluation and the Airborne Television Project," Educational Research Bulletin, XXXIX (October, 1960), p. 180.

developed by a teacher as in the case of a teaching machine). At the interaction level the student learns through interacting with peers. Some content can be learned at any level, while other content seems to be linked to a specific level (e.g., it is hard to imagine how democratic leadership could be learned except through interaction). As it has been used, instructional television, and it might be better termed televised instruction, has been limited almost entirely to the reaction level. It is dubious if ways can be found for utilizing television at either of the other levels. It is certainly clear that unless educational programs can be made more open-ended or problem-raising in nature, the interaction level is ruled out.[9]

A third area of concern is that of the adaptability of instructional television to meet the needs of individual differences in the classroom. It has already been pointed out that the classroom must adapt to the telecast rather than vice versa; therefore, since the telecasts are presented at some particular average or other level, ways must be found to individualize the instruction after the fact by the teacher in the local using classroom. This is particularly crucial since the individual differences found in a typical classroom are vastly exceeded by the individual differences found in a typical school district, state, or region which a televised program might reach.

A fourth area of concern is that of the development of skills required for learning by television. In learning through reading, we recognize the need to emphasize the development of word recognition skills, vocabulary skills, factual and critical comprehension skills, inferential thinking skills, summary or organizational skills, improved speed, and the like; however, to this point we have not been able to determine specifically what skills or patterns of viewing and listening are appropriate for effective learning. The viewing of a telecast which is instructional in nature is

[9]Ibid., p. 181.

certainly not equivalent to viewing an entertaining type of program. This lack of specific knowledge of these required skills makes it impossible to plan the television presentation in order to make possible use of these most effective viewing patterns, if they exist.

A fifth area of concern is that of achieving curricular and scheduling flexibility. With a one or two channel operation in an area, typically there are provided one to three alternate time offerings for a particular telecast. This requires rigid scheduling in order to meet the demands of television. In addition, consideration must be given at the same time to the scheduling of all other special instruction and activities. This becomes even more critical when the area served by an organization, such as MPATI, includes six different states and several different time zones. Again in this area, we find the need for the classroom teacher and the school to adapt to the television rather than vice versa. This could be relieved somewhat through an increase in the number of broadcast channels made available for instructional television which in turn would increase the flexibility and improve the matter of scheduling. Limitations on channel allocations and funds for station development and operation make this possibility somewhat remote.

The development of instructional television and its use on a broad scale poses a very basic threat to many teachers. The problem takes many forms: technological unemployment, relegation to second class citizen necessary for the teacher to redefine her instructional role and the implied teaching functions as she continues to use instructional television. She is forced to become a manager of learning situations and a counselor of individual learners.[10] Local teachers, including the most professional, experienced, and interested, require a great deal of help in defining and achieving this changed role.

A final problem which includes aspects of all of the previously stated ones concerns the challenge to local autonomy in developing curriculum and in selecting methods of instruction that broad scale instructional television presents. The televised curriculum is defined by persons other than the local teacher. At best there is mutual consultation on a representative basis. Regardless of how democratically a television curriculum may have been developed, once it is accepted and in use, it poses a strict requirement for all its consumers, and local autonomy is delegated to the central transmitting agency. This becomes a more serious problem as we extend the organization of networks or regional organizations for transmitting instructional telecasts.

In order to focus more specifically on this problem of rapid growth and development of instructional television and the concomitant problems, we can review the number of actual courses or instructional series which are currently available for a given instructional area. In the 1964 Guide of the Instructional Television Library Project,[11] a total of 44 elementary science courses are listed. All of these are available on a lease basis for

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[10] I. Keith Tyler, "Impact of Instructional Television on Teaching Roles and Functions," Audio Visual Communication Review, X (January, 1962), p. 52.

[11] Instructional Television Library Project, Instructional Television Materials: A Guide to Films, Kinescopes and Videotapes Available for Televised Use, (New York: Instructional Television Library Project, 1964), pp. 28-31.

rebroadcast by individual stations or networks. Twelve of these courses have in excess of 50 lessons; sixteen of the courses have between 25 and 49 lessons; sixteen of the courses have fewer than 25 lessons. This represents a huge amount of instructional telecasting time for one curricular area. With this quantity of televised courses available for use in elementary science, questions regarding their adaptability to the on-going school program, adaptability to different levels of learning, adaptability to varying student abilities, adaptability to local curricular needs, and the structure and selection of course content become matters of critical concern to the particular school system which plans to use them. It is not enough to accept the telecasts simply because they are available.

In light of the rapid expansion of the offerings now available in the various instructional areas and the vital concerns which have been listed, local school systems, as potential users of instructional telecasts, must become involved to a greater extent not only in the planning, structuring, and selection of specific courses, but of necessity, they should be prepared to undertake local evaluation studies. These studies should be designed to assist them in making decisions regarding the adaptability of courses to local curriculum needs, their effectiveness for use with students of varying levels of ability, and the effect of the courses on the interests and attitudes of students and teachers alike.

The passage of Title VII of the National Defense Education Act in 1958 provided federal funds for research in the new media, which included television. This provided the impetus for a considerable amount of research; however, most of it has been carried out by radio, television, and film researchers who are removed from the local level. There is also a need for teachers and other users of the new media to become involved as initiators or at least prime movers in such research. Television and other media should be in the hands of the teacher or at their disposal, instead of vice versa.

The research needs at the local level should not be restricted to a determination of whether instructional television can be used to teach as well as with conventional classroom methods. Most studies which have been concerned with this type of comparison have been limited to measurement of the relatively simple dimension of information gain and achievement.[12] It is even more important that the research be directed toward an evaluation of the effectiveness of courses in meeting local curricular and instructional needs.

The present study is concerned with such an evaluation of the MPATI course offerings in elementary science. The School City of Gary, Indiana, as a participating member of MPATI, began to make selective use of the offerings at the elementary school level in a limited number of schools which were fully equipped for classroom reception of the instructional telecasts. This study was locally planned at the start of the 1962-63 school year in an attempt to provide evaluative data on which decisions regarding future use might be made.

During this particular school year, the offerings of MPATI included a total of 23 different courses for elementary and high school classes. They covered the fields of science, foreign language, mathematics, social studies, music, English language arts, and literature. Sixteen of these courses were at the elementary school level. The courses varied in length from 32 lessons

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[12] Teaching by Television: A Report from the Ford Foundation and the Fund for the Advancement of Education, (New York: Ford Foundation, 1961), p.23.

to 128 lessons for the school year. The courses with the smallest number of lessons were offered one day a week during the school year. The courses with the greatest number of lessons were offered four days a week. Many of the courses were offered two days a week. The elementary school lessons were 20 minutes long and the high school classes lasted 30 minutes. The question of what courses to produce was decided by three advisory commissions for MPATI - one each for elementary, secondary, and higher education - made up of representative school personnel from throughout the region served by MPATI.

In a survey conducted by MPATI, the most popular courses in terms of use were those in elementary science.[13] There are four different elementary science courses offered by MPATI. They include "Scienceland" for grades one and two, "The Science Corner" for grades three and four, "Exploring with Science" for grade five, and "The Adventure of Science" for grade six. Details of the content outline for each course and the scheduling pattern for each course follows:

"Scienceland"[14]- Thirty-two lessons offered once a week

Unit	Topic	Number of Lessons
I	All Around You	2
II	Around Your House	6
III	Under Your Feet	4
IV	In the Woods	5
V	In the Water	5
VI	In the Air	5
VII	Out in Space	4
VIII	Scienceland is Everywhere	1

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[13]Kalmer E. Stordahl, MPATI Member School Survey, (Lafayette: Midwest Program on Airborne Television Instruction, Inc., 1964), p. 4, (Mimeographed).

[14]Barbara Yanowski, Scienceland: Resource Units in Science for 1st and 2nd Grade Students, (Lafayette: Midwest Program on Airborne Television Instruction, Inc., 1962), pp. 6-7.

"The Science Corner"[15]- One-Hundred Twenty-Eight lessons offered four days a week

Unit	Topic	Number of Lessons
I	Looking at Things Around Us	7
II	Studying Rocks	8
III	Protection Against the Weather	4
IV	Water-Living Animals	4
V	Land-Living Animals	5
VI	The Earth in Space	9
VII	Class Science Fair	1
VIII	Living Things in Autumn	8
IX	Your Body and How it Works	2
X	Obtaining and Preserving Food	4
XI	Communication	8
XII	Journey into Space	4
XIII	Magnetism and Electricity	9
XIV	Transportation	9
XV	Simple Machines	4
XVI	Scientific Instruments	2
XVII	Understanding Weather	9
XVIII	Young Animals	5
XIX	Plants in Spring	9
XX	Animals in Spring	7
XXI	School Science Fair	1
XXII	Exploring Our Country	9

"Exploring with Science"[16]- Sixty-four lessons offered two days a week

Unit	Topic	Number of Lessons
1	Introduction	1
II	Geology	4
III	Animals	14
IV	Air	2
V	Weather	6
VI	Flight	4
VII	Magnetism	3
VIII	Electricity	9
IX	Fire	3
X	Plants	4
XI	Vertebrates	7
XII	Prehistory	6
XIII	Conclusion	1

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[15]Barbara Yanowski, The Science Corner: Resource Units in Science for 3rd and 4th Grade Students, (Lafayette: Midwest Program on Airborne Television Instruction, Inc., 1960), pp. 7-10.

[16]John W. Burns, Exploring with Science: Resource Units in Science for 5th Grade Students, (Lafayette: Midwest Program on Airborne Television Instruction, Inc., 1961), pp. 7-9.

"The Adventure of Science"[17] - Thirty-two lessons offered one day a week

Unit	Topic	Number of Lessons
I	Cells	5
II	Health	3
III	Matter and Energy	12
IV	Machines	3
V	Universe	9

The strong interest which teachers have toward the use of instructional television for elementary science may be in some way related to the national interest and enthusiasm for the improvement of instruction in mathematics and science. By having a specialist, in the person of the television teacher, come into the classroom, the classroom teacher is relieved somewhat of the responsibility for carrying out intensive planning and preparation for the teaching of science, an area in which she might feel that she is poorly prepared. The specialist or television teacher has an extended time period for preparation, has the support and assistance of others in her preparation work, and has access to all of the up-to-date science equipment and learning aids to accomplish her task. In this way, each teacher is able to use the specialist teacher and the televised lessons as a major resource for her teaching of science.

The classroom teacher does retain basic responsibility for the learning of her students. Through her use of the Resource Guide, which has been developed for each course offered by MPATI, the teacher has an outline of the content, vocabulary, lesson objectives, suggested activities, and a listing of additional resource materials to be used with each telecast. These

[17] John W. Burns, The Adventure of Science: Resource Units in Science for 6th Grade Students, (Lafayette: Midwest Program on Airborne Television Instruction, Inc., 1962), pp. 7-8.

Resource Guides are intended to help the teacher to prepare for, utilize, and follow-up each telecast lesson in such a way that it becomes an integral part of the total program of instruction. Since these telecasts are of a resource nature rather than a total teaching type, the classroom teacher does continue to share a large responsibility for instruction with the television teacher.

Since this same strong interest in finding ways to improve science instruction in the elementary schools existed in Gary, this study will focus on an evaluation of the effectiveness of the elementary science offerings of MPATI which have been described previously. It was necessary to limit the evaluation of student achievement to selected units from "The Science Corner" at the third grade level and from "Exploring with Science" at the fifth grade level. It was felt that these two offerings were representative of the science courses of MPATI, since the other two course offerings are taught by the same two television teachers as the courses selected.

The study has been designed to:

1. determine the relative effect on learning when the MPATI science telecasts are used for selected units of instruction as compared to conventional classroom instruction in terms of acquisition and retention of scientific facts, the understanding and application of scientific generalizations and principles, and scientific vocabulary growth,
2. determine whether any differences in achievement exist for students at different levels of ability for the two methods,
3. determine the attitudes of teachers who use these instructional telecasts toward their use for elementary science as compared

to the attitudes of teachers in conventional classrooms toward the use of instructional television for elementary science,

4. determine the general attitudes toward the study of science of students in classes which use these instructional telecasts as compared to the attitudes of students in conventional classrooms toward the study of science,

5. determine the feelings of confidence about teaching science of the teachers who are using these instructional telecasts and compare with the feelings of confidence about the teaching of science of the teachers in conventional classrooms.

Terminology in this study which requires specific definition includes the following.

Airborne Television refers to the total operation of the Midwest Program on Airborne Television, Inc. The transmitters for the broadcast channels are operated from within an aircraft which is in flight or airborne.

Broadcast Television is that which is transmitted on either a Very High Frequency channel or an Ultra High Frequency channel with reception available to any full receiver within the signal area.

Closed Circuit Television is that which is transmitted through a cable or by means of micro wave transmission and is available only to those receivers which are connected by cable or specially equipped for the micro wave frequency.

A Conventional Classroom is a self-contained elementary classroom in which the teacher does not have access to classroom use of instructional television.

Educational Television includes all programing which is contrived to convey information or teach skills and techniques. These are telecast of general cultural value and have appeal for a broad spectrum of the population. Educational television includes programing for out-of-school viewers as well as in-school viewers.

<u>Instructional Television</u> is that which is specifically intended for in-school viewing. Programs are usually of a regular and continuing nature with explicit learning objectives or outcome for each telecast. It is a specific type of educational television.

<u>A Resource Guide</u> is provided for the classroom teacher who is using an instructional telecast series. It usually contains an outline of the lesson content, objectives, vocabulary, suggested activities, and additional learning resources. It is intended to help the teacher better use the telecast series.

<u>The Ultra High Frequency (UHF)</u> telecast band is in the range of 300-3000 Megacycles and includes 70 telecasting channels. It includes those channels numbered from 14-83.

<u>The Very High Frequency (VHF)</u> telecast band is in the range of 30-300 Megacycles and includes 12 telecasting channels. It includes those channels numbered from 2-13.

This chapter has been concerned with a summary of the development of educational television and its growing use for instructional purposes in the elementary school. The growth and development of MPATI along with a statement and definition of the problem of this dissertation followed. Chapter II presents a summary of the previous research relevant to the problem. In Chapter III are reported the experimental data collected on student achievement for this study. Chapter IV presents the treatment of the data by analysis of covariance and Chapter V their treatment by methods by level analysis of variance. Chapter VI reports the data on student attitudes and the treatment of the data by chi square analysis. Chapter VII presents the data on teacher attitudes and an analysis of these. Chapter VIII presents the data on the feelings of confidence of teachers and an analysis of these. In Chapter IX are given a summary and the conclusions derived from this experimentation.

CHAPTER II

REVIEW OF RELATED RESEARCH

Actual use of instructional television in the schools has far outstripped evaluation of its use. There has been little coordination between the producing agencies for instructional telecasts and users in the schools. As a result, most of the studies which have been carried out have been instituted after the instructional course has been put on the air. The research person is then asked to evaluate the program without having been involved in the development of the objectives or aims of the series. If the researcher did have a greater voice at the planning level, conditions could be arranged that would allow for a more clear-cut evaluation of instructional television.

The critical question in the acceptance and use of instructional television is concerned with the possible effect that it might have in furthering educational objectives. Quite a sizable body of research literature has now been accumulated on ascertaining effects. A great deal of the literature is unsystematic, but it does constitute the base from which arguments on utilizing or rejecting instructional television may proceed.

This chapter will be concerned primarily with research which has been conducted on the use of instructional television at the elementary school level. Some references will be made to studies at the secondary school level for those areas where comparison is necessary. The review will consider those studies which have been concerned with questions of student achievement, students' attitudes, and teachers' attitudes toward the use of instructional television in the elementary school.

Many of the individual original sources of research studies of this type were prepared by local school systems, and because of their informal publication nature, are unfortunately unavailable. Where this is true great reliance has been placed on several significant reviews of instructional television research.

Where a number enclosed in parentheses appears — as for example (3) — this would indicate that the findings were indicated in the third reference in the bibliography at the end of this dissertation.

In regard to the learning effectiveness of instructional television, most of the studies report no significant differences when information gain is compared between students taught by television and students taught under face-to-face conditions. Holmes (7) reports that of the 281 comparisons reported, he found 246 which produced no significant differences between television and face-to-face instruction. In 1961, a samll booklet was published which attempted to bring together all of the research done on instructional television to that time (38). It reported the findings of the first two years of testing of the National Program in the Use of Television in the Public Schools. For 1957-58, they included 14,326 television students and 12,666 control students of equal ability; and for 1958-59, they included 43,105 television students and 26,092 control students. Of the 251 comparisons made during the two year period, in 90 cases, there was a statistically significant difference in achievement between the students in the two groups. Of these differences, 69 were in favor of the television classes and 21 were in favor of the control groups.

In a later review by Schramm (18), the results of 393 comparisons of instructional television with classroom teaching in schools and colleges showed no significant differences in 255 of these. A total of 85 comparisons reported significant differences in achievement in favor of television classes, while a total of 55 reported significant differences in favor of conventional classroom instruction. In this same review, 152 studies were reported for use in grades 3-6. No significant differences in achievement were reported for 86 of these, while 50 studies reported significant differences in favor of television instruction and 16 studies reported significant differences in favor of conventional classroom instruction. Twenty-three of these studies in grades 3-6 were concerned with science instruction. No significant differences were reported for 14 of these comparisons, while 8 studies reported studies in elementary science reported significant differences in achievement in favor of television classes and 1 study reported significant differences in favor of conventional classroom instruction.

In reviewing some of these specific studies which have been carried out at the elementary level in science, Jacobs and Bollenbacher (16) found significant differences in favor of conventional classes for low ability students and found significant differences in favor of television classes for high ability students. In a later study in the same city, Jacobs and Grate (17) found differences in achievement which favored the conventional classes for below average and average ability students. No differences were reported for the above average ability students.

In a study in the Norfolk City Schools (25), matched pairs were used and separate results were reported for white and Negro schools. At the 5th grade level, no significant differences in achievement were reported in the white schools while significant differences were reported in favor of the television classes in the Negro schools. At the 6th grade level, significant differences were reported in favor of the television classes in the white schools, but none were reported in the Negro schools. Pre and post testing was carried out; however, differences were measured on the differences between correlated means on the post-test. This was done with t tests. It should also be noted that fewer than 25 students were in the conventional class and television class groups in this study.

In a report of one of the largest closed-circuit uses of instructional television (39), students who had received instruction by television showed an unusual growth in achievement as measured by the Stanford Intermediate Science Test; however, only mean growth scores were reported and no statistical analysis was made. Greatest growth in achievement was reported for below average ability students.

A group of studies ranging from short teacher comments to more sophisticated research reports have been collected by the MPATI area coordinators and member schools. These have been published by the Bureau of Research of the College of Education at Michigan State University (36). One of the better studies is reported by the Skokie, Illinois School District 68 with the title "Intermediate Grades Television Science Experiment" in 1962. Both a locally constructed science achievement test and the Sequential Tests of Educational Progress (STEP) were used in evaluating achievement of eight 5th and 6th grade classes using MPATI science telecasts and thirteen conventional 5th and 6th grade classes during the 1961-62 school year. Only on the locally constructed tests did the results favor the television classes.

In a MPATI reported study at the Resurrection School, Chicago, Illinois, no significant differences were reported between two 5th grade classes during the 1961-62 school year; however, the two classes were not matched completely prior to the start of the study.

The research on the learning effectiveness of students in television classes as compared to those in conventional classes cannot be considered as conclusive. It appears that with a few exceptions, the design of the evaluations of learning at the elementary level are usually of low quality. The reviews of instructional television research appear to use very liberal standards in reporting significant differences found in studies of learning effectiveness. The specific studies which have been reviewed have used a variety of designs and a variety of evaluative measures to determine differences. It would seem that when differences have been found, they can be better explained by conditions other than the mere fact of television transmission. These would include, for example, many of the studies reviewed (25, 26, 35, 38, 39). In these studies, television did not carry the entire teaching load in the class but was used as an augmentation to regular classroom instruction. It is reasonable to expect that television instruction alone is not the most important factor being considered in the evaluations of teaching effectiveness. The instructional role of the classroom teacher in the learning process when television is used remains a very important one. This important aspect of the evaluation of learning effectiveness of television is supported by Williams (24).

That learning can take place through the medium of television communication can be answered in the affirmative. That television can do a better job of teaching than conventional classroom instruction is more dependent upon the capabilities of present staff members in the curriculum area being taught, the resources at hand for teaching, and the curriculum objectives of the particular course being evaluated. All of these factors should be considered in an evaluation of the learning effectiveness of instructional television.

Studies of the attitudes toward television of persons who have been students in television classes must be interpreted with extreme caution. In most of the cases, respondents are asked to make a comparison with other courses they have had. The effect of immediate experience of television instruction may result in higher ratings in favor of television. In the greatest number of studies, a study of the attitudes toward television instruction is a minor appendage to the main part of the study and is usually limited to one five point rating scale.

Acceptance of television for instruction has generally been enthusiastic by students at the elementary level. When students in three school systems (26, 31, 34) were asked, "Do you think students learn more, the same, or less from a television class?", students at the elementary level responded in greater percentages that they learned more as compared to high school students. In the MPATI review (36), a brief attitude study by the Dublin Elementary School, Dublin, Ohio, toward MPATI science telecasts was carried out for 3rd, 4th, and 5th grad students. They were compared with students of the same grade from a nearby school which did not use MPATI lessons. A larger proportion of the television students indicated that science was their favorite subject and that science was the subject in which they had learned most. The results were reported as more conclusive for the 3rd and 5th grades than for the 4th grades. In the same MPATI report (36), an evaluation conducted in the Middletown, Ohio, schools showed that the attitudes of television students were favorable to the use of television for science. The students were more influenced by the subject matter and the television teacher than by the frequency of use of the telecasts.

Elementary students at the 3rd through 6th grade levels in eight schools in Detroit reported that they felt it was easier to learn by television and had attitudes which were generally favorable toward its continued use (20). In Jefferson County, Kentucky, almost 100% of the children preferred the televised science class to the regular class (30). Norfolk students (25) also reported that they like televised science more.

In the Cincinnati report (26), the reactions of the 6th grade students were more favorable toward instructional television than the reactions of either seventh grade mathematics or the ninth grade biology students who used instructional television.

As has been mentioned previously, little research has been carried out in the area of student attitudes which reflected more than a direct question approach to the student on whether he preferred television instruction or conventional instruction. Except for the limited study reported in the Dublin, Ohio, schools, none of the studies attempted to determine whether television really had an effect on the basic attitudes of the students toward the subject which was being taught with television.

In reviewing the studies of the attitudes of teachers toward the use of instructional television, it is revealed that most elementary teachers come to like and depend on television as one part of their teaching resources. In

Hagerstown, Maryland (39), 83% of the teachers preferred to teach with the aid of television. In a sample of Florida elementary school teachers in Dade County (27, 28) 67% of the teachers felt that the progress of their students was greater with television for science instruction. A sample of 1191 Milwaukee elementary teachers and principals (33) indicated that the most preferred courses are those that provide useful demonstrations or in which the teacher needed special help. Science was included as a most preferred course.

In a survey of 85% of the classes that were using the MPATI science telecasts during the 1962-63 school year (40), teachers indicated that these telecasts were generally valuable for the new interests, their lively teaching methods, their use of aids and demonstrations, their pacing, and their suitability for classes using them.

In two studies reported by Westley and Jacobsen (22, 23), a group of 4th and 9th grade teachers who were using instructional television reflected favorable attitudes toward its continued use. They consistently rejected the idea that instructional television represented a threat to the classroom teacher. When the total favorability scores of these teachers were compared with those of teachers who were not using instructional television, there were significant differences reported in favor of the television users. In addition, significantly more favorable attitudes were expressed by the 4th grade teachers when compared with the attitudes of the 9th grade teachers. No significant differences were found when training level or length of experience were considered as individual factors.

Of those studies which directly assessed the attitudes of teachers toward the use of instructional television or toward the use of television for science instruction, the attitudes of elementary teachers have generally been favorable.

In summarizing the recent studies, the following limitations are noted:

1. Most of the studies reported in the general literature on the effectiveness of learning by television as compared to conventional classroom instruction are not sufficiently definitive and do not have adequate design.
2. Most of the studies are general rather than specific in nature.
3. Assessment of student attitudes has been largely restricted to a direct question of the student's like or dislike for television instruction.
4. Little attention has been given to comparing the attitudes of teachers using television to those who are non-users.

One can therefore see that the questions raised in this study are ones which require continued study at the local school system level.

CHAPTER III

THE EXPERIMENTAL DATE - STUDENT ACHIEVEMENT

This study was conducted in several selected schools in the Gary Public Schools, Gary, Indiana, during the Spring semester of the 1962-63 school year. Six classes of students at the fifth grade level in two schools which were using the television course offerings of the Midwest Program on Airborne Television Instruction, Inc. for elementary science were included. Five classes of fifth grade students from schools of similar socio-economic level, student ability, and student achievement were evaluated in elementary science while operating under conventional teaching conditions. Specifically, at the fifth grade level, instruction in a unit on "Magnetism and Electricity" was evaluated. The instruction in both groups of classes began on January 16, 1963 and continued for a period of approximately seven weeks until March 5, 1963.

Classes in the schools which were using the instructional television offerings for elementary science viewed twenty minute telecasts two days a week. Teachers in these classes utilized the Resource Units[18] for this course in planning for preparatory and follow-up activities. Total time spent in viewing telecasts and in follow-up instruction was approximately two and one-half hours per week. Teachers in the conventional classes used a teaching guide for the unit which was prepared by the writer (see appendix). This teaching guide followed the identical format of the regular science

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[18]Burns, Exploring with Science: Resource Units in Science for 5th Grade Students, pp. 41-52.

curriculum guide for the Gary Public Schools. In objectives and content it was identical to the Resource Units for the program offerings of the Midwest Program on Airborne Television Instruction, Inc. Teachers in the conventional classrooms spent the same amount of time in science instruction as the television classes. This was approximately two and one-half hours per week.

Another group of students, from these same schools, was also evaluated as part of this study. These students were at the third grade level. Data from these students were treated separately from those classes at the fifth grade level. Five classes of students at the third grade level used the instructional telecasts of the Midwest Program on Airborne Television Instruction, Inc. for elementary science. Six classes of third grade students from conventional classrooms were also evaluated. These classes were in the same schools as the conventional classes at the fifth grade level.

The specific unit of instruction which was evaluated at the third grade level, was "Young Animals" and "Plants and Animals in the Spring." Instruction for this unit at the third grade level began on March 26, 1963, and continued for a period of approximately seven weeks until May 7, 1963. Classes at this grade level in the schools which were using the instructional television offerings, viewed twenty minute telecasts four days a week. Teachers in these classes utilized the Resource Units[19] for this course in planning for preparatory and follow-up activities. Total time spent in viewing telecasts and in follow-up instruction was approximately two and one-

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[19]Yanowski, The Science Corner: Resource Units - Elementary Science for 3rd and 4th Grade Students, pp. 78-91.

half hours per week. Teachers in the conventional classrooms used a teaching guide for the unit which was prepared by the writer (see appendix). This teaching guide followed the identical format of the regular science curriculum guide for the Gary Public Schools. In objectives and content, it was identical to the Resource Units for the program offerings of the Midwest Program on Airborne Television Instruction, Inc. Teachers in the conventional classrooms spent the same amount of time in science instruction as the television classes. This was approximately two and one-half hours per week.

All students included in this part of the study had taken the California Test of Mental Maturity as part of the normal testing program conducted by the Bureau of Research and Publication for the Gary Public Schools. Scores for the students at the fifth grade level were those which they had received during the regular fourth grade testing period in October, 1962. All students had taken the Short Form, Elementary, S Form of this test. The third grade students had taken the California Test of Mental Maturity: Short Form, Primary, S Form in October, 1962, while they were in the second grade. All scores are part of the cumulative records of the students and are recorded in the files of the Bureau of Research and Publications.

Students in both the television and conventional classes were administered pre-tests on the units of instruction on the class day preceding the beginning of instruction for these particular units of instruction. The pre-test for the fifth grade unit on "Magnetism and Electricity" and the pre-test for the third grade unit on "Young Animals" and "Plants and Animals in the Spring" were prepared by the writer (see appendix). Prior to this study, these tests were administered to other students at these grade levels who were not included in this study. From these administrations, item analysis were conducted and revision and selection of items for the tests used in this study were made. These same tests were also used as post-tests in this study. These were administered on the class day following the conclusion of instruction on these particular units of instruction.

The fifth grade test on "Magnetism and Electricity" consisted of a total of 63 items. There were 48 multiple choice type items and 15 true-false type items. In constructing the test an attempt was made to achieve balance in the number of items for each lesson objective. Students used separate answer sheets for these tests, and they were scored mechanically in the Bureau of Research and Publications.

The third grade test on "Young Animals" and "Plants and Animals in the Spring" was made up of a total of 80 responses. There were 28 multiple choice type items, 35 items which required a true-false type of response, and the remaining 17 items were of a simple matching type. At this grade level, the students responded directly on the test booklets, and these were hand scored by the writer.

To simplify the recording of data as well as the separation of data into different categories, a three by five card was prepared for each student listing the student's complete name, grade level, teacher's name, school of assignment, sex, and date of birth. Beneath this, other information was recorded. The squared and products of the scores which were of use in later computation were also listed on this card.

SAMPLE SUMMARY CARD

Student's Name	Grade Level	Teacher's Name	School	Sex	Date of Birth
	X_1 (CTMM score)		X_1^2		
	X_2 (Pre-Test score)		X_2^2		
	Y (Post-Test score)		Y^2		
	X_1X_2		X_1Y		
			X_2Y		

A summary card for each section was prepared listing the sums of each of these scores, squares, and products. These scores, squares, and products were then totaled for the television classes and the conventional classes. Summary sheets for the grade five data and the grade three data are incorporated in Table I and II in the Appendix.

If the _California Test of Mental Maturity_, pre-test, or post-test score for an individual student were not available, the student's card was rejected for purposes of tabulation and statistical analysis.

Frequency distributions of the _California Test of Mental Maturity_ scores, pre-test scores, and post-test scores were tallied and are reported in Tables I, II, III, IV, and V. All means and standard deviations were computed from ungrouped data. These results are believed to be more accurate than those calculated from frequency distributions because of the coarseness of grouping characteristic of frequency distributions. It was also necessary to have the totals for subsequent calculations.

One can note from Tables III and V that students in the conventional classes attained post-test scores higher than those of the students in the television classes. These results suggest that elementary grade students in this study did achieve at a higher level than those students in classes which utilized instructional television for selected units of study in elementary science. It should be clearly understood that these results do not justify a conclusion to the effect that conventional classroom instruction is superior to instruction with television, because there may be other factors - teacher differences within the conventional and television classes - which explain the greater achievement of the students in the conventional classes. This possibility will be explored and analyzed subsequently in this study.

The means for each teacher's class at the fifth grade level are listed in Table VI. These means were calculated using the ungrouped data from Table I of the Appendix. Preceding each mean is given the rank of that teacher's class; these are in parentheses. A rank of "(1)", for instance, indicates that the class of the given teacher was the highest listed in the group; the highest or largest number for a group indicates that the class of this teacher was the lowest in rank in the group.

Considering the students in the television classes, the table indicates that Teacher 2 had students who initially ranked highest on the California Test of Mental Maturity and the pre-test and ultimately highest on their post-test mean score. The post-test mean score for the class taught by Teacher 5 was secondest highest; his students ranked fourth on the California Test of Mental Maturity and third on the pre-test. This indicates that his class

TABLE I

CALIFORNIA TEST OF MENTAL MATURITY SCORES

Class Interval	Grade Five		Grade Three	
	Television	Conventional	Television	Conventional
156-160				1
151-155				
146-150			2	
141-145	1		2	2
136-140	1	1	3	3
131-135	3	1	3	12
126-130	1	2	8	3
121-125	9	7	13	8
116-120	13	14	19	10
111-115	9	11	10	15
106-110	15	9	18	13
101-105	24	34	15	22
96-100	14	18	17	18
91-95	16	19	12	17
86-90	23	14	13	20
81-85	17	17	5	11
76-80	4	8	4	14
71-75	6	10	1	3
66-70	3	2		3
61-65		2	1	
56-60				
51-55	1			
N	160	169	146	175
Mean	99.14	97.76	107.23	102.27
Sigma	15.71	15.03	16.15	17.69
Grade Total	N	329	N	321
	Mean	98.43	Mean	104.52
	Sigma	15.38	Sigma	17.45

TABLE II

PRE-TEST SCORES
GRADE FIVE

Class Interval	Television		Conventional
45-47		2	
42-44			
39-41		1	
36-38		3	1
33-35		4	6
30-32		20	13
27-29		29	20
24-26		39	44
21-23		36	45
18-20		18	32
15-17		6	7
12-14		1	1
9-11		1	
N		160	169
Mean		25.28	23.85
Sigma		5.36	4.52
Grade Total	N	329	
	Mean	24.54	
	Sigma	4.99	

TABLE III

POST-TEST SCORES
GRADE FIVE

Class Interval		Television	Conventional
54-56		1	2
51-53			3
48-50		4	8
45-47		5	9
42-44		6	7
39-41		14	23
36-38		12	16
33-35		21	15
30-32		27	24
27-29		28	17
24-26		21	25
21-23		14	13
18-20		5	3
15-17		1	4
12-14		1	
N		160	169
Mean		31.54	33.41
Sigma		7.51	8.74
Grade Total	N	329	
	Mean	32.50	
	Sigma	8.22	

TABLE IV

PRE-TEST SCORES
GRADE THREE

Class Interval	Television		Conventional
64-66		2	4
61-63		9	4
58-60		3	14
55-57		19	10
52-54		25	27
49-51		22	38
46-48		24	27
43-45		16	19
40-42		10	15
37-39		10	10
34-36		4	4
31-33		1	2
28-30		1	1
N		146	175
Mean		49.12	48.93
Sigma		7.18	6.94
Grade Total	N	321	
	Mean	49.02	
	Sigma	7.05	

TABLE V

POST-TEST SCORES
GRADE THREE

Class Interval		Television	Conventional
73-75			8
70-72			17
67-69		6	18
64-66		11	27
61-63		21	22
58-60		22	22
55-57		26	24
52-54		13	12
49-51		16	13
46-48		10	3
43-45		9	3
40-42		9	3
37-39		3	3
N		146	175
Mean		54.86	60.42
Sigma		7.51	8.15
Grade Total	N	321	
	Mean	57.89	
	Sigma	8.35	

achieved post-test scores which were higher than those expected from the initial test data. The class taught by Teacher I showed next to the lowest post-test mean score, but it should be noted that his students ranked third on the intelligence test and fourth on the pre-test.

Within the conventional group of classes for this grade level, there are also differences between rankings on the intelligence test and the pre-test as compared to ranking on the post-test. The class of Teacher 3 within this group showed the highest post-test score; however, this class ranked fourth on the intelligence test score and second on the pre-test. The class of Teacher 4 within this group ranked second highest on the post-test while they ranked second on the intelligence test and fifth on the pre-test. The class of Teacher 5 ranked first on the intelligence test and third on the pre-test, but they ranked fourth on their mean score for the post-test.

One may note, in general, that the _California Test of Mental Maturity_ and pre-test scores for the conventional classes were lower than those of the classes using television; however, the mean scores of the conventional classes on the post-test were higher.

The means on the _California Test of Mental Maturity_, pre-test, and post-test for the grade three students were calculated using the ungrouped data from Table II of the Appendix. These means are listed in Table VII. As in Table VI the rank of each teacher's class is listed in parentheses preceding each score. One may also note within this grade level, that the _California Test of Mental Maturity_ and pre-test scores for the conventional classes were lower than those of the television classes; however, the mean

TABLE VI

RANK ON CTMM, PRE-TEST, AND POST-TEST SCORES
GRADE FIVE DATA

Teacher	N	CTMM Scores		Pre-Test Scores		Post-test Scores	
		Mean	Sigma	Mean	Sigma	Mean	Sigma
TV							
1	29	(3) 102.17	15.89	(4) 25.55	5.03	(5) 29.48	6.84
2	27	(1) 107.67	12.04	(1) 27.52	6.20	(1) 37.70	7.27
3	22	(6) 91.32	14.78	(6) 23.18	4.41	(4) 30.14	5.60
4	24	(2) 105.17	15.70	(2) 25.88	4.70	(3) 31.88	7.18
5	31	(4) 95.77	16.18	(3) 25.71	6.13	(2) 32.35	7.97
6	27	(5) 92.22	11.07	(5) 23.30	3.63	(6) 27.52	5.03
TV Total	160	99.14	15.71	25.28	5.36	31.54	7.51
Conventional							
1	36	(5) 94.28	15.38	(1) 24.64	4.38	(5) 28.47	7.15
2	38	(3) 96.84	16.91	(4) 23.21	4.93	(3) 30.95	7.30
3	32	(4) 96.78	11.84	(2) 24.56	4.32	(1) 42.50	7.04
4	38	(2) 98.39	14.75	(5) 22.76	4.35	(2) 35.18	7.59
5	25	(1) 104.44	13.31	(3) 24.40	4.10	(4) 29.96	6.62
Conv. Total	169	97.76	15.03	23.85	4.52	33.41	8.74
Grade Total	329	98.43	15.38	24.54	4.99	32.50	8.22

TABLE VII

RANK ON CTMM, PRE-TEST, AND POST-TEST SCORES
GRADE THREE DATA

Teacher	N	CTMM Scores		Pre-test Scores		Post-test Scores	
		Mean	Sigma	Mean	Sigma	Mean	Sigma
TV							
1	31	(4) 105.58	16.31	(1) 53.97	5.88	(1) 59.58	6.12
2	22	(5) 100.23	17.64	(5) 45.82	8.12	(5) 51.14	7.99
3	31	(2) 108.97	14.47	(3) 48.42	6.38	(3) 54.29	6.89
4	32	(1) 113.03	11.32	(2) 50.16	5.65	(2) 56.22	6.34
5	30	(3) 106.07	18.36	(4) 46.17	6.92	(4) 51.87	7.39
TV Total	146	107.23	16.15	49.12	7.18	54.86	7.51
Conventional							
1	28	(6) 93.57	13.66	(5) 46.54	6.09	(5) 54.14	6.24
2	25	(5) 97.20	15.38	(4) 46.96	7.45	(6) 53.28	7.99
3	34	(2) 107.09	18.52	(3) 47.85	5.36	(3) 62.50	5.98
4	30	(4) 101.33	17.86	(1) 53.37	5.21	(2) 65.50	5.74
5	32	(3) 102.34	14.97	(6) 46.34	8.06	(4) 59.78	7.25
6	26	(1) 111.19	19.18	(2) 52.88	4.88	(1) 66.27	5.69
Conv. Total	175	102.27	17.69	48.93	6.94	60.42	8.15
Grade Total	321	104.52	17.45	49.02	7.05	57.89	8.35

scores of the conventional classes on the post-test were higher than those of the television classes. This is similar to the data for the students at the fifth grade level.

CHAPTER IV

STATISTICAL ANALYSIS OF THE DATA - STUDENT ACHIEVEMENT

ANALYSIS OF COVARIANCE

The fifth grade and third grade data were separately subjected to analysis of covariance. This technique has the advantage of making it possible to compensate for any initial lack of equivalence of the groups participating in the experiment as measured by the pre-test and the general intelligence test mentioned.

Before an analysis of variance and covariance can be made there are certain assumptions which must be satisfied. It is assumed in an analysis of variance and covariance that the population variances from which the samples have been drawn are equal; thus, it is to be expected that estimates of the population variance differ only within the limits of random sampling.

Since the analysis was made separately for the fifth grade students and the third grade level, tests for the homogeneity of variance at each grade level were made using the Bartlett test for unequal n's.[20] In this method the test of significance is made by means of χ^2. The χ^2 test attempts to answer the question as to how likely the variances of the measures are the same except for chance. The degrees of freedom is one less than the number of samples or r - 1.

In Table VIII the χ^2 value of 7.8273, d.f. = 10, is indicative of a P = 0.65. This indicates that merely as a result of chance the variances

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[20]Allen L. Edwards, Experimental Design in Psychological Research (New York: Rinehart, 1950), pp. 197-198.

TABLE VIII

BARTLETT'S TEST FOR HOMOGENEITY OF VARIANCE
GRADE FIVE DATA

Teacher	n	n-1	$\frac{1}{n-1}$	$\sum x^2$	s^2	log s^2	(n-1)(log s^2)
TV							
1	29	28	0.035714	1,355	48.3925	1.68478	47.17384
2	27	26	0.038462	1,426	54.8468	1.73915	45.21790
3	22	21	0.047619	689	32.8095	1.51600	31.83600
4	24	23	0.043478	1,237	53.7823	1.73064	39.80472
5	31	30	0.033333	1,971	65.6993	1.81757	54.52710
6	27	26	0.038462	709	27.2696	1.43568	37.32768
Conv.							
1	36	35	0.028571	1,839	52.5421	1.72051	60.21785
2	38	37	0.027027	2,028	54.8108	1.73878	64.33486
3	32	31	0.032258	1,588	51.2257	1.70949	52.99419
4	38	37	0.027027	2,190	59.1891	1.77226	65.57362
5	25	24	0.041667	1,095	45.6254	1.65921	39.82104
Total		318	0.393618	16,127			538.82880

Computations:

1. $\frac{\sum \sum x^2}{(n-1)} = \frac{16,127}{318} = 50.7138$; log 50.7138 = 1.70512

2. $\left[\sum(n-1)\right]\left[\log \frac{\sum \sum x^2}{\sum(n-1)}\right] = 318(1.70512) = 542.22816$

3. Diff. $= \left[\sum(n-1)\right]\left[\log \frac{\sum \sum x^2}{\sum(n-1)}\right] - \sum(n-1)(\log s^2)$

$= 542.22816 - 538.82880 = 3.39936$

4. $\chi^2 = (2.3026)\,(\text{diff.}) = 2.3026(3.39936) = 7.82737$

From table of χ^2, using df = r - 1 = 10, this gives a P = 0.65. Therefore, assumption of homogeneity of variance is accepted.

TABLE IX

BARTLETT'S TEST FOR HOMOGENEITY OF VARIANCE
GRADE THREE DATA

Teacher	n	n-1	$\frac{1}{n-1}$	$\sum x^2$	s^2	log s^2	(n-1)(log s^2)
TV							
1	31	30	0.033333	1,162	38.7329	1.58808	47.64240
2	22	21	0.047619	1,405	66.9047	1.82544	38.33424
3	31	30	0.033333	1,470	48.9995	1.69020	50.70600
4	32	31	0.032258	1,287	41.5160	1.61822	50.16482
5	30	29	0.034483	1,639	56.5176	1.75218	50.81322
Conv.							
1	28	27	0.037037	1,091	40.4074	1.60646	43.37442
2	25	24	0.041667	1,595	66.4589	1.82256	43.74144
3	34	33	0.030303	1,218	36.9091	1.56713	51.71529
4	30	29	0.034483	987	34.0347	1.53192	44.42568
5	32	31	0.032258	1,681	54.2257	1.73421	53.76051
6	26	25	0.040000	840	33.6000	1.52634	38.15850
Total		310	0.396774	14,375			512.83652

Computations:

1. $\frac{\sum \sum x^2}{(n-1)} = \frac{14,375}{310} = 46.3710$; log 46.3710 = 1.66625

2. $\left[\sum (n-1)\right] \left[\log \frac{\sum \sum x^2}{\sum (n-1)}\right] = 310(1.66625) = 516.53750$

3. Diff. $= \left[\sum (n-1)\right] \left[\log \frac{\sum \sum x^2}{\sum (n-1)}\right] - \sum (n-1)(\log s^2)$

   $= 516.53750 - 512.83652 = 3.70098$

4. $\chi^2 = (2.3026)(\text{diff.}) = 2.3026(3.70098) = 8.52187$

From table of χ^2, using df = r - 1 = 10, this gives a P = 0.58. Therefore, assumption of homogeneity of variance is accepted.

in sixty-five times out of a hundred could differ as they do. This is not regarded as significant, and therefore the assumption of homogeneity of variance for the fifth grade data can be accepted.

A probability of 0.58 for the third grade data, Table IX, again justifies the acceptance of the assumption of the homogeneity of variance.

When the assumption of homogeneity of variance is not satisfied, experimental differences may be due to differences in the variability of the groups compared rather than to the differences in average achievement usually regarded as evidence of the comparative effectiveness of the instructional methods studied.

The analysis of covariance also assumes that there are no real differences among the group regressions. This assumption is necessary because the adjusted sum of squares for a group is measured by the sum of the squared deviations from the regression line for that group based on the common within groups regression coefficient.[21] Thus there must be no real difference between the group regressions.

Homogeneity of regression, i.e. significantly different regression coefficients for the compared groups, in addition to reducing the dependability of the adjustments made in the achievement means and the estimate of experimental error (the adjusted within groups variance) may indicate the compared methods vary in relative effectiveness for different levels of initial ability thus suggesting a different type of analysis such as the methods by levels design.

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[21]E. F. Lindquist, Design and Analysis of Experiments in Psychology and Education (Cambridge: Riverside Press, 1953), p. 330.

The test for homogeneity of regression for the fifth grade and the third grade data was made using the method described by Lindquist.[22] The data for these tests are summarized in Tables X and XI. Since the F ratios are not significant, one may conclude that the assumptions of homogeneity of regression are satisfied.

The sums of squares and products of Tables X and XI were calculated from the individual group data of Tables I and II of Appendix I by means of formulas of this type:

$$\sum x_1^2 = \sum X_1^2 - \frac{(\sum X_1)^2}{n}$$ where n is size of given group

$$\sum x_1 y = \sum X_1 Y - \frac{\sum X_1 \sum Y}{n}$$

The following formulas were employed in calculating the regression coefficients and the errors of estimate using the data given to the left of these statistics in each line of Table X and XI.

Regression Coefficients: use data from each line

$$b_{x_1} = \frac{\sum x_1 y \sum x_2^2 - \sum x_2 y \sum x_1 x_2}{\sum x_1^2 \sum x_2^2 - (\sum x_1 x_2)^2}$$

$$b_{x_2} = \frac{\sum x_2 y \sum x_1^2 - \sum x_1 y \sum x_1 x_2}{\sum x_1^2 \sum x_2^2 - (\sum x_1 x_2)^2}$$

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[22]Ibid., pp. 330-331.

TABLE X

TEST FOR HOMOGENEITY OF REGRESSION
GRADE FIVE DATA

Teacher	n	Sums of Squares and Products						Regression Coefficients		Errors of Estimate	
		Σx_1^2	Σx_2^2	Σx_1x_2	Σx_1y	Σx_2y	[illegible]	b_{x_1}	b_{x_2}	$\Sigma' y^2$	d.f.
TV											
1	29	7,330	735	611	1,946	600	55	0.2121	0.6399	558.3134	26
2	27	3,918	1,039	872	1,038	587	26	0.2420	0.4213	927.5009	24
3	22	4,805	427	512	249	98	89	0.9371	0.1918	660.9657	19
4	24	5,921	531	785	1,674	484	37	0.2013	0.6138	634.0554	21
5	31	8,117	1,164	2,013	2,427	1,147	71	-0.1767	0.8199	1,459.4256	28
6	27	3,311	354	- 103	182	67	09	0.0061	0.2071	694.0141	24
Conv.											
1	36	8,512	690	408	1,367	726	39	0.1133	0.9851	968.9363	33
2	38	10,872	924	1,267	2,665	628	28	0.1974	0.4088	1,275.2026	35
3	32	4,489	598	330	855	464	88	0.1390	0.6991	1,144.7726	29
4	38	8,264	719	1,069	1,824	548	90	0.1512	0.5373	570.2292	35
5	25	4,428	420	652	1,326	402	95	0.2054	0.6381	566.1234	22
	329	69,967	7,601	8,416	15,553	5,751	27	0.1514	0.5888	9,459.5392	296

d.f. = three less than the number of students

Continued from Page 48

	Degrees of freedom	Errors of Estimate	
		Sum of squares	Variance
Deviations from average regression within groups	316	10,066.97	31.85
Deviations from individual group regressions	296	9,459.53	31.95
Differences among group regressions	20	607.44	30.37

d.f. for within groups variance = N - n - i where N = total number of students

= 329 - 11 - 2 = 316 n = number of groups

i = number of initial tests

F = 30.37/31.95 = 0.9503, for 20 and 296 d.f.

This F ratio is not significant, and the null hypothesis for homogeneity of regression is accepted.

Deviations from average regression within groups value is obtained by multiplying total Σy^2 value from the first part of table by

$$1 - R^2_{y.x_1x_2}$$ (Table XIII, page 57)

The value for individual group regressions is the total value, $\Sigma' y^2$, from the first part of table.

The value for differences among group regressions is obtained by subtracting the values listed above.

TABLE XI

TEST FOR HOMOGENEITY OF REGRESSION
GRADE THREE DATA

Teacher	n	Sums of Squares and Products						Regression Coefficients		Errors of Estimate	
		Σx_1^2	Σx_2^2	Σx_1x_2	Σx_1y	Σx_2y	Σy^2	b_{x_1}	b_{x_2}	$\Sigma' y^2$	d.f.
TV											
1	31	8,158	1,073	1,535	1,376	877	1,162	0.0203	0.7882	442.8158	28
2	22	6,844	1,451	1,919	1,181	996	1,405	0.0316	0.7282	717.0324	19
3	31	6,495	1.262	1,159	1,431	947	1,470	0.1033	0.6554	701.5139	28
4	32	4,103	1,024	651	680	767	1,287	0.0521	0.7158	702.5534	29
5	30	10,116	1,438	2,054	2,707	985	1,639	0.1810	0.4264	729.0290	27
Conv.											
1	28	5,221	1,039	1,0[illegible]	980	680	1,091	0.0735	0.5819	623.2780	25
2	25	5,914	1,387	1,547	1,681	905	1,595	0.1603	0.4736	896.9277	22
3	34	11,663	976	1,578	2,202	655	1,218	0.1254	0.4682	635.1982	31
4	30	9,571	815	1,286	1,342	244	987	0.1268	0.0991	792.6540	27
5	32	7,169	2,083	2,062	2,224	1,390	1,681	0.1653	0.5035	613.5078	29
6	26	9,566	619	1,085	1,498	335	841	0.1188	0.3328	551.5496	23
	321	84,820	13,167	15,900	17,302	8,781	14,376	0.1020	0.5436	7,406.0598	288

d.f. = three less than the number of students

Continued from Page 50

	Degrees of freedom	Errors of Estimate	
		Sum of squares	Variance
Deviations from average regression within groups	308	7,839.20	25.45
Deviations from individual group regressions	288	7,406.05	25.71
Differences among group regressions	20	433.15	21.65

d.f. for within groups variance = N - n - i where N = total number of students

= 321 - 11 - 2 = 308 n = number of groups

i = number of initial tests

F = 21.65/25.71 = 0.8420, for 20 and 288 d.f.

This F ratio is not significant, and the null hypothesis for homogeneity of regression is accepted.

Errors of Estimate: use regression coefficient and data in each line

$$\sum{}' y^2 = \sum y^2 - b_{x_1} \sum x_1 y - b_{x_2} \sum x_2 y$$

A non-significant F is necessary in order to satisfy the basic assumption of homogeneity of regression. One may accept the assumption if F is non-significant below the 10% level.

A significant F would indicate that the effectiveness of the compared methods is related to the ability levels of the students as measured by the initial tests. This would then suggest further study using the methods by levels design.

The logic of the F test here may be more clear if one thinks of regression lines rather than the regression planes involved where there are three variables. Visualize lines for each group and an average regression line for all groups. According to the theory of least squares if one considers a single line for one of the groups, the summation of squared deviations from this line will be less than the summation of squared deviations of the same points from any other line including the average regression line. Thus the summation of all squared deviations from their respective group regression lines will be less than the sum from the average regression line. If all of the group lines are similar in direction or slope to the average regression line, the differences among group regressimns, the difference just referred to, will be smaller than if the directions or slopes are markedly different thus leading to a smaller and possible non-significant F.

The term "errors of estimate" has the same meaning as in the more typical use of regression equations. The usual standard error of estimate is the standard deviation of the deviates from a regression line (the square root of the sum of squares of the deviates or errors of estimate from the regression line divided by N); this is more easily computed from the appropriate standard deviation and correlation or multiple coefficient.

Since the data satisfied the fundamental assumptions of homogeneity of variance and homogeneity of regression, an analysis of covariance, with the California Test of Mental Maturity scores and pre-test scores as the initial variables, was made.

The data necessary for an analysis of covariance were compiled from the summary card of each student.[23] The totals for each score, for the square of each score, and for the products of any two scores were summed for each teacher within each group, television and conventional, at the fifth and third grade levels.

The sums of squares and of products for the different sources of variation were computed as follows:

> The sums of squares and products for total, for between groups, and for within groups were computed from the appropriate data of Tables I and II of Appendix I by means of the equations listed below. The symbol x_1 refers to the California Test of Mental Maturity scores, x_2 to pre-test scores, and Y to post-test scores. Where no other subscript is given summation is over all N scores. Where the subscripts a, b, etc. appear summation is over the scores of a given group.

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[23]See page 32 - Chapter III.

For total:

$$\sum x_1^2 = \sum X_1^2 - \frac{(\sum X_1)^2}{N}$$

$$\sum x_2^2 = \sum X_2^2 - \frac{(\sum X_2)^2}{N}$$

$$\sum y_2 = \sum Y^2 - \frac{(\sum Y)^2}{N}$$

$$\sum x_1 x_2 = \sum X_1 X_2 - \frac{\sum X_1 \sum X_2}{N}$$

$$\sum x_1 y = \sum X_1 Y - \frac{\sum X_1 \sum Y}{N}$$

$$\sum x_2 y = \sum X_2 Y - \frac{\sum X_2 \sum Y}{N}$$

For between groups: (Dots refer to terms for other groups)

$$\sum x_1^2 = \frac{(\sum X_{1a})^2}{N_a} + \frac{(\sum X_{1b})^2}{N_b} + \cdots\cdots\cdot - \frac{(\sum X_1)^2}{N}$$

$$\sum x_2^2 = \frac{(\sum X_{2a})^2}{N_a} + \frac{(\sum X_{2b})^2}{N_b} + \cdots\cdots\cdot - \frac{(\sum X_2)^2}{N}$$

$$\sum y^2 = \frac{(\sum Y_a)^2}{N_a} + \frac{(\sum Y_b)^2}{N_b} + \cdots\cdots\cdot - \frac{(\sum Y)^2}{N}$$

$$\sum x_1 x_2 = \frac{\sum X_{1a} \sum X_{2a}}{N_a} + \frac{\sum X_{1a} \sum X_{2b}}{N_b} + \cdots\cdots\cdot - \frac{\sum X_1 \sum X_2}{N}$$

$$\sum x_1 y = \frac{\sum X_{1a} \sum Y_a}{N_a} + \frac{\sum X_{1b} \sum Y_b}{N_b} + \cdots\cdots\cdot - \frac{\sum X_1 \sum Y}{N}$$

$$\sum x_2y = \frac{\sum X_{2a} \sum Y_a}{N_a} + \frac{\sum X_{2b} \sum Y_b}{N_b} + \ldots\ldots - \frac{\sum X_2 \sum Y}{N}$$

For <u>within</u> groups $\sum x_1^2$, $\sum x_2^2$, $\sum y^2$, $\sum x_1x_2$, $\sum x_1y$, $\sum x_2y$ was obtained by subtracting the computed <u>between</u> value from the computed <u>total</u> value.

To afford a check on the accuracy of the calculation the within groups sums of squares and products were computed using the equations

$$\sum x_1^2 = \sum X_1^2 - \left[\frac{(\sum X_{1a})^2}{N_a} + \frac{(\sum X_{1b})^2}{N_b} + \ldots\ldots\right]$$

$$\sum x_2^2 = \sum X_2^2 - \left[\frac{(\sum X_{2a})^2}{N_a} + \frac{(\sum X_{2b})^2}{N_b} + \ldots\ldots\right]$$

$$\sum y^2 = \sum Y^2 - \left[\frac{(\sum Y_a)^2}{N_a} + \frac{(\sum Y_b)^2}{N_b} + \ldots\ldots\right]$$

$$\sum x_1x_2 = \sum X_1X_2 - \left[\frac{\sum X_{1a} \sum X_{2a}}{N_a} + \frac{\sum X_{1b} \sum X_{2b}}{N_b} + \ldots\ldots\right]$$

$$\sum x_1y = \sum X_1Y - \left[\frac{\sum X_{1a} \sum Y_a}{N_a} + \frac{\sum X_{1b} \sum Y_b}{N_b} + \ldots\ldots\right]$$

$$\sum x_2y = \sum X_2Y - \left[\frac{\sum X_{2a} \sum Y_a}{N_a} + \frac{\sum X_{2b} \sum Y_b}{N_b} + \ldots\ldots\right]$$

The data for the fifth grade level are summarized in Table XII.

TABLE XII

SUMS OF SQUARES AND PRODUCTS
GRADE FIVE DATA

	Σx_1^2	Σx_2^2	Σx_1x_2	Σx_1y	Σx_2y	Σy^2	Adjusted or reduced sum of squares $\Sigma' y^2$	d.f.	Adjusted or reduced variance
Between groups	7,879	617	1,417	1,871	436	6,108	5,674.69	10	567.47
Within groups	69,964	7,601	8,415	16,553	5,751	16,127	10,066.97	316	31.85
Total	77,843	8,218	9,832	18,424	6,187	22,235	15,741.66		

$$F = \frac{\text{reduced between}}{\text{adjusted within}} = \frac{567.47}{31.85} = 17.8169$$

d.f. for between groups = number of groups - 1 = 11 - 1 = 10

d.f. for within groups = N - n - i where N is total number of students

= 329 - 11 - 2 n is number of groups

= 316 i is number of initial tests

Since the F value exceeds the 1% level value of 2.39, the F test is concluded to be significant at the 1% level.

TABLE XIII

CORRELATION COEFFICIENTS
GRADE FIVE DATA

	$r_{x_1x_2}$	r_{x_1y}	r_{x_2y}	$R_{y.x_1x_2}$
Total groups	0.3887	0.4428	0.4576	0.5404
Within groups	0.3649	0.4927	0.5194	0.6130

The adjusted or reduced sum of square data of Table XII were obtained by calculating the Pearson product-moment correlation coefficient from the total group and within groups data. From these the multiple coefficients of correlation, R, for the total group and the within groups data were computed. The adjusted or reduced sum of squares column of Table XII was obtained by multiplying the appropriate original Σy^2 value for the total group by one minus the square of the total multiple coefficient R and the Σy^2 value for the within groups by one minus the square of the within multiple coefficient.

The coefficients for the fifth grade data are summarized in Table XIII.

The adjusted or reduced variance is obtained by dividing the adjusted or reduced sum of squares by the appropriate degrees of freedom.

Since the F ratio is significant at the 1% level, adjusted total score means were computed for each teacher's class using regression coefficients based on the within groups data. The adjusted mean is equal to the original mean minus a correction for the initial California Test of Mental Maturity score minus a correction for the initial pre-test score. The correction, c_1 and c_2, was obtained by multiplying the regression coefficients b_{x_1} (for the California Test of Mental Maturity scores) and b_{x_2} (for the pre-test scores) by the difference between the original mean and the grand mean.

Where the California Test of Mental Maturity and pre-test means of a group are above the general means this results in a lowered adjusted achievement of post-test mean. Conversely, where the California Test of Mental Maturity and pre-test means are lower than the general means this results in a higher adjusted post-test mean.

Table XIV lists the California Test of Mental Maturity score correction factors and the pre-test score correction factors for the fifth grade data.

Using the adjusted achievement score means of Table XIV, t tests of the difference between adjusted means were computed using Wishart's formula for the error of a difference.[24] The formula used is

$$\sigma \text{ diff} = \sqrt{V \left(G + \frac{N_a + N_b}{N_a N_b} \right)}$$

where V = adjusted within groups variance

$$G = \frac{(M_{x1a} - M_{x1b})^2 \sum x_1^2 - 2\,(M_{x2a} - M_{x2b})\,(M_{x1a} - M_{x1b}) \sum x_1 x_2 \ (M_{x2a} - M_{x2b})^2 \sum x_2^2}{\sum x_1^2 \sum x_2^2 - (\sum x_1 x_2)^2}$$

and N_a and N_b are the sizes of groups a and b respectively.

Using this standard error of the difference between the adjusted means; a t test of this difference was computed. The computed t was compared for significance with standard t tables[25] using degrees of freedom = $N_1 + N_2 - 2$.[26]

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[24] Jim Schunert, "The Association of Mathematical Achievement with Certain Factors Resident in the Teacher, in the Teaching, in the Pupil, and in the School," Journal of Experimental Education, XIX, (March, 1951), p. 227.

[25] J. P. Guilford, Fundamental Statistics in Psychology and Education (New York: McGraw-Hill, 1956), p. 539.

[26] Ibid., p. 220.

TABLE XIV

ADJUSTED ACHIEVEMENT SCORE MEANS
GRADE FIVE DATA

Teacher	N	TMM Score			Pre-Test Score			Post-Test Score	
		Mean X_1	Differences between mean and grand mean	b_{x_1} times difference between mean and grand mean (c_1)	Mean X_2	Differences between mean and grand mean	b_{x_2} times difference between mean and grand mean (c_2)	Post-Test Mean	Adjusted mean = original mean $-c_1$ $-c_2$
1	29	102.17	+3.74*	+0.56	25.55	+1.01*	+0.59	29.48	28.33
2	27	107.67	+9.24	+1.39	27.52	+2.98	+1.75	37.70	34.56
3	22	91.32	-7.11	-1.07	23.18	-1.36	-0.80	30.14	32.01
4	24	105.17	+6.74	+1.02	25.88	+1.34	+0.78	31.88	30.08
5	31	95.77	-2.66	-0.40	25.71	+1.17	+0.68	32.35	32.07
6	27	92.22	-6.21	-0.94	23.30	-1.24	-0.73	27.52	29.19
TV Total	160	99.14	+0.71	+0.10	25.28	+0.74	+0.43	31.54	31.01
Conv. 1	36	94.28	-4.15	-0.62	24.64	+0.10	+0.05	28.47	29.04
2	38	96.84	-1.59	-0.24	23.21	-1.33	-0.78	30.95	31.97
3	32	96.78	-1.65	-0.24	24.56	+0.02	+0.01	42.50	42.73
4	38	98.39	-0.04	0.00	22.76	-1.78	-1.04	35.18	36.22
5	25	104.44	+6.01	+0.90	24.40	-0.14	-0.08	29.96	29.14
Conv. Total	169	97.76	-0.67	-0.10	23.85	-0.69	-0.40	33.41	33.91
Grand Total	329	98.43			24.54			32.50	

* Negative sign indicates that mean is less than grand mean
Positive sign indicates that mean is more than grand mean

$b_{x_1} = 0.1515$ $b_{x_2} = 0.5888$

The results of these t tests are summarized below:

Teacher 3 (conventional):	over Teacher 1 (television)[27]
	over Teacher 2 (television)
	over Teacher 3 (television)
	over Teacher 4 (television)
	over Teacher 5 (television)
	over Teacher 6 (television)
	over Teacher 1 (conventional)
	over Teacher 2 (conventional)
	over Teacher 4 (conventional)
	over Teacher 5 (conventional)
Teacher 4 (conventional):	over Teacher 1 (television)
	over Teacher 3 (television)- 5% level
	over Teacher 4 (television)
	over Teacher 5 (television)
	over Teacher 6 (television)
	over Teacher 1 (conventional)
	over Teacher 2 (conventional)
	over Teacher 5 (conventional)
Teacher 2 (television):	over Teacher 1 (television)
	over Teacher 4 (television)
	over Teacher 6 (television)
	over Teacher 1 (conventional)

[27] Unless noted otherwise, the t tests revealed differences which were significant at the 1% level.

Teacher 2 (television) continued

	over Teacher 5 (conventional)
Teacher 5 (television):	over Teacher 1 (television)- 5% level
	over Teacher 1 (conventional)-5% level
Teacher 3 (television):	over Teacher 1 (television)-5% level
Teacher 2 (conventional:	over Teacher 1 (television)-5% level

In attempting to interpret these results, it is apparent that Teacher 3 (conventional) and Teacher 4 (conventional) were largely responsible for the difference which occured between the post-test score means of the television group and the conventional classroom group. The class of Teacher 3 (conventional) achieved post-test mean scores which were significantly higher than all other classes in both the conventional and television groups. Likewise, the class of Teacher 4 (conventional) achieved post-test scores with a mean which was significantly higher than all but one of the television classes, that of Teacher 2.

The significant F can therefore be attributed to the differences just described, as well as those indicated in the summary of the t test findings, rather than to differences between television instruction and conventional instruction. Thus these differences were among classes taught by different teachers rather than between the television and conventional classes. The F test is merely an overall test indicating significant differences among some of the comparisons.

The data at the third grade level were similarly analyzed. Since the required assumptions regarding variance and regression had been satisfied, an analysis of covariance was made for the grade three data.

TABLE XV

SUMS OF SQUARES AND PRODUCTS
GRADE THREE DATA

	Σx_1^2	Σx_2^2	Σx_1x_2	Σx_1y	Σx_2y	Σy^2	Adjusted or reduced sum of squares $\Sigma' y^2$	d.f.	Adjusted or reduced variance
Between groups	9,977	2,790	2,037	2,451	3,506	7,996	10,219.73	10	1,021.97
Within groups	84,819	13,166	15,901	17,303	8,782	14,379	7,839.20	308	25.45
Total	94,796	15,956	17,938	19,754	12,288	22,375	18,958.93		

$$F = \frac{\text{reduced between}}{\text{adjusted within}} = \frac{1,021.97}{25.45} = 40.1559$$

d.f. for between groups = number of groups - 1 = 11 - 1 = 10
d.f. for within groups = N - n - i, where N is total number of students
= 321 - 11 - 2 n is number of groups
= 308 i is number of initial tests

Since the F value exceeds the 1% level value, the F test is concluded to be significant at the 1% level.

TABLE XVI

CORRELATION COEFFICIENTS
GRADE THREE DATA

	$r_{x_1x_2}$	r_{x_1y}	r_{x_2y}	$R_{y \cdot x_1x_2}$
Total groups	0.4612	0.4289	0.2820	0.4392
Within groups	0.4758	0.4954	0.6382	0.6744

The correlation coefficients necessary to calculate the adjusted or reduced sum of square data of Table XV are given in Table XVI.

Since the F ratio was signficant beyond the 1% level, adjusted post-test score means were computed for all classes and the total television and total conventional classes. Wishart's formula for the error of a difference was used to compute t tests of the difference between adjusted means.

Results of the t test computations indicate that there are differences between the conventional class totals and the television class totals which favor the conventional classes.

Differences between individual classes were also checked for significance. The differences are significant at the 1% level unless noted otherwise. The differences are as follows:

Teacher 6 (conventional): over Teacher 1 (television)
over Teacher 2 (television)
over Teacher 3 (television)
over Teacher 4 (television)
over Teacher 5 (television)
over Teacher 1 (conventional)
over Teacher 2 (conventional)

Teacher 4 (conventional): over Teacher 1 (television)
over Teacher 2 (television)
over Teacher 3 (television)
over Teacher 4 (television)
over Teacher 5 (television)
over Teacher 1 (conventional)

TABLE XVII -

ADJUSTED ACHIEVEMENT SC ANS
GRADE THREE DAT

Teacher	N	CTMM Score: Mean X_1	CTMM Score: Differences between mean and grand mean	CTMM Score: c_1 b_{x_1} times difference between mean and grand mean	Pre-Test Score: Mean X_2	Pre-Test Score: Differences between mean and grand mean	Pre-Test Score: c_2 b_{x_2} times difference between mean and grand mean	Post-Test Score: Post-Test Mean	Post-Test Score: Adjusted mean = original mean $-c_1 -c_2$
TV 1	31	105.58	+1.06*	+0.11	53.97	4.[illegible]5*	+2.69	59.58	56.78
2	22	100.23	-4.29	-0.44	45.82	3.20	-1.74	51.14	53.32
3	31	108.97	+4.45	+0.45	48.42	0.60	-0.33	54.29	54.17
4	32	113.03	+8.51	+0.87	50.16	1.14	+0.62	56.22	54.73
5	30	106.07	+1.55	+0.16	46.17	2.85	-1.55	51.87	53.26
TV Total	146	107.23	+2.71	+0.28	49.12	0.10	+0.05	54.86	54.53
Conv. 1	28	93.57	-10.95	-1.12	46.54	2.48	-1.35	54.14	56.61
2	25	97.20	- 7.32	-0.75	46.96	2.06	-1.12	53.28	55.15
3	34	107.09	+ 2.57	+0.26	47.85	1.17	-0.64	62.50	62.88
4	30	101.33	- 3.19	-0.33	53.37	4.35	+2.36	65.50	63.47
5	32	102.34	- 2.18	-0.22	46.34	2.68	-1.46	59.78	61.46
6	26	111.19	+ 6.67	+0.68	52.88	3.86	+2.10	66.27	63.49
Conv. Total	175	102.27	- 2.25	-0.23	48.93	.09	-0.05	60.42	60.70
Grand Total	321	104.52			49.02			57.89	

* negative sign indicates that mean is less than grand mean
positive sign indicates that mean is more than grand mean
$b_{x_1} = 0.1020$ $b_{x_2} = 0.5436$

Teacher 4 (conventional) continued

	over Teacher 2 (conventional)
Teacher 3 (conventional):	over Teacher 1 (television)
	over Teacher 2 (television)
	over Teacher 3 (television)
	over Teacher 4 (television)
	over Teacher 5 (television)
	over Teacher 1 (conventional)
	over Teacher 2 (conventional)
Teacher 5 (conventional):	over Teacher 1 (television)
	over Teacher 2 (television)
	over Teacher 3 (television)
	over Teacher 4 (television)
	over Teacher 5 (television)
	over Teacher 1 (conventional)
	over Teacher 2 (conventional)
Teacher 1 (television):	over Teacher 2 (television)- 5% level
	over Teacher 3 (television)- 5% level
	over Teacher 5 (television)
Teacher 1 (conventional):	over Teacher 2 (television)- 5% level
	over Teacher 5 (television)- 5% level

At this grade level the results of the t tests differ somewhat from those at the fifth grade level. Here, four out of the six conventional classes achieved post-test score means which were significantly higher than all five of the television classes. However, it should be noted that these same four conventional classes also achieved post-test mean scores which were significantly higher than those of the other two conventional classes. Likewise television class 1 also achieved significantly higher than three of the other television classes. At this grade level there is also an indication that the differences are related to teacher differences and not to method differences; however, this is not quite as clear as it was at the fifth grade level.

CHAPTER V

STATISTICAL ANALYSIS OF THE DATA

METHODS BY LEVELS ANALYSIS OF VARIANCE

The fifth grade and third grade data were subjected to methods by levels analysis of variance. The method, essentially, is an application of the analysis of variance technique to groups which have been matched on the basis of some initial test score. Its advantage over the classic matched group techniques is that it provides a means of determining whether or not the relative effectiveness of the compared methods of instruction is related to the initial levels of ability of the students. In the present case methods by levels analyses were made first with the fifth grade data and then with the third grade data using frequency distributions of the California Test of Mental Maturity scores matched for the television and conventional groups.

The scores on the California Test of Mental Maturity were divided into three large frequencies. They were from 111 and up, 91-110, and from 90 down. Distributions of matching ability scores were obtained by arranging the 3 x 5 cards of each student's data in order of decreasing ability score. Where unequal numbers of students from either of the two groups had a particular ability score, an attempt was made in the matching process to choose samples from various classes, and consideration was given also to the pre-test score.

The data for the methods by levels analysis of variance of the fifth grade data are summarized in Table XVIII. The items in each cell of the main part of Table XVIII contain data relevant to the cases of the given group in the given class interval (intelligence level) as follows:

a	d
b	e
c	f

a. The number of cases, n

b. The sum of the final scores, $\sum Y$

c. The sum of the squares of the final scores, $\sum Y^2$

d. The square of the sum of the final scores, $(\sum Y)^2$

e. The cell mean, M, which equals $\sum Y \div n$ or $b \div a$

f. The square of the sum of final scores divided by n, $(\sum Y)^2 \div n$ or $d \div a$

In the cells of the column headed "Both Groups" the following data were computed from data in the cells of that row:

g	i
h	j

g. The total number of cases in row, $n_{TV} + n_{Conv.} = n_i$

h. The sum of the final scores in that row $= \sum \sum Y_i$

i. The squares of the sum of final scores in that row $= (\sum \sum Y_i)^2 = h^2$

j. The square of the sum of final scores in that row divided by number of cases in row $= (\sum \sum Y_i)^2 \div n_i = i \div g$

The cells at the bottom of each column contain data computed from data in the cells of that column:

k	m
l	n

k. The total number of cases in column, $n_{TV} + n_{Conv.} = n_j$

l. The sum of the final scores in that column $= \sum \sum Y_j$

TABLE XVIII

METHODS BY LEVELS ANALYSIS OF VARIANCE

GRADE FIVE DATA
CTMM SCORES MATCHED

Initial score level	Television		Conventional		Both Groups	
	21	549,081	21	541,696	42	2,181,529
111 up	741	35.28	736	35.04	1,477	51,941.16
	27,237	26,146.71	27,098	25,795.50		
	51	2,480,625	51	3,168,400	102	11,256,025
91 - 110	1,575	30.88	1,780	34.90	3,355	110,353.18
	50,173	48,639.70	65,394	62,125.49		
	35	917,764	35	960,400	70	3,755,844
90 down	958	27.37	980	28.00	1,938	53,654.91
	27,248	26,221.82	29,922	27,440.00		
	107	10,719,076	107	12,222,016	214	45,832,900
	3,274	100,178.28	3,496	114,224.44	6,770	214,172.42

m. The square of the sum of final scores in that column = $(\Sigma \Sigma Y_j)^2 = l^2$

n. The square of the sum of final scores in that row divided by number of cases in column = $(\Sigma \Sigma Y_j)^2 \div n_j = m \div k$

The cell at the bottom of the column headed "Both Groups" contains similar data:

o	q
p	r

o. Sum of n's in this column is the total number of cases, N.

p. The total sum of the sums of the final scores in each row = $\Sigma \Sigma \Sigma Y$

q. The square of the total sum of the sums of the final scores in each row = $(\Sigma \Sigma \Sigma Y)^2 = p^2$

r. The square of the total sum of the sums of the final scores in each row $\div N = (\Sigma \Sigma \Sigma Y)^2 \div N = q \div o$

Computations, based on the table, were made as follows:

A = r from lowest cell of right-hand column of table

B = sum of c scores from each cell

= sum of sum of squares of final scores

C = sum of f scores from each cell

= sum of squares of sum of final scores $\div$ n

D = sum of j scores from each cell of "Both Groups" column

= sum of squares of sums of final scores on each level $\div$ total number of cases on that level

E = sum of n scores from total columns cells

= sum of squares of sums of final scores in each column $\div$ total number of cases in column

SS_T = sums of squares total = B - A

SS_L = sums of squares of levels = D - A

SS_M = sums of squares of methods = E - A

SS_{cells} = sums of squares of cells = C - A

SS_{ML} = sums of squares of methods by levels = $SS_{cells} - SS_M - SS_L$

SS_W = sums of squares within subgroups = $SS_T - SS_{cells}$

TABLE XIX

SUMS OF SQUARES OF METHODS x LEVELS ANALYSIS OF VARIANCE
GRADE FIVE DATA
CTMM SCORES MATCHED

	Sums of squares	Degrees of freedom		Variance
Methods	230.30	(M - 1)	1	230.30
Levels	1,776.83	(L - 1)	2	888.41
Cells	2,196.80	(ML - 1)	5	
Methods x levels	189.67	(M - 1) x (L - 1)	2	94.83
Within sub-groups	10,702.78	(N - ML)	208	51.45
Total	12,899.58	(N - 1)	213	

$$F_{methods} = \frac{230.30}{51.45} = 4.4761$$

From tables for 1 and 208 d.f.,
F is significant at 5% level

$$F_{MxL} = \frac{94.83}{51.45} = 1.8431$$

From tables for 2 and 208 d.f.,
F is non-significant

Since an F value for methods was obtained which was significant at the 5% level, a t test for the difference between means was made to see where differences occurred. To do this the standard t formula for the difference between two means was utilized:

$$t = \frac{M_1 - M_2}{\sqrt{V\left(\frac{1}{n} + \frac{1}{n}\right)}}$$

where the standard error of the difference = $\sqrt{V\left(\frac{1}{n} + \frac{1}{n}\right)}$.

V is the within sub-groups variance

and n refers to the number of cases in each of the two cells on the same level.

At the fifth grade level of instruction, no significant differences between means were obtained for the 111 and up level or for the 90 and down level. However, for the 91-110 level, the difference between the conventional and the television mean was 4.02 was significant at the 1% level since the t test yielded a t of 2.8309. In this analysis, the average ability students in the conventional classes did achieve post-test score means which were significantly higher than those of the average ability television students.

The methods by levels analysis of variance was computed similarly for the students at the third grade level. Table XX gives the basic data for this analysis while the sums of squares of methods by levels analysis of variance for this grade level are reported in Table XXI. The data are based on a matching of the initial California Test of Mental Maturity scores.

TABLE XX

METHODS BY LEVELS ANALYSIS OF VARIANCE

GRADE THREE DATA
CTMM SCORES MATCHED

Initial score level	Television		Conventional		Both Groups	
	32	3,613,801	32	4,418,404	64	16,024,009
111 up	1,901	59.40	2,102	65.68	4,003	250,375.14
	113,527	112,931.28	138,998	138,075.12		
	44	5,669,161	44	7,193,124	88	25,633,969
91 - 110	2,381	54.11	2,682	60.95	5,063	291,295.10
	130,881	128,844.56	165,776	163,480.09		
	21	980,100	21	1,261,129	42	4,464,769
90 down	990	47.14	1,123	53.47	2,113	106,304.02
	47,910	46,671.42	61,539	60,053.76		
	97	27,793,984	97	34,892,649	194	124,970,041
	5,272	286,535,91	5,907	359,718.03	11,179	644,175.46

TABLE XXI

SUMS OF SQUARES OF METHODS x LEVELS ANALYSIS OF VARIANCE

GRADE THREE DATA
CTMM SCORES MATCHED

	Sums of squares	Degrees of freedom	Variance
Methods	2,078.48	(M - 1) 1	2,078.48
Levels	3,798.80	(L - 1) 2	1,899.40
Cells	5,880.77	(ML - 1) 5	
Methods x levels	3.49	(M - 1) x (L - 1) 2	1.74
Within sub-groups	8,574.77	(N - ML) 188	45.61
Total	14,455.54	(N - 1) 193	

$$F_{methods} = \frac{2,078.48}{45.61} = 45.5707$$

$$F_{MxL} = \frac{1.74}{45.61} = 0.0003$$

From tables for 1 and 188 d.f., F is significant at the 1% level

From tables for 1 and 188 d.f., F is non-significant

Since an F value for methods was obtained which was significant at the 1% level, a t test for the differences between means was made to see where differences occurred. Once again, the standard t formula for the difference between two means was utilized.

At the third grade level of instruction, significant differences between means were obtained for all levels of ability. All differences were in favor of the conventional classroom instruction. For the 111 and up level of ability the difference between means was 6.28 with a t of 3.7225. For the 91 - 110 level, the difference between means was 6.84 with a t of 4.7533. For the 90 and down level of ability, the difference between means was 6.33 with a t of 3.0374.

This analysis, at the third grade level, indicates that the differences which were originally found in favor of the conventional classroom instruction, are true for all levels of ability. The achievement of students in the conventional classrooms was consistent for all levels of ability.

CHAPTER VI

THE EXPERIMENTAL DATA AND STATISTICAL ANALYSIS

STUDENT ATTITUDES

In addition to the evaluation of student achievement which has been described in Chapters III, IV, and V, an attempt was made to assess and compare the attitudes of the students toward the study of science. For this purpose a questionnaire, which was designed to measure the reactions of students to instruction by television, was utilize.[28] The original form of this questionnaire was designed for use with high school age students; therefore, it was necessary to make an adaptation of this questionnaire for use with elementary school children.[29] A sample of the teacher instruction sheet and the student answer sheet are included in Appendix III.

The questionnaire attempts to evaluate the students' attitudes on ten aspects of instruction which are of particular concern in those cases where the instructional television medium is being used experimentally. It is so designed and administered that it prevents the student from being aware that his responses will be used to assess his reactions to television instruction.

The fundamental technique of the questionnaire is one that requires the student to compare each of the basic instructional areas, including the area in which television may or may not be used, with every other instructional area. He makes ten sets of comparisons. For example, the first set of

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[28] Henry S. Dyer and Anne H. Ferris, "Sizing Up Your School Subjects" (Princeton: Educational Testing Service, 1958)

[29] This adaptation was accomplished by Professor Warren G. Findley, University of Georgia, for use in the Atlanta Public Schools.

comparisons has to do with how well the student likes the study of each instructional area. The task of making the comparisons is presented as an exercise in which the student selects the area of instruction which he likes best and the area of instruction which he likes second best. In addition the student has an opportunity to indicate the area of instruction which he likes least and the area of instruction which he likes second least. In an effort to eliminate likes and dislikes which might be related to the specialized areas of instruction such as music, art and physical education, the areas of instruction were limited to those considered basic or academic in nature. These included arithmetic, reading, language, science, spelling, and social studies.

The ten comparison exercises, expressed as questions, are as follows:

1. How do you like the subjects you are now studying?
2. How much time do you actually spend on the subjects you are now studying - both at school and at home?
3. How often do you have a chance to ask the teacher questions in your different subjects?
4. How often do your subjects - classwork and homework - keep you from taking part in outside activities you would rather do?
5. How easy to learn are the subjects you are now studying?
6. How useful do you think your different subjects are to you?
7. How clear and understandable is the teaching of the different subjects you are now studying?
8. How much do students discuss in class what you are taught in the different subjects?

9. How much does your mind wander in your different subjects?

10. How much do you learn in your different subjects?

From a review of the nature of the exercise just described, it should be clear that the questionnaire constitutes an indirect approach to the reactions of students to the use of instructional television. That is, students are never asked directly their reactions to various aspects of instructional television. They simply react to various features of instruction in the different subject areas. From the basic data, we are able, by a perfectly straightforward inference, to decide whether the use of television in one of the subject areas is having an important influence on the students' reactions to that subject. Basically the inference runs as follows:

1. Suppose one group of students is studying reading, arithmetic, and science and that the instruction in science is given to this group by means of television;
2. Suppose that a closely similar group of students is also studying reading, arithmetic, and science, but that the instruction for this group in science is not given by television;
3. If the reaction of the first group to the study of science is different from the reaction of the second group to the study of science,
4. Then the difference between the reactions of the two groups is a possible measure of the effect instructional television is having on the reaction of the first group toward the study of science.

In this study, the questionnaire was used to assess the students' reactions to the study of science. All of the classes included in the study of student achievement were included in the assessment of student reactions to the study of science. The questionnaire was administered by the classroom teachers at the fifth grade level and at the third grade level on May 27, 1963. All student answer sheets were individually surveyed by the writer to screen out those which included double responses and other errors which prevented them from being scored.

For the purposes of scoring, the responses of the students in the television group and the responses of the students in the conventional classroom group were tallied by hand. For example, a tally of the number of students who indicated that they liked arithmetic best was made for the television group at the fifth grade level. This was done for each of the areas of instruction. The tally of responses was extended to include the responses to the questions for the ten comparisons and for all subject areas. The following is a model of the form which was used in collecting the student response data for each group, television and conventinnal, at each grade level.

From these summary tables, it was possible to extract data regarding the reaction of the students, in each group, toward the study of science. For example, when the first comparison question is used, it is possible to determine the number of students within the television group who indicated that science was the area of instruction which they liked best. It was also possible to determine the number of students who indicated that science was their choice for the area of instruction which they liked second best. Likewise, it was possible to determine the number of students in each group who indicated a negative response or a dislike for the study of science on this comparison question.

SAMPLE SUMMARY CARD

STUDENT ATTITUDES - RESPONSE SUMMARY

Grade Level ________________ Comparison Question ________________

	First Choice	Second Choice	Next to Last Choice	Last Choice
Arithmetic				
Reading				
Language				
Science				
Spelling				
Social Studies				
Totals				

Since this study involved the use of instructional television for science only, it was possible to make direct comparisons of the responses of the students in the television group with the responses of the students in the conventional classrooms regarding their reactions to the ten comparison questions as they pertained to science instruction.

The reactions of the students to the study of science were categorized in such a way that all first and second choice responses were grouped together. These were considered to be positive responses to the question. In the same manner, all last choice and next to the last choice responses were grouped together. These were considered to be negative responses to the question. All of those students within the total group, television or conventional, who did not react to the question with a choice of science were considered to have neutral reactions to the question, as it related to the study of science. The following is a model of the structure that was used for organization and statistical treatment of the data.

	Television	Conventional	Sums of Rows
Positive Science Responses	f_{a_1}	f_{a_2}	$\sum f_a$
Neutral Responses	f_{b_1}	f_{b_2}	$\sum f_b$
Negative Science Responses	f_{c_1}	f_{c_2}	$\sum f_c$
Sums of Columns	$\sum f_1$	$\sum f_2$	N

After the data were organized in this manner for each comparison question and for each grade level, it was possible to apply the chi square[30] test of the null hypothesis. In this case the null hypothesis was that there was no difference in the reactions of students toward the study of science in the television group, at each grade level, as compared to the reactions of the students in the conventional classes toward the study of science.

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[30] J. P. Guilford, Fundamental Statistics in Psychology and Education (New York: McGraw-Hill, 1956), pp. 228-233.

The basic notion underlying the chi square technique, stated in terms of the null hypothesis, is that the observed frequencies in a category of the contingency table are chance departures from the hypothetical or expected frequencies for the category.

In determining the expected frequencies for each category, a formula of this type was applied to the data:

$$f_e = \frac{(\Sigma f_r)(\Sigma f_k)}{N}$$

where:

f_e = frequency expected

Σf_r = sum of any rows, for example, Σf_a, Σf_b, ... etc.

Σf_k = sum of any column, for example, Σf_1, Σf_2,.. etc.

Thus, the expected frequency corresponding to cell f_{b_2} in the contingency table would be derived from the product $(\Sigma f_b)(\Sigma f_2)$ divided by N. The expected frequency for other cells in the contingency table would be determined in the same fashion.

Having the expected frequencies for each cell, it was now possible to determine whether the observed frequencies deviated from the expected frequencies sufficiently to cause us to reject the hypothesis of no difference. For each of the six cells of the table, it was necessary to determine the discrepancy, between the observed and the expected frequency.

In the solution of chi square, each discrepancy was squared and was divided by the corresponding expected frequency. All of these ratios were added, and this sum is chi square. This may be expressed by the following formula:

$$\chi^2 = \sum \left[\frac{(f_o - f_e)^2}{f_e} \right]$$

This chi square value stands for the total amount of discrepancy between the hypothesis and the observation. Chi square can be small enough in value to allow us to accept the null hypothesis or to retain it with some doubt, or it can be large enough to lead us to reject the hypothesis with moderate or positive assurance. Tables of chi square[31] enable us to decide the matter. In using the table it is necessary to determine the degrees of freedom. In a contingency table the degrees of freedom equal the product of the number of rows minus one and the number of columns minus one. The following formula was applied in determining the degrees of freedom for all tables within this chapter.

$$\begin{aligned} df &= (r - 1)\ (k - 1) \\ &= (3 - 1)\ (2 - 1) \\ &= 2 \times 1 \\ &= 2 \end{aligned}$$

Table XXII through XXXI show the responses of the fifth grade students to each of the ten comparison questions, as they pertained to the study of science. Each table also includes the chi square computation for the data in each table.

In reviewing the results of the chi square analysis of the data at the fifth grade level, the following interpretations are noted.

1. There was a stronger dislike of science expressed by the students in the conventional classes as compared to the students in the television classes. (See Table XXII)

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[31]See any standard statistical tables for values of chi square. For example, see Guilford, p. 540.

TABLE XXII

STUDENT ATTITUDE RESPONSE

GRADE FIVE DATA

QUESTION: How do you like the subjects you are now studying?

	Television	Conventional	Total
Positive Science Response	36	34	70
Neutral Response	80	54	134
Negative Science Response	63	94	157
Total	179	182	361

f_e		$f_o - f_e$		$(f_o - f_e)^2$		$\frac{(f_o-f_e)^2}{f_e}$	
TV	Conv	TV	Conv	TV	Conv	TV	Conv
34.7	35.3	1.3	-1.3	1.69	1.69	.05	.05
66.4	67.6	13.6	-13.6	184.96	184.96	2.79	2.74
77.9	79.1	-14.9	14.9	222.01	222.01	2.85	2.81
179.0	182.0	0.0	0.0	-	-	5.69	5.60

$\chi^2 = 11.29$

From the table of χ^2, using df = 2, a value of 9.210 is required for significance at the 1% level; therefore, the null hypothesis for this comparison question is rejected.

TABLE XXIII

STUDENT ATTITUDE RESPONSE

GRADE FIVE DATA

QUESTION: How much time do you actually spend on the subjects you are now studying - both at school and at home?

	Television	Conventional	Total
Positive Science Response	20	33	53
Neutral Response	91	59	150
Negative Science Response	68	90	158
Total	179	182	361

f_e		$f_o - f_e$		$(f_o - f_e)^2$		$\frac{(f_o - f_e)^2}{f_e}$	
TV	Conv	TV	Conv	TV	Conv	TV	Conv
26.3	26.7	-6.3	6.3	39.69	39.69	1.51	1.41
74.4	75.6	16.6	-16.6	275.56	275.56	3.70	3.64
78.3	79.7	-10.6	10.3	106.09	106.09	1.35	1.33
179.0	182.0	0.0	0.0	-	-	6.56	6.46

$\chi^2 = 13.02$

From the table of χ^2, using df = 2, a value of 9.210 is required for significance at the 1% level; therefore, the null hypothesis for this comparison question is rejected.

TABLE XXIV

STUDENT ATTITUDE RESPONSE

GRADE FIVE DATA

QUESTION: How often do you have a chance to ask the teacher questions in your different subjects?

	Television	Conventional	Total
Positive Science Response	25	50	75
Neutral Response	92	72	164
Negative Science Response	62	60	122
Total	179	182	361

f_e		$f_o - f_e$		$(f_o - f_e)^2$		$\frac{(f_o - f_e)^2}{f_e}$	
TV	Conv	TV	Conv	TV	Conv	TV	Conv
37.2	37.8	-12.2	12.2	148.84	148.84	4.00	3.94
81.3	82.7	10.7	-10.7	114.49	114.49	1.41	1.38
60.5	61.5	1.5	-1.5	2.25	2.25	.04	.04
179.0	182.0	0.0	0.0	-	-	5.45	5.36

$\chi^2 = 10.81$

From the table of χ^2, using df = 2, a value of 9.210 is required for significance at the 1% level; therefore, the null hypothesis for this comparison is rejected.

TABLE XXV

STUDENT ATTITUDE RESPONSE

GRADE FIVE DATA

QUESTION: How often do your subjects - classwork and homework - keep you from taking part in outside activities you would rather do?

	Television	Conventional	Total
Positive Science Response	25	28	53
Neutral Response	93	81	174
Negative Science Response	61	73	134
Total	179	182	361

f_e		$f_o - f_e$		$(f_o - f_e)^2$		$\frac{(f_o - f_e)^2}{f_e}$	
TV	Conv	TV	Conv	TV	Conv	TV	Conv
26.3	26.7	-1.3	1.3	1.69	1.69	.06	.06
86.3	87.7	6.7	-6.7	44.89	44.89	.52	.51
66.4	67.6	-5.4	5.4	29.16	29.16	.44	.43
179.0	182.0	0.0	0.0	-	-	1.02	1.00

$\chi^2 = 2.02$

From the table of χ^2, using df = 2, a value of 9.210 is required for significance at the 1% level; therefore, the null hypothesis for this comparison is accepted.

TABLE XXVI

STUDENT ATTITUDE RESPONSE

GRADE FIVE DATA

QUESTION: How easy to learn are the subjects you are now studying?

	Television	Conventional	Total
Positive Science Response	25	29	54
Neutral Response	103	73	176
Negative Science Response	51	80	131
Total	179	182	361

f_e		$f_o - f_e$		$(f_o - f_e)^2$		$\frac{(f_o - f_e)^2}{f_e}$	
TV	Conv	TV	Conv	TV	Conv	TV	Conv
26.8	27.2	-1.8	1.8	3.24	3.24	.12	.12
87.3	88.7	15.7	-15.7	246.49	246.49	2.82	2.78
64.9	66.1	-13.9	13.9	193.21	193.21	2.98	2.92
179.0	182.0	0.0	0.0	-	-	5.92	5.82

$\chi^2 = 11.74$

From the table of χ^2, using df = 2, a value of 9.210 is required for significance at the 1% level; therefore, the null hypothesis for this comparison is rejected.

TABLE XXVII

STUDENT ATTITUDE RESPONSE

GRADE FIVE DATA

QUESTION: How useful do you think your different subjects are to you?

	Television	Conventional	Total
Positive Science Response	17	38	55
Neutral Response	78	59	137
Negative Science Response	84	85	169
Total	179	182	361

f_e		$f_o - f_e$		$(f_o - f_e)^2$		$\frac{(f_o - f_e)^2}{f_e}$	
TV	Conv	TV	Conv	TV	Conv	TV	Conv
27.3	27.7	-10.3	10.3	106.09	106.09	3.91	3.82
67.9	69.1	10.1	-10.1	102.01	102.01	1.50	1.48
83.8	85.2	0.2	-0.2	.04	.04	.00	.00
179.0	182.0	0.0	0.0	-	-	5.41	5.30

$\chi^2 = 10.71$

From the table of χ^2, using df = 2, a value of 9.210 is required for significance at the 1% level; therefore, the null hypothesis for this comparison is rejected.

TABLE XXVIII

STUDENT ATTITUDE RESPONSE

GRADE FIVE DATA

QUESTION: How clear and understandable is the teaching of the different subjects you are now studying?

	Television	Conventional	Total
Positive Science Response	30	33	63
Neutral Response	88	55	143
Negative Science Response	61	94	155
Total	179	182	361

f_e		$f_o - f_e$		$(f_o - f_e)^2$		$\frac{(f_o - f_e)^2}{f_e}$	
TV	Conv	TV	Conv	TV	Conv	TV	Conv
31.2	31.8	-1.2	1.2	1.44	1.44	.05	.05
70.9	72.1	17.1	-17.1	292.41	292.41	4.11	4.06
76.9	78.1	-15.9	15.9	252.81	252.81	3.29	3.24
179.0	182.0	0.0	0.0	-	-	7.45	7.35

$\chi^2 = 14.80$

From the table of χ^2, using df = 2, a value of 9.210 is required for significance at the 1% level; therefore, the null hypothesis for this comparison is rejected.

TABLE XXIX

STUDENT ATTITUDE RESPONSE

GRADE FIVE DATA

QUESTION: How much do students discuss in class what you are taught in the different subjects?

	Television	Conventional	Total
Positive Science Response	25	62	87
Neutral Response	75	75	150
Negative Science Response	79	45	124
Total	179	182	361

f_e		f_o-f_e		$(f_o - f_e)^2$		$\frac{(f_o - f_e)^2}{f_e}$	
TV	Conv	TV	Conv	TV	Conv	TV	Conv
43.1	43.9	-18.1	18.1	327.61	327.61	7.60	7.46
74.4	75.6	0.6	-0.6	.36	.36	.00	.00
61.5	62.5	17.5	-17.5	306.25	306.25	4.98	4.90
179.0	182.0	0.0	0.0	-	-	12.58	12.36

$\chi^2 = 24.94$

From the table of χ^2, using df = 2, a value of 9.210 is required for significance at the 1% level; therefore, the null hypothesis for this comparison is rejected.

TABLE XXX

STUDENT ATTITUDE RESPONSE

GRADE FIVE DATA

QUESTION: How much does your mind wander in your different subjects?

	Television	Conventional	Total
Positive Science Response	50	84	134
Neutral Response	87	53	140
Negative Science Response	42	45	87
Total	179	182	361

f_e		$f_o - f_e$		$(f_o - f_e)^2$		$\frac{(f_o - f_e)^2}{f_e}$	
TV	Conv	TV	Conv	TV	Conv	TV	Conv
66.5	67.5	-16.5	16.5	272.25	272.25	4.09	4.03
69.4	70.6	17.6	-17.6	309.76	309.76	4.46	4.39
43.1	43.9	-1.1	1.1	1.21	1.21	.03	.03
179.0	182.0	0.0	0.0	-	-	8.58	8.45

$\chi^2 = 17.03$

From the table of χ^2, using df = 2, a value of 9.210 is required for significance at the 1% level; therefore, the null hypothesis for this comparison is rejected.

TABLE XXXI

STUDENT ATTITUDE RESPONSE

GRADE FIVE DATA

QUESTION: How much do you learn in your different subject?

	Television	Conventional	Total
Positive Science Response	26	26	52
Neutral Response	82	57	139
Negative Science Response	71	99	170
Total	179	182	361

f_e		$f_o - f_e$		$(f_o - f_e)^2$		$\frac{(f_o - f_e)^2}{f_e}$	
TV	Conv	TV	Conv	TV	Conv	TV	Conv
25.8	26.2	0.2	-0.2	.04	.04	.00	.00
68.9	70.1	13.1	-13.1	171.61	171.61	2.49	2.45
84.3	85.7	-13.3	13.3	176.89	176.89	2.09	2.06
179.0	182.0	0.0	0.0	-	-	4.58	4.51

$\chi^2 = 9.09$

From the table of χ^2, using df = 2, a value of 7.824 is required for significance at the 2% level; therefore, the null hypothesis for this comparison is rejected at this level.

2. More students in the conventional classes felt that science was difficult to learn as compared to students in the television classes. (See Table XXVI)
3. More students in the conventional classes felt that the teaching of science was not clear and understandable as compared to the students in the television classes. (See Table XXVIII)
4. More students in the conventional classes felt that their minds wandered more during science instruction as compared to students in the television classes. (See Table XXX)
5. More students in the conventional classes felt that they learned the least in science as compared to students in the television classes. (See Table XXXI)
6. More students in the conventional classes felt that they had a chance to ask the teacher questions in their study of science as compared to students in the television classes. (See Table XXIV)
7. More students in the conventional classes felt that they had an opportunity for discussion in their study of science as compared to students in the television classes. (See Table XXIX)
8. More students in the conventional classes felt that the study of science was useful as compared to students in the television classes. (See Table XXVII)

The chi square analysis of the data did indicate that there were significant differences between the responses of the students in the two groups. The interpretation of the differences outlined in the first five items above suggests that students in the conventional classes had attitudes toward the study of science which were more negative than those expressed by students in the television classes. It is interesting to note that in every analysis of differences, the attitudes expressed were of a negative nature.

The last three items listed above suggest more favorable or positive attitudes by the students in the conventional classes. The differences noted in items number six and seven above may reflect a definite shortcoming of instructional television in the matter of student questioning and discussion opportunities. Since a considerable amount of time was spent in viewing telecasts, little time or opportunity was apparently provided for general questioning and discussion by the students.

In an effort to verify the rationale of this analysis of differences reported in student attitudes toward the study of science between the two groups, an identical analysis of the student attitude responses toward the study of arithmetic was made. Since the students within both the science television classes and the conventional science classes were receiving instruction in arithmetic by conventional means, it would be expected that no difference in their attitude toward the study of arithmetic should be expressed.

The data for the student responses toward the study of arithmetic were treated in the same way as the data for science. A summary of the student attitude response data for arithmetic at the fifth grade level is reported in Table XXXII. In the chi square analysis of the data, only one of the questions of the student attitude questionnaire produced results which permitted rejection of the null hypothesis at the 1% level. This was for question number four. In this question, more students in the television

TABLE XXXII

STUDENT ATTITUDE RESPONSE SUMMARY
GRADE FIVE DATA: ARITHMETIC

	Question #1*			Question #2			Question #3			Question #4			Question #5		
	TV	Conv	Total	TV	Conv	Total	TV	Conv	Total	TV	Conv	Total	TV	Conv	Total
Positive Arithmetic Response	88	103	191	118	99	217	109	103	212	139	106	245	84	74	158
Neutral Response	34	30	64	29	45	74	30	41	71	7	29	36	17	30	47
Negative Arithmetic Response	57	49	106	32	38	70	40	38	78	33	47	80	78	78	156
Total	179	182	361	179	182	361	179	182	361	179	182	361	179	182	361

	Question #6			Question #7			Question #8			Question #9			Question #10		
	TV	Conv	Total	TV	Conv	Total	TV	Conv	Total	TV	Conv	Total	TV	Conv	Total
Positive Arithmetic Response	128	128	256	109	108	217	115	105	220	65	59	124	135	142	277
Neutral Response	25	28	53	16	25	41	35	51	86	26	34	60	13	20	33
Negative Arithmetic Response	26	26	52	54	49	103	29	26	55	88	89	177	31	20	51
Total	179	182	361	179	182	361	179	182	361	179	182	361	179	182	361

*See pages 77 and 78 for a complete listing of the questions used in the survey questionnaire.

Question #1 $\chi^2 = 2.00$ #4 $\chi^2 = 20.20$ #7 $\chi^2 = 2.15$ #10 $\chi^2 = 4.02$

#2 $\chi^2 = 5.63$ #5 $\chi^2 = 4.19$ #8 $\chi^2 = 3.53$

#3 $\chi^2 = 1.89$ #6 $\chi^2 = 0.14$ #9 $\chi^2 = 1.31$

From the table of χ^2, using df = 2, a value of 9.210 is required for significance at the 1% level.

classes felt that their arithmetic work kept them from taking part in outside activities as compared to students in the conventional classes. On all of the other items of the student attitude questionnaire, as it related to the study of arithmetic, there were no differences between the responses of the students in the two groups.

This strongly suggests that the differences reported between television classes and the conventional classes, at the fifth grade level, in their attitudes toward the study of science are related to differences in the method of instruction used.

The student attitude responses, at the third grade level, toward the study of science were subjected to the same statistical treatment. Table XXXIII provides a summary of the student attitude responses for all of the questions in the survey for the third grade level. At this grade level, it was necessary to accept the null hypothesis for all of the questions in the survey questionnaire. In no case was there a difference in the responses of students in the two groups which would allow rejection of the null hypothesis.

It is possible that children at this early grade level have not yet formed strong attitudes toward the study of any subject which would be reflected in an analysis of the type used.

TABLE XXXIII

STUDENT ATTITUDE RESPONSE SUMMARY
GRADE THREE DATA: SCIENCE

	Question #1*			Question #2			Question #3			Question #4			Question #5		
	TV	Conv	Total	TV	Conv	Total	TV	Conv	Total	TV	Conv	Total	TV	Conv	Total
Positive Science Response	39	57	96	33	45	78	30	60	90	17	37	54	27	29	56
Neutral Response	68	86	154	67	98	165	70	87	157	74	86	160	67	85	152
Negative Science Response	43	54	97	50	54	104	50	50	100	59	74	133	56	83	139
Total	150	197	347	150	197	347	150	197	347	150	197	347	150	197	347

	Question #6			Question #7			Question #8			Question #9			Question #10		
	TV	Conv	Total	TV	Conv	Total	TV	Conv	Total	TV	Conv	Total	TV	Conv	Total
Positive Science Response	13	32	45	23	37	60	36	67	103	53	68	121	28	43	71
Neutral Response	75	87	162	67	84	151	65	66	131	64	74	138	69	79	148
Negative Science Response	62	78	140	60	76	136	49	64	113	33	55	88	53	75	128
Total	150	197	347	150	197	347	150	197	347	150	197	347	150	197	347

*See pages 77 and 78 for a complete listing of the questions used in the survey questionnaire.

Question #1 $\chi^2 = 0.36$ #4 $\chi^2 = 3.64$ #7 $\chi^2 = 0.68$ #10 $\chi^2 = 1.28$

#2 $\chi^2 = 1.46$ #5 $\chi^2 = 1.11$ #8 $\chi^2 = 4.96$

#3 $\chi^2 = 5.58$ #6 $\chi^2 = 4.53$ #9 $\chi^2 = 1.73$

From the table of χ^2, using df = 2, a value of 9.210 is required for significance at the 1% level.

CHAPTER VII

THE EXPERIMENTAL DATA AND STATISTICAL ANALYSIS

TEACHER ATTITUDES

The evaluation of the attitudes of teachers toward the use of instructional television for elementary science was accomplished with a questionnaire. In a study of the attitudes of teachers toward the use of instructional television for elementary mathematics, Westley and Jacobson[32] developed and used a questionnaire instrument which attempted to evaluate the specific dimensions of teachers' attitudes. The writer adapted this survey questionnaire to evaluate teachers' attitudes toward the use of instructional television for elementary science. A copy of this instrument, "Teacher Survey on the Use of Instructional Television," is included in Appendix IV.

All teachers of grades two through six in the two schools which were using instructional television for elementary science in this study completed the survey questionnaire. Even though all students in the classes of these teachers were not included in the previous part of this study dealing with the evaluation of student achievement and student attitudes, all of the classes within these two schools in grades two through six were using the instructional science telecasts of the Midwest Program on Airborne Television Instruction, Inc.; therefore, all of the teachers of these classes were included in this part of the study. There was a total of

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[32] B. H. Westley and H. K. Jacobson, "Dimensions of Teachers' Attitudes toward Instructional Television," Audio Visual Communication Review, X (May, 1962), pp. 179-183.

twenty-seven (27) teachers in these two schools who responded to the survey questionnaire.

In addition, a total of forty-one (41) teachers of grades two through six in the three control schools, which contained the conventional classes included in the part of the study dealing with student achievement and student attitudes, responded to the survey questionnaire.

The teachers in the two groups completed the survey questionnaire on May 23, 1963. This was after the teachers in the schools using instructional television had completed the regular telecast series for the school year.

In analyzing the responses of the teachers within the two groups, an attempt was made to determine the nature of their responses. This was done by determining whether there was general agreement or disagreement with each of the items included in the survey questionnaire. From this data, it was possible to evaluate whether the particular group of teachers in question reflected positive or negative attitudes toward the use of instructional television for elementary science.

The scale which the teachers used in responding to each item consisted of five different values ranging from the positive position of "agreeing entirely" to the negative position of "disagreeing entirely." The numerical values associated with each of these responses on the original survey questionnaire were transposed for the purpose of analysis. In the original form the numerical value for "agree entirely" was (1) and this was transposed to a numerical value of (5) for analysis. Similarly, the other values were transposed, so that the scale value for "disagree entirely" was (1). This resulted in higher numerical values, those approaching (5), as being indicative of a positive response or agreement while lower numerical values, those approaching (1), would be indicative of a negative response or disagreement. The numerical value at the mid-point of the scale was (3), and this indicated neither agreement or disagreement.

The analysis of the responses of the teachers within each of the groups was accomplished by computing the mean or average score for each item included in the survey questionnaire. From this, it was possible to determine the average amount of positive or negative reaction of the group for each item. From the frequency distribution of the responses for each group of teachers on each of the items, the mean score and the standard deviation were computed.

Having computed the mean response score and the standard deviation for each group of teachers on each of the items of the survey questionnaire, it was possible to compare the difference in the average or mean responses between the two groups of teachers. In order to determine whether the two groups differed sufficiently in mean response to enable us to say with confidence that a difference would persist upon repetition of the analysis, it was necessary to compute the standard error of the difference between the two means for each of the items in the survey questionnaire.

Since the number of teachers within the television group was particularly small, this was taken into account in the selection of formulas. The formulas used are those for the reliability of the difference between means in small independent samples.[33]

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[33]Henry E. Garrett, Statistics in Psychology and Education. (New York: Longmans, Green and Co., 1954), pp. 222-225.

In computing the standard deviation when the two N's being compared are small, we get a better estimate of the "true" standard deviation (σ in the population) by pooling the sums of squares of the deviations taken around the means of the two groups and computing a single standard deviation. The justification for pooling is that under the null hypothesis no real mean difference exists as between the two samples, which are assumed to have been drawn from the same parent population. We have, therefore, only one σ (that of the common population) to estimate. Furthermore, by increasing N we get a more stable S D based upon all of our cases. The formula used for computing the "pooled" S D is as follows:

$$S\,D = \sqrt{\frac{\sum (X_1 - M_1)^2 + \sum (X_2 - M_2)^2}{(N_1 - 1) + (N_2 - 1)}}$$

where:

$\sum (X_1 - M_1)^2 = \sum x_1^2$ = sum of the squared deviations around the mean of Group 1

$\sum (X_2 - M_2)^2 = \sum x_2^2$ = sum of the squared deviations around the mean of Group 2

$d\,f = (N_1 - 1) + (N_2 - 1)$ since one degree of freedom is used in computing each mean

The formula used for the standard error of the difference between the means is as follows:

$$S\,E_D = S\,D \sqrt{\frac{N_1 + N_2}{N_1 N_2}}$$

where: S D = the pooled S D as computed above

From the computations made above, it is possible to test the significance of the difference by use of the sampling distributions of t. In this procedure the formula used is as follows:

$$t = \frac{(M_1 - M_2)}{S\ E_D}$$

After computation of t, we refer to the Table of t[34] to determine the required values of t for significance at the .05 and .01 levels. In using the table it is necessary to use the df for inferring the significance of the mean difference under consideration. In all of the comparisons made by the writer in this chapter, the df = 66; therefore, using the Table t, the following values are required for significance at the specified levels.

t value required		level of significance
2.00	=	.05
2.65	=	.01

In Table XXXIV, each of the items from the survey questionnaire are listed with the pertinent data included which was used in computing the $S\ E_D$ for each item. The t values are listed where these reflect significance at the specified levels.

In this table, the items are grouped according to the particular attitudinal area which they are designed to reflect. These areas are the same as those used by Westley and Jacobson[35] in their original study from which the survey questionnaire was adapted.

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[34] See any standard statistical table.

[35] Westley and Jacobson, loc. cit.

TABLE XXXIV

ANALYSIS OF RESPONSES

TEACHER SURVEY ON THE USE OF INSTRUCTIONAL TELEVISION

Survey items listed by item number and attitudinal area - Anticipated or desired response is indicated within the parentheses following each item.	Television		Conventional		Pooled S D	S E_D	M_1-M_2	t
	M_1	$\sum x_1^2$	M_2	$\sum x_2^2$				
ATTITUDE AREA: CHALLENGE-THREAT								
5. Even if it proves to be a saving in instructional costs, televised instruction is too costly in terms of human resources. (-)	2.22	26.667	2.73	38.049	0.990	.245594	0.51	2.07*
8. Television instruction tends to impair normal teacher-pupil relationships by making a celebrity of the television teacher. (-)	1.44	20.660	2.51	66.240	1.148	.284704	1.07	3.75**
21. Televised instruction tends to leave too much to the television teacher; the classroom teacher is not challenged.	1.56	16.667	2.00	32.000	0.859	.213032	0.44	2.06*
24. Instructional television, especially if expanded, threatens the classroom teacher with eventual unemployment. (-)	1.22	8.667	1.61	39.756	0.857	.212536	0.39	N.S.
34. Television instruction tends to impair the pupil's total intellectual growth. (-)	1.78	28.667	1.51	20.244	0.861	.213528	0.27	N.S.
36. Widespread use of classroom television endangers the classroom teacher's chances of advancement (-)	1.78	24.667	1.93	40.781	0.995	.246760	0.15	N.S.
38. Science instruction by television reduces teacher satisfaction by disrupting the normal teacher pupil relationship. (-)	1.74	21.185	2.15	45.123	1.003	.248744	0.31	N.S.
41. Since its value is unknown, this is no time to experiment with things like science instruction by television. (-)	1.59	18.519	1.68	34.878	0.899	.222952	0.09	N.S.
44. Television may have its place in providing entertainment in the home but does not belong in the classroom. (-)	1.59	14.519	1.61	31.756	0.837	.207576	0.02	N.S.

TABLE XXXIV - continued

	Television		Conventional					
	M_1	$\sum x_1^2$	M_2	$\sum x_2^2$	Pooled S D	S E_D	M_1-M_2	t
47. With the new emphasis on scientific achievement, this is no time to experiment with a subject as important as science. (-)	1.44	24.667	1.44	18.098	0.804	.199392	0.00	N.S.
48. Science instruction by television endangers the position of authority of the teacher in the classroom. (-)	1.26	9.185	1.80	38.440	0.849	.210552	0.54	2.56*
49. Television instruction in science reduces teacher satisfaction by subjecting him (her) to comparison with a "Master Teacher."(-)	1.37	8.296	2.12	36.390	0.823	.204704	0.75	3.65**
50. In the long run instructional television can only have an adverse effect on the caliber of teachers entering the profession. (-)	1.44	14.667	1.95	39.903	0.909	.225432	0.51	2.26*
ATTITUDE AREA: ECONOMY								
6. Most communities stand to gain from instructional television, because it should bring about substantial savings in instructional costs in the long run. (-)	2.63	28.296	2.59	45.952	1.058	.262384	0.04	N.S.
9. One of the functions of television in the classroom is in helping schools to cope with increasing enrollments. (-)	2.26	29.185	2.90	73.610	1.248	.309504	0.64	2.06*
15. Even if it costs more than conventional instruction, classroom television can make savings in terms of human resources. (+)	3.15	33.407	2.93	57.337	1.172	.289912	0.22	N.S.
16. In the long run instructional television can make important savings in instructional costs. (-)	2.81	26.075	2.93	56.781	1.058	.262384	0.12	N.S.
23. An important value of science instruction by television is that it helps the schools to handle increased enrollments. (-)	2.48	20.741	3.17	51.805	1.048	.259904	0.69	2.65**
ATTITUDE AREA: INSTRUCTIONAL SIDE-BENEFITS								
10. A good way to acquaint teachers with new science content is through television for elementary classes. (+)	3.93	21.852	3.85	63.122	1.063	.263624	0.08	N.S.
26. Television instruction can serve as an in-service course for teachers in methods while at the same time serving as a content course for the students. (+)	3.81	27.265	4.10	33.610	0.961	.238328	0.29	N.S.

	Television		Conventional		Pooled S D	S E_D	M_1-M_2	t
	M_1	Σx_1^2	M_2	Σx_2^2				
27. A function of television in the classroom is in bringing the classroom teacher new ways of teaching her subject. (+)	3.70	19.530	4.02	20.976	0.784	.194432	0.32	N.S.
51. A function of television in the classroom is in helping provide more uniform instruction. (+)	3.37	33.666	3.56	54.098	1.153	.285944	0.19	N.S.
ATTITUDE AREA: PARTNERSHIP								
7. Televised instruction in science can help to bring about the acceptance of course content change in science. (+)	3.81	16.075	3.76	39.562	0.918	.227664	0.05	N.S.
11. Having a "master teacher" on television backing her up strengthns the position of the classroom teacher with her pupils. (+)	3.33	18.000	3.59	53.952	1.053	.261440	0.26	N.S.
12. Television is a good means for a supervisory staff to make its work effective in the schools. (+)	3.00	10.000	2.85	42.122	0.879	.217992	0.15	N.S.
14. My own feeling is that televised science instruction can bring about increased achievement. (+)	4.04	24.963	3.73	42.049	1.008	.249984	0.31	N.S.
46. The celebrity of the television teacher in the eyes of the pupils tends to improve their attitudes toward science. (+)	2.44	32.667	2.83	31.805	0.989	.245272	0.39	N.S.
ATTITUDE AREA: RESPONSIVENESS								
19. Television lessons in science have a tendency to dull the pupil's interest in the subject matter. (-)	1.74	19.185	2.02	46.976	1.048	.259904	0.28	N.S.
20. Science instruction by television can retard the advancement of teachers in their professional careers. (-)	1.11	16.467	1.90	37.610	0.905	.224440	0.79	3.51**
35. The television teacher helps to produce positive attitudes toward science. (+)	3.93	27.852	3.78	31.024	0.944	.234112	0.15	N.S.
43. Science instruction by television does not hold student interest as well as conventional instruction. (-)	2.48	40.741	2.41	35.952	1.077	.267096	0.07	N.S.

TABLE XXXIV - continued

	Television		Conventional		Pooled S D	S E_D	M_1-M_2	t
	M_1	Σx_1^2	M_2	Σx_2^2				
ATTITUDE AREA: SECURITY								
17. The television teacher can never replace the classroom teacher. (+)	4.74	9.185	4.76	13.562	0.587	.145601	0.02	N.S.
45. Instructional television is a help to the classroom teacher because it provides more time to devote to other important duties. (-)	1.96	28.963	2.56	56.098	1.135	.281480	0.60	2.13*
ATTITUDE AREA: INVIDIOUS COMPARISON								
2. An advantage of instructional television is that it tends to keep the classroom teacher on his (her) toes. (+)	3.33	24.000	3.37	41.513	0.996	.247082	0.04	N.S.
3. With the new emphasis on scientific achievement, we should try anything that might improve instruction in science. (+)	4.19	18.505	4.19	28.440	0.843	.209064	0.00	N.S.
4. The "master teacher" on television can't help making the classroom teacher seem inept at times. (-)	2.96	37.523	2.88	46.390	1.127	.279496	0.16	N.S.
ATTITUDE AREA: EXPERIMENTAL ATTITUDE								
1. Even though its value is not known, we should be willing to give television instruction a try. (+)	4.67	6.000	4.56	24.218	0.676	.167821	0.11	N.S.
32. It is doubtful that television science can have an important effect on achievement. (-)	2.30	23.630	2.24	29.562	0.896	.222208	0.06	N.S.
ATTITUDE AREA: IN-SERVICE OPPORTUNITIES								
28. A good way to acquaint teachers with new science content for schools would be to have television lessons for teachers after school hours. (+)	3.00	46.000	3.60	49.760	1.205	.298840	0.40	N.S.
31. For purposes of in-service education for teachers, television should be available for supervisory staffs. (+)	3.56	20.667	4.05	23.902	0.822	.203856	0.49	2.40*

TABLE XXXIV - continued

	Television		Conventional		Pooled S D	S E_D	M_1-M_2	t
	M_1	Σx_1^2	M_2	Σx_2^2				
ATTITUDE AREA: GENERALIZED								
13. One of the dangers of television in the classroom is that it increases disciplinary problem. (-)	1.67	34.000	2.41	45.952	1.100	.272800	0.74	2.71**
18. By bringing wider resources into the classroom, television instruction tends to foster the pupil's total intellectual growth. (+)	4.19	14.075	4.07	42.781	0.928	.230144	0.12	N.S.
22. An important value of science instruction by television is that it improves instruction. (+)	3.56	30.667	3.59	31.952	0.974	.241552	0.03	N.S.
25. Television instruction in science detracts from the quality of instruction. (-)	1.85	23.407	2.00	46.000	1.048	.259904	0.15	N.S.
29. A function of television in the classroom is in the improvement of instruction. (+)	3.26	27.185	3.76	35.562	0.975	.241800	0.50	2.06*
30. One of the advantages of television in the classroom is that it tends to reduce disciplinary problems. (-)	2.48	30.541	2.49	30.244	0.959	.237832	0.01	N.S.
33. When there is a staff of well prepared science teachers, television should not be used in the schools. (-)	2.33	30.333	2.07	30.781	0.959	.237832	0.26	N.S.
37. From a community standpoint, instructional television is just another luxury that costs the taxpayers money. (-)	2.00	24.000	2.27	34.049	0.937	.232376	0.27	N.S.
39. Television instruction in science increases teacher satisfaction by serving as an additional stimulus to energizing the class. (+)	3.96	28.963	3.90	19.610	0.857	.212526	0.06	N.S.
40. Television instruction in science enhances the student-teacher relationship by introducing a new dynamic into the classroom. (+)	3.56	34.667	3.78	29.024	0.982	.243536	0.22	N.S.
42. Science instruction by television can increase the classroom teacher's chances for advancement by exposing him (her) to new developments in teaching. (+)	3.37	34.296	3.93	30.781	0.993	.246264	0.56	2.27*

* denotes significance at the 5% level ** denotes significance at the 1% level

In reviewing the statistical analysis of the items in the survey questionnaire shown in Table XXXIV, the following interpretations are made.

CHALLENGE-THREAT - For those items which evaluated the teachers' attitude toward the challenge-threat which instructional television presented to them, the mean scores of the teachers in both the television group and the conventional classroom group rejected the notion that instructional television represented a threat to them as teachers. All of the items in this attitude area were written in such a manner that negative responses or those of disagreement with the items would suggest favorable or desirable attitudes toward the use of instructional television for elementary science. Six of the thirteen items in this area of challenge-threat also resulted in mean differences between the television group and the conventional classroom group which were statistically significant. Mean differences for the responses on items (5), (21), (48) and (50) were significant at the 5% level, and the mean differences for items (8) and (49) were significant at the 1% level. In the mean differences which were significant at these levels, the differences reflected stronger rejection for these challenge-threat items by the teachers in the television group. The teachers who had used television responded with significantly more positive attitudes toward the use of instructional television for elementary science for six of the challenge-threat items as compared with the mean response of the teachers in the conventional classroom group.

ECONOMY - For those survey items related to the possible economies which instructional television might provide, the teachers in both groups mildly rejected the notion that instructional television could provide economies by meeting increased enrollments and by contributing toward general savings in instructional costs. In this attitude area, two of the survey items resulted in significant differences between the mean responses of the teachers in the two groups. Both of these items suggested that instructional television could be used to meet increased enrollments and through this provide for economy of operation in instruction. For both of these items, the mean response of the teachers who had used television reflected significantly stronger rejection of the notion that instructional television could help to provide economy by meeting increased enrollments. In item (9), the mean difference was significant at the 5% level, and for item (23), the mean difference was significant at the 1% level.

INSTRUCTIONAL SIDE-BENEFITS - For those survey items which suggested that instructional television for elementary science provides instructional side-benefits for teachers, the mean response of the teachers in both groups reflected agreement or acceptance of this notion. They agreed that instructional television could acquaint teachers with new science content, provide ideas for using new methods, and provide more uniform science instruction. None of the mean differences between the television group and the conventional classroom group were significant for this attitude area.

PARTNERSHIP - For the five items of the attitude area which suggested the partnership which exists between the studio television teacher and the teacher in the classroom who is using instructional television, the mean responses of the teachers in both groups reflected agreement with this notion on three of the items. For item (12) which suggested that instructional television was a good means for a supervisory staff to make its work effective in the schools, the mean responses of the teachers in both groups reflected neither agreement nor disagreement. On item (46) which suggested that the celebrity of the television teacher in the eyes of the pupils tends to improve their attitudes toward science was rejected by both groups of teachers. None of the mean differences between the television group and the conventional classroom group were significant for this attitude area.

RESPONSIVENESS - For those survey items which suggested that instructional television was responsive to the instructional needs of elementary teachers, the mean responses of teachers in both groups reflected agreement. On item (20) there was a significant difference between the mean responses of the teachers in the two groups. This is an item in which we would anticipate a negative response or rejection by the teachers. The mean response of the teachers in the television group reflected significantly stronger rejection of the notion that instructional television could retard the professional advancement of teachers than did the mean response of teachers in the conventional classroom group. This difference was significant at the 1% level.

SECURITY - For the two items which suggested that instructional television might affect the security of the classroom teacher, the mean responses of both groups of teachers reflected rejection of this notion. Both groups of teachers strongly agreed that the television teacher can never replace the classroom teacher as shown by their mean responses for item (17). In addition, the mean responses of both groups of teachers rejected the notion that instructional television can release the classroom teacher for more important duties by providing more free time for her.

This was reflected in their responses for item (45). However, there was a significant difference in the mean response of the teachers for this particular item. The teachers in the television group rejected this item more strongly. This difference was significant at the 5% level.

INVIDIOUS COMPARISON - The items in this attitude area suggested that the introduction of instructional television into the classroom resulted in the classroom teacher being subjected to a comparison with the television teacher that was offensive to the classroom teacher. For two of the items, (2) and (4), the mean responses of the teachers in the two groups reflected neither agreement nor disagreement. For one of the items, (3), there was strong agreement by both groups. None of the mean differences between the television group and the conventional group were statistically significant for this attitude area.

EXPERIMENTAL ATTITUDE - For the two items which suggested that we should be willing to make use of instructional television with an open mind toward its value, the mean responses of both groups of teachers reflected agreement with this notion. None of the mean differences between the television group and the conventional classroom group were statistically significant for this attitude area.

IN-SERVICE OPPORTUNITIES - For the two items which suggested that instructional television should be used for in-service programs outside of its use in the regular instructional program, the mean response of the teachers in the television group reflected neither agreement nor disagreement. For item (31), the mean response of the teachers in the conventional classroom group reflected acceptance of this possible use of television.

For this particular item, there was a difference in the mean response of the two groups which was significant at the .05 level.

GENERALIZED - These survey items were not identified by Westley and Jacobson[36] as being related to any of the preceding attitude areas in their analysis; therefore, they are treated as a separate area of generalized attitudes. For all of these items, the mean responses of the teachers in both groups were consistent with the anticipated responses which would suggest favorable attitudes toward the use of instructional television.

For three of these items, there were significant differences between the mean responses of the teachers in the two groups. For item (13) which suggested that instructional television increased disciplinary problems, the mean response of the teachers in the television group reflected significantly stronger rejection than did the mean responses of the teachers in the conventional classroom group. This difference was significant at the 1% level.

For item (29), which suggested that a function of television in the classroom was in the improvement of instruction, the mean response of the teachers in the television group reflected neither agreement nor disagreement. The mean response of the teachers in the conventional classroom group reflected agreement or acceptance for this item. The difference in the mean responses between the two groups was significant at the 5% level.

For item (42), which suggested that science instruction by television increased the teacher's chances for advancement by exposing her to new developments in teaching, the mean response of the teachers in the television

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[36] Ibid.

group reflected neither agreement nor disagreement. The mean response of the teachers in the conventional classroom group reflected agreement or acceptance for this item. The difference in the mean response between the two groups was significant at the 5% level.

In summary, the mean responses of the teachers in both the television group and the conventional classroom group reflected attitudes which were favorable toward the use of instructional television. For the fourteen which resulted in significant differences between the mean responses of the teachers in the two groups, eleven of the mean differences reflected more favorable attitudes by the teachers in the television group, and the significant mean differences on the remaining three items reflected more favorable attitudes on the part of the teachers in the conventional classroom group.

CHAPTER VIII

THE EXPERIMENTAL DATA AND ANALYSIS

TEACHERS' FEELINGS OF CONFIDENCE

In attempting to determine how confident the teachers involved in the study felt about teaching science, a questionnaire instrument was used. This questionnaire, "How Do I Feel About Teaching Science?", was developed by L. D. Evans[37] at the Center for School Experimentation, Ohio State University and is included in Appendix V.

This questionnaire was designed to measure how confident the teachers felt in various situations involving several aspects of elementary science teaching. There were a total of eight different teaching situations presented with an opportunity for the teachers to indicate how confident they felt about carrying out five specific teaching activities for each of the situations. The eight teaching situations were concerned with the following teaching questions or problems.

Situation A - "How are plants and animals alike?"

Situation B - "Demonstrating the presence of carbon dioxide in the breath"

Situation C - "How do plants grow?"

Situation D - "How do we predict the weather?"

Situation E - "How simple machines help us"

Situation F - "Requirements for healthy plant growth"

[37] L. D. Evans, "How Confident are Elementary School Teachers about Teaching Science?" Educational Research Bulletin, XL (October, 1961), pp. 179-185.

Situation G - "A study of the solar system"

Situation H - "Electricity and what it can do"

Five specific teaching activities were listed for each of the eight teaching situations outlined above, and the teachers had to indicate their feelings of confidence about carrying out these activities according to the following code.

(5) Very confident

(4) Moderately confident

(3) Uncertain

(2) Moderately unconfident

(1) Very unconfident

From the data which were collected with this instrument, it was possible to determine the feelings of confidence of teachers who were using instructional television and also for teachers in the conventional classroom group. All teachers of grades two through six in the two schools that were using instructional television and all teachers in grades two through six in the three control schools originally completed the questionnaire on January 11, 1963. This was prior to any evaluation of student achievement, student attitudes, or teacher attitudes. The teachers were asked to respond to the questionnaire a second time on May 23, 1963 at the conclusion of the study. Data were only collected for those teachers in the two groups who completed both the first and second administration of the questionnaire. A total of twenty-seven (27) teachers who were using instructional television and a total of thirty-six (36) teachers in the conventional classroom group responded to the questionnaire on both of these dates.

In an effort to collect data that would be a true and accurate reflection of the teachers' feelings of confidence, they were asked to supply only the name of their school and their grade level assignment on the questionnaire answer sheet; therefore, in analyzing the responses of the teachers in the two groups, it was not possible to individually match the responses of a given teacher on the first administration with her responses on the second administration of the questionnaire. This did limit the statistical analyses which could be made of the possible changes which might have occured between the two administrations. It also limited the amount of statistical analysis that could be made of the difference between the responses of the teachers in the two groups.

A frequency distribution of the responses of the teachers within the two groups on both the first and second administration of the questionnaire is reported in Table XXXV. In addition, the mean response of the teachers in both groups for each of the eight teaching situations previously described are reported. These mean responses will principally be considered in analyzing this data.

In teaching situation "A" the mean response of the teachers in both groups on the first administration indicated a feeling of moderate confidence. On the second administration the mean response of the teachers in both groups indicated a slightly higher feeling of confidence. Since this situation was concerned with an area of natural science with which most elementary teachers feel at ease, these results suggest a typical reaction.

In teaching situation "B" which was concerned with the teaching of physical science concepts which involved simple experimentation, the mean

TABLE XXXV

FREQUENCY DISTRIBUTION OF TEACHERS' RESPONSES

"HOW DO I FEEL ABOUT TEACHING SCIENCE?"

Teaching Situation and teaching activities		First Administration										Second Administration									
		Television					Conventional					Television					Conventional				
	SCALE*	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1
<u>SITUATION A</u>																					
Your class is doing a unit on "Animals." The children ask the question, "How are plants and animals alike?" How confident would you feel about carrying out these activities?																					
1. Have children observe pets and plants at home to see how they are similar in basic needs.		13	12	2	0	0	20	12	3	1	0	18	9	0	0	0	26	9	1	0	0
2. Take the class on a field trip to notice the variations in plants and animals.		7	13	7	0	0	15	17	3	1	0	11	15	1	0	0	17	19	0	0	0
3. Do experiments to see if both plants and animals need water, food, etc.		12	9	5	1	0	23	9	4	0	0	13	13	1	0	0	17	17	2	0	0
4. Discuss with the class some of the similarities and differences between plants and animals.		8	18	1	0	0	20	15	1	0	0	14	12	1	0	0	23	12	1	0	0
5. Provide reference lists of children's books on plants and animals.		10	14	3	0	0	19	13	3	0	1	12	8	5	2	0	19	12	5	0	0
MEAN RESPONSE FOR SITUATION A		4.22					4.42					4.41					4.53				

TABLE XXXV - continued

	First Administration										Second Administration									
	Television					Conventional					Television					Conventional				
	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1
SITUATION B A fourth grade teacher is just a little afraid to do experimentation with her class. One day she attempted to demonstrate the presence of carbon dioxide in the breath. She had one of the pupils blow air through a straw which was immersed in a glass of lime water. The carbon dioxide in the pupil's breath should have made the calcium precipitate out and turn the water a milky color. However, much to the class's delight, the lime water stayed clear and the calcium did not precipitate. How confident would you feel about carrying out these activities?																				
6. Do the experiment over again using a new solution of lime water.	4	13	7	2	1	12	18	6	0	0	9	9	8	1	0	18	14	4	0	0
7. Discuss suggestions from the class to determine what was the reason for the failure in the experiment.	4	12	6	4	1	9	23	1	3	0	9	11	6	1	0	20	11	5	0	0
8. Try another experiment which will show the same body process as the one which failed.	2	9	10	4	2	5	19	10	2	0	4	13	7	3	0	12	18	4	2	0
9. Discuss some other related experiments which attempt to show the same results as the one which failed.	1	10	10	4	2	4	22	7	2	1	5	9	8	5	0	9	17	8	1	1
10. Encourage reading by children to discover possible reasons for failure in the experiment, provide reference materials for them to use.	4	10	11	0	2	16	10	7	2	1	10	10	3	3	1	18	9	8	0	1
MEAN RESPONSE FOR SITUATION B	3.40					4.01					3.84					4.20				
SITUATION C Your class is working on a unit of study in "How do plants grow?" How confident would you feel about carrying out these activities?																				
11. Read in books about plants and how they grow.	20	7	0	0	0	27	5	3	1	0	21	6	0	0	0	30	3	2	1	0

TABLE XXXV - continued

	First Administration										Second Administration									
	Television					Conventional					Television					Conventional				
	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1
12. Observe a plant in a box or container to record growth changes.	19	8	0	0	0	26	9	0	1	0	23	4	0	0	0	28	8	0	0	0
13. Do experiments to show how a plant seed germinates.	15	9	2	1	0	15	19	2	0	0	16	9	2	0	0	24	8	3	1	0
14. Provide a list of references of children's books.	15	9	3	0	0	19	11	5	0	1	14	8	4	1	0	22	8	5	0	1
15. Have a sharing discussion about plants that children have in their homes.	17	9	0	1	0	22	12	1	1	0	19	6	2	0	0	21	12	2	1	0
MEAN RESPONSE FOR SITUATION C	4.49					4.49					4.61					4.58				
SITUATION D Your fourth grade class is studying a unit on weather. The question is raised, "How does the weather man know it's going to rain?" How confident would you feel about carrying out these activities?																				
16. Construct and use a model barometer or other equipment used by the weather man.	3	9	7	6	2	7	14	9	5	1	2	14	8	3	0	7	12	15	2	0
17. Use science kit to conduct experiments to determine causes of precipitation, condensation, etc.	3	10	9	4	1	7	17	9	2	1	5	13	6	3	0	12	16	5	3	0
18. Encourage children to read in reference materials to find information about weather.	8	14	5	0	0	18	14	3	1	0	13	11	2	1	0	20	13	3	0	0
19. Help the children design and follow through with a daily weather chart.	10	14	3	0	0	23	10	2	1	0	16	11	0	0	0	23	9	4	0	0
20. Form a committee to investigate the question further and provide a list of resource materials for committee use.	9	12	4	2	0	13	15	5	2	1	10	8	7	2	0	16	14	5	1	0
MEAN RESPONSE FOR SITUATION D	3.79					4.05					4.04					4.19				

TABLE XXXV - continued

	First Administration										Second Administration									
	Television					Conventional					Television					Conventional				
	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1
SITUATION E																				
Your class is doing a unit study in "How simple machines help us." How confident would you feel about carrying out these activities?																				
21. Observe the ways that simple machines are used in the school or community and record results of observations.	12	11	4	0	0	19	11	5	1	0	16	8	3	0	0	21	10	5	0	0
22. Provide a list of children's books on the use of simple machines.	11	9	7	0	0	15	14	6	0	1	14	9	3	1	0	21	11	3	0	1
23. Discuss with the class the basic principles behind the workings of a pulley and some of its practical uses.	7	10	7	3	0	17	12	6	1	0	9	14	4	0	0	18	13	2	3	0
24. Have a sharing and discussion period about children's toys which resemble simple machines.	11	11	3	2	0	18	13	4	1	0	14	10	3	0	0	17	13	4	2	0
25. Discuss some of the uses of similar simple machines such as the lever, inclined plane, ball bearings, etc.	7	7	8	4	1	17	11	7	1	0	10	11	6	0	0	19	11	3	2	1
MEAN RESPONSE FOR SITUATION E	3.99					4.26					4.31					4.33				
SITUATION F																				
While on a field trip, the school bus passes through an area where corn is planted. It has been a rainy year, and some of the corn fields are flooded in spots, and the corn is dying. The children discussing the trip the next day, raise the question, "We have always been told that water is needed for plant life; why is the corn dying? It has plenty of water." How confident would you feel about carrying out these activities?																				
26. Discuss some experiments which the class may do to determine some of the requirements of plant life, and some conditions which may harm plants.	8	13	6	0	0	11	22	2	1	0	11	11	4	1	0	17	16	2	1	0

TABLE XXXV - continued

	First Administration										Second Administration									
	Television					Conventional					Television					Conventional				
	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1
27. Do experiments with different kinds of plants to show that each of them have slightly or greatly different environmental requirements for ideal growth.	8	9	9	1	0	7	18	11	0	0	11	11	3	2	0	12	20	3	1	0
28. Form a committee for further investigation of the problem; provide appropriate reference materials for them to use.	11	8	6	2	0	10	11	11	3	1	13	5	6	3	0	12	19	3	1	1
29. Have children observe plants in their homes and gardens to determine effects of the environment on the plants.	9	12	6	0	0	8	23	5	0	0	13	10	4	0	0	17	14	5	0	0
30. Make an observational chart of some local plants which live in the water, others which live on dry land. Observe local plants and record results.	5	16	3	2	1	9	19	8	0	0	9	14	3	1	0	14	12	9	1	0
MEAN RESPONSE FOR SITUATION F	3.99					3.98					4.17					4.22				
SITUATION G Your classroom is doing a unit study on the solar system. How confident would you feel about carrying out these activities?																				
31. Plan a trip to a nearby observatory or planetarium.	9	14	4	0	0	15	17	2	2	0	17	8	0	2	0	22	9	5	0	0
32. Find information about the solar system in materials other than the text which would be at an appropriate reading level for the children.	10	12	5	0	0	14	18	3	1	0	15	9	2	1	0	22	11	3	0	0
33. Design an observation chart of the visible planets. Observe the visible planets and keep a record of their positions in the night sky.	2	8	10	6	1	4	14	13	3	2	5	7	10	2	3	7	16	9	4	0
34. Construct a model of the solar system using balls, marbles, or beads to show the approximate relative sizes of the sun and the planets.	8	11	7	1	0	14	8	9	4	1	13	9	5	0	0	15	10	8	3	0

TABLE XXXV - continued

	First Administration										Second Administration									
	Television					Conventional					Television					Conventional				
	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1
35. Have a class discussion on the importance of the sun.	9	13	5	0	0	21	12	2	0	1	16	9	2	0	0	25	9	2	0	0
MEAN RESPONSE FOR SITUATION G	3.93					4.04					4.21					4.28				
SITUATION H																				
Your classroom is working on a unit study of "Electricity and what it can do." How confident would you feel about carrying out these activities?																				
36. Construct a model electric motor from inexpensive materials.	0	3	8	6	10	6	6	15	4	5	2	5	11	5	4	5	8	15	3	5
37. Do experiments to show how a light bulb works.	1	6	8	9	3	5	14	9	5	3	4	11	7	5	0	13	8	8	4	3
38. Dismantle old or broken appliances to observe and learn more about how they work.	2	3	10	7	5	3	13	12	5	3	3	10	6	5	3	9	12	6	3	6
39. Provide a list of references of children's books on the uses of electricity.	5	12	9	1	0	14	13	6	2	1	11	9	5	2	0	17	14	2	2	1
40. Discuss some of the ways electricity is used in the school.	11	14	2	0	0	20	13	2	1	0	15	10	2	0	0	25	9	1	1	0
MEAN RESPONSE FOR SITUATION H	3.13					3.63					3.62					3.81				

* The scale for responses used in this table is detailed in the original questionnaire. Explanation may be found on page

The mean responses for the groups on each situation were computed by using the numerical values identified with each of the responses in the original scale.

response of the teachers in the television group was between the uncertain and the moderately confident region on the first administration. On the second administration, there was some increase in the mean responses of this group toward a feeling of moderate confidence. The conventional classroom group of teachers indicated a mean response of moderate confidence on both administrations.

In teaching situation "C" which again was concerned with a study of plant life or the natural science area, the mean responses of the teachers in both groups indicated a feeling that was between moderately and very confident. On the second administration, there was a slightly stronger feeling of confidence expressed as indicated by the mean responses for both groups of teachers.

In teaching situation "D" which was concerned with activities on the study of weather, the mean responses of the teachers in both groups indicated a feeling of moderate confidence on the first administration. For both groups, there was some increase in the mean response on the second administration; however, the mean response of both groups remained close to the level of a feeling of moderate confidence.

In teaching situation "E" which was concerned with a study of simple machines, the mean response of the teachers in both groups indicated a feeling of moderate confidence on the first administration. Once again, for both groups, there was some increase in the mean response on the second administration; however, the mean response of both groups remained similar and close to the level of a feeling of moderate confidence.

In teaching situation "F" which was concerned with the study of plant life, the mean response of the teachers in both groups indicated a feeling of moderate confidence on the first administration. Once again, for both groups, there was some increase in the mean response on the second administration; however, the mean response of both groups remained similar and close to the level of a feeling of moderate confidence.

In teaching situation "G" which was concerned with a study of the solar system, the mean response of the teachers in both groups indicated a feeling of moderate confidence on the first administration. Once again, for both groups, there was some increase in the mean response on the second administration; however, the mean response of both groups remained similar and close to the level of a feeling of moderate confidence.

In teaching situation "H" which was concerned with the teaching of a unit on electricity, the mean response of the teachers in the television group indicated a feeling of uncertainty on the first administration. For the conventional classroom group, the mean response on the first administration was between uncertainty and a feeling of moderate confidence. On the second administration, the mean response of the teachers in the television group was between uncertainty and a feeling of moderate confidence. For the teachers in the conventional classroom group, the mean response on the second administration approached the level of a moderate feeling of confidence.

The two teaching situations that suggested uncertainty or slight confidence by the teachers in both groups were "B" and "H". Both of these teaching situations suggested experimental activities in areas of physical science study. It appears that those specific items in the questionnaire which suggested experimentation or trial activities in the broad areas of physical science were the ones which elicited the largest number of responses of unconfidence or uncertainty. If more items of this nature would have been included in the questionnaire, it is projected that a different response pattern would have resulted.

The results of this questionnaire as reported do not suggest any apparent differences in the feelings of confidence between the two groups of teachers as indicated by their mean responses. For most of the teaching situations, both groups of teachers indicated positive feelings of confidence as measured by the mean response. This level of confidence may be somewhat affected by the nature of the items, since a few specific items did suggest uncertainty and unconfidence for a number of teachers in both groups.

In considering the changes in the mean responses between the two administrations of the questionnaire, it does not appear that any unusual deviations in increase for the two groups can be noted. In every case the mean response on the second administration indicated an increase in the feeling of confidence for every teaching situation for both groups of teachers. This may have resulted from a normal increase which can be attributed to a period of teaching experience or to familiarity with the questionnaire on the second administration which elicited responses of a greater confidence level. With the exception of the mean responses of the two groups for teaching situation "B", there were very small numerical differences between the mean responses of the teachers in the two groups for the second administration.

The results of this questionnaire do suggest the need to offer less support for the elementary teacher in the areas of teaching related to natural science while more assistance might be provided to help the teacher gain more confidence in meeting experimental activities in the physical science area.

CHAPTER IX

SUMMARY AND CONCLUSIONS

This study of the effectiveness of elementary science telecasts of the Midwest Program on Airborne Television Instruction as utilized in selected schools of the School City of Gary, Indiana, was carried out during the Spring semester of the 1962-63 school year. The purpose of the study was to:

1. determine the relative effect on learning when the MPATI science telecasts are used for selected units of instruction as compared to conventional classroom instruction in terms of acquisition and retention of scientific facts, the understanding and application of scientific generalizations and principles, and scientific vocabulary growth,
2. determine whether any differences in achievement exist for students at different levels of ability for the two methods,
3. determine the attitudes of teachers who use these instructional telecasts toward their use for elementary science as compared to the attitudes of teachers in conventional classrooms toward the use of instructional television for elementary science,
4. determine the general attitudes toward the study of science of students in classes which use these instructional telecasts as compared to the attitudes of students in conventional classrooms toward the study of science,
5. determine the feelings of confidence about teaching science of the teachers who are using these instructional telecasts and compare

the feelings of confidence about the teaching of science of the teachers in the conventional classrooms.

In evaluating student achievement, six classes of students at the fifth grade level, which were using the MPATI "Exploring with Science" program series, were included. Five classes of students from conventional classrooms in schools of similar socio-economic level, student ability, and student achievement were included as a control group. Student achievement was evaluated on a unit of study on Magnetism and Electricity which extended for seven weeks in both types of classes. An achievement test prepared by the writer was used for pre and post testing.

At the third grade level five classes of students, which were using "The Science Corner" program series of MPATI, were evaluated for achievement. Six classes of third grade students in conventional classrooms from the same control schools identified earlier were also evaluated. Student achievement was evaluated on a unit of study on Young Animals and Plants and Animals in the Spring which extended for seven weeks in both types of classes. An achievement test that was prepared by the writer was used for pre and post testing.

In evaluating the students' attitudes toward the study of science, all of the classes of students which participated in the evaluation of achievement were also included in this part of the study. This included those in the television classes and in the conventional classes at both the fifth and third grade levels. In evaluating the students' attitudes toward the study of science, a questionnaire with an indirect scoring technique was used. The students were required to rank all of the academic subjects which they were studying in response to ten different questions which were posed. From this data, it was possible to compare the relative ranking which the students in the television group gave to the study of science as compared to the ranking which the students in the conventional classes gave to the study of science.

The evaluation of the attitudes of teachers toward the use of instructional television for elementary science was also accomplished with a questionnaire. A total of 27 teachers in grades two through six from the two schools which were using the MPATI science telecasts responded to the questionnaire. A total of 41 teachers in grades two through six from the three control schools with conventional classrooms also responded to the questionnaire.

The same two groups of teachers described above also responded to another questionnaire which determined how confident they felt about carrying out teaching activities in eight different teaching situations. The two groups of teachers responded to the questionnaire at the beginning of the Spring semester and also at the end of this semester.

This study gives and tends to imply certain conclusions.

Considering the 5th and 3rd grade students in the television and conventional classroom schools, the television group at both grade levels achieved higher mean scores on the California Test of Mental Maturity and on the pre-test. The conventional classroom group, at both grade levels, achieved higher mean scores on the post-test. All calculations of means and standard deviations were made using ungrouped data.

The fundamental assumptions of homogeneity of variance and homogeneity of regression which are fundamental to an analysis of variance and covariance are accepted.

Following an analysis of covariance an F value significant at the 1% level for these data at the 5th grade level and at the 3rd grade level indicated that there were differences in achievement of the classes taught by the different methods in favor of the conventional classes. Further analysis of these data by individual teacher class groups indicated significant differences in post-test scores achieved by the classes of different teachers. The class of one conventional classroom teacher at the 5th grade level achieved significantly better at the 1% level than all other classes in both the television and conventional classroom groups. The class of one other conventional classroom teacher at this grade level achieved significantly better at the 1% level than three of the television classes and three of the conventional classes and achieved significantly better at the 5% level than one of the television classes. The scores of one of the television classes at this grade level were significantly better at the 1% level than three other television classes and two of the conventional classes. Additional significant differences were found between classes in each of the two groups which suggest that the significant differences in achievement between the conventional classroom group and the television group can be attributed to factors other than those of method, at the 5th grade level. These differences are likely related to teacher differences.

The achievement data for the 3rd grade classes were similarly analyzed by individual teacher class groups. Results at this grade level also indicated that some differences in achievement were related to the teachers within each group; however, differences between the two groups were more consistent. The classes of four out of six conventional classroom teachers at the 3rd grade level achieved significantly better at the 1% level than all five of the television classes and two of the conventional classes. The class of one other conventional classroom teacher also achieved significantly better at the 5% level than two of the television classes. Only one of the television classes at this grade level achieved significantly better at the 1% level than one other television class and achieved significantly better at the 5% level than two other television classes. None of the television classes at the 3rd grade level achieved significantly better than any conventional class. Even though significant differences in achievement were found between classes within each group, the overall differences between achievement in favor of the conventional classroom group at the third grade level reflect a consistent pattern of superiority.

A methods by levels analysis of variance of the 5th grade data is which students were matched on the basis of initial California Test of Mental Maturity scores indicated that the achievement scores for the conventional classroom group were superior to the television group at the 1% level for students with a California Test of Mental Maturity score between 91-110. No significant differences were found between the two groups for the students who scored 111 and up and for those students who scored 90 and below. In view of the teacher differences which were suggested in the earlier analysis of covariance, one is reluctant to draw a conclusion that this difference for the 91-110, or average ability group, is a difference of method.

At the third grade level of instruction, a methods by levels analysis of variance in which students were matched on the basis of initial California Test of Mental Maturity scores was also performed. It indicated that the means for the conventional classroom group were superior to the television group at the 1% level for students at all three levels of ability identified above. This does indicate that the original differences found at the 3rd grade level in favor of the conventional classroom group were not related to any special level of ability, but were consistent for all levels of ability.

The attitudes of the students at the 5th grade level toward the study of science as measured by the questionnaire were subjected to chi square analysis. In their ranking of science as an area of study on the questionnaire, there were significant differences between the responses of the students in the two groups on nine of the ten comparison questions. Five of these questions indicated attitudes toward the study of science which were significantly better at the 1% level for the group as compared to the conventional classroom group. One other comparison question indicated an attitude toward the study of science that was significantly better at the 2% level for the television group as compared to the conventional classroom group. Three of the questions indicated attitudes toward the study of science which were significantly better at the 1% level for the conventional classroom group as compared to the television group. Two of these attitude questions which favored the conventional classroom group were concerned with the opportunity for questions and the opportunity for discussion which the students felt they had in the study of science. The students in the conventional classes indicated a more favorable response of these two items. These differences may suggest a serious shortcoming of the use of instructional television for science as it restricts interaction of the students. In reviewing all differences reported at the 5th grade level, students in the television group did reflect better attitudes toward the study of science than the students in the conventional classrooms did.

The student attitude responses toward the study of science at the 3rd grade level were subjected to the same statistical treatment. At this grade level, there were no significant differences indicated in the responses of the students in the two groups when they were compared.

In interpreting the responses of the teachers on the questionnaire used to assess their attitudes toward the use of instructional television for elementary science, mean scores and standard deviations for each of the 51 questionnaire items were computed for the two groups of teachers. These were later used to determine the significance of possible differences between the groups on each of the items. The mean responses of the teachers in both groups reflected attitudes which were decidely favorable toward the use of instructional television for elementary science. For fourteen of the items in the questionnaire, there were significant differences between the mean responses of the teachers in the two groups. On five of the items the mean response of the teachers in the television group reflected attitudes toward the use of instructional television for elementary science which were significantly better at the 1% level than those of the teachers in the conventional classroom group. On six other items in the questionnaire, the mean response of the teachers in the television group reflected attitudes toward the use of instructional television for elementary science which were significantly better at the 5% level than those of the teachers in the conventional classroom group. On three of the questionnaire items, the mean response of the teachers in the conventional classroom group reflected attitudes toward the use of instructional television for elementary science that were significantly better at the 5% level than those of the teachers in the television group. It can be concluded that both groups of teachers had positive attitudes toward the use of instructional television for elementary science; however, those teachers who had been using the MPATI science telecasts had significantly better attitudes on about one-fifth of the questionnaire items.

In an analysis of the feelings of confidence about the teaching of science which were indicated by the teachers in the two groups, a feeling of moderate confidence was reflected by the mean responses of the teachers in the two groups for six of the science teaching situations presented in the questionnaire. For two of the teaching situations presented, the mean responses of the teachers in the two groups reflected neither feelings of confidence nor unconfidence. Comparisons of the feelings of confidence of the teachers on the two administrations and a comparison of the responses of the teachers in the two groups did not reflect any apparent differences.

In view of the findings of this study which have been reported, the following recommendations are made for further study.

1. Continued evaluation of student achievement should be made which would extend over a longer period of time since the amount of time involved in the units of study evaluated in this study were limited.

2. Evaluation of student achievement should include more intensive evaluation of problem solving ability and the ability to apply scientific generalizations, since the actual level of achievement on the tests used in this study was low for students in both groups.
3. Evaluation of student achievement should be broadened to include more classes of students in an effort to minimize the possible effect of teacher differences within any group.
4. Evaluation of students' attitudes toward the study of science for the students involved in this study should be evaluated again after a lapse of time to determine whether the favorable attitudes of the television group remain.
5. Evaluation of teachers' attitudes toward the use of instructional television for elementary science involved in this study should be evaluated again after a lapse of time to determine whether the favorable attitudes of teachers in the two groups remain the same.
6. A different approach to determining whether teachers feel more confident in teaching science with instructional television should be devised for future evaluation.

As an evaluation of the use of the MPATI telecasts for elementary science in selected schools, this study suggests that classroom teachers are definitely interested and favorably disposed toward its use. The students at the 5th grade level who used instructional television for science reflected better attitudes toward the study of science. The results of the evaluation of student achievement at the 5th grade level were not totally conclusive, due to limitations already discussed. The students in the 3rd grade did achieve significantly better in the conventional classrooms. Therefore, it is recommended that continued utilization of all instructional telecasts be accompanied by a continuing program of evaluation and study including investigations of the type which have been suggested.

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APPENDIX I.

Table I - MAGNETISM AND ELECTRICITY UNIT SUMMARY SHEET - GRADE FIVE DATA

Table II - YOUNG ANIMALS AND PLANTS AND ANIMALS IN THE SPRING UNIT SUMMARY SHEET - GRADE THREE DATA

APPENDIX I

TABLE I

UNIT: MAGNETISM AND ELECTRICITY - GRADE FIVE

Teacher	N	CTMM ΣX_1	Pre-Test ΣX_2	Post-Test ΣY	ΣX_1^2	ΣX_2^2	ΣY^2	ΣX_1X_2	ΣX_1Y	ΣX_2Y
TV										
1	29	2,963	741	855	310,067	19,669	25,563	76,321	89,303	22,447
2	27	2,907	743	1,018	316,905	21,485	39,808	80,868	110,643	28,601
3	22	2,009	513	663	188,263	12,389	20,669	47,358	60,793	15,558
4	24	2,524	621	765	271,362	16,599	25,621	66,094	82,127	20,278
5	31	2,969	797	1,003	292,471	21,655	34,423	78,345	98,489	26,934
6	27	2,490	629	743	232,944	15,007	21,155	57,904	68,703	17,376
TV Total	160	15,862	4,044	5,047	1,612,012	106,804	168,239	406,890	511,058	131,194
Conventional										
1	36	3,394	887	1,025	328,490	22,545	31,023	84,032	98,002	25,981
2	38	3,680	882	1,176	367,250	21,396	38,422	86,682	116,551	27,924
3	32	3,097	786	1,360	304,221	19,904	59,388	76,400	132,478	33,869
4	38	3,739	865	1,337	376,161	20,409	49,231	86,180	133,370	30,982
5	25	2,611	610	749	277,121	15,304	23,535	64,360	79,552	18,678
Conv. Total	169	16,521	4,030	5,647	1,653,243	99,558	201,599	397,654	559,961	137,434
Grade Total	329	32,383	8,074	10,694	3,265,255	206,362	369,838	804,544	1,[illegible]1,019	268,628

APPENDIX I
TABLE II

UNIT: PLANTS AND ANIMALS IN THE SPRING - GRADE THREE

Teacher	N	CTMM ΣX_1	Pre-Test ΣX_2	Post-Test ΣY	ΣX_1^2	ΣI_2^2	ΣY^2	ΣX_1X_2	ΣX_1Y	ΣX_2Y
TV										
1	31	3,273	1,673	1,847	353,723	91,361	111,207	178,171	196,383	100,555
2	22	2,205	1,008	1,125	227,845	47,636	58,933	102,948	113,937	52,541
3	31	3,378	1,501	1,683	374,588	73,939	92,841	164,720	184,824	82,437
4	32	3,617	1,605	1,799	412,937	81,523	102,425	182,066	204,023	90,998
5	30	3,182	1,385	1,556	347,620	65,379	82,344	148,956	167,747	72,820
TV Total	146	15,655	7,172	8,010	1,716,713	359,838	447,750	776,861	866,914	399,351
Conventional										
1	28	2,620	1,303	1,516	250,378	61,675	83,172	122,948	142,834	71,228
2	25	2,430	1,174	1,332	242,110	56,518	72,564	115,660	131,151	63,456
3	34	3,641	1,627	2,125	401,571	78,833	134,031	175,811	229,765	102,343
4	30	3,040	1,601	1,965	317,624	86,255	129,695	163,521	200,462	105,372
5	32	3,275	1,483	1,913	342,345	70,811	116,043	153,838	198,008	90,046
6	26	2,891	1,375	1,723	331,023	73,335	115,023	153,974	193,082	91,455
Conv. Total	175	17,897	8,563	10,574	1,885,051	427,427	650,528	885,752	1,095,302	523,900
Grade Total	321	33,552	15,735	18,584	3,601,764	787,265	1,098,278	1,662,613	1,962,216	923,251

APPENDIX II

UNIT TEST FOR GRADE 5, MAGNETISM AND ELECTRICITY

UNIT TEST FOR GRADE 3, YOUNG ANIMALS AND PLANTS AND ANIMALS IN THE SPRING

UNIT OUTLINE FOR MAGNETISM AND ELECTRICITY

UNIT OUTLINE FOR YOUNG ANIMALS AND PLANTS AND AND ANIMALS IN THE SPRING

MULTIPLE CHOICE: Read each question and the numbered answers. When you have decided which answer is correct, blacken the space under that number on the answer sheet. Make your mark as long as the pair of lines, and move the pencil point up and down firmly to make a heavy black line. If you change your mind, erase your first mark completely. Make no stray marks on the answer sheet. The following is a sample question.

A. Gary is

1. a country
2. a mountain
3. an island
4. a city
5. a state

A. 1 2 3 4 5

Since answer number 4 is the correct answer, the space under the number 4 is blackened.

When your teacher tells you, start to answer the following questions in the same way.

1. An electric oven needs a larger wire in it than a light bulb because

    1. a large wire takes less electricity.
    2. a thick wire gives off more heat than light.
    3. a thin wire gives little light.
    4. all wires make the same amount of heat.

2. When we wish to stop an electric current, it is best to use a

    1. battery.
    2. socket.
    3. switch.
    4. terminal.

3. Copper is not a good metal for a heating element, because it

    1. is too expensive.
    2. has a low melting point.
    3. has a high melting point.
    4. breaks too easily.

4. When an electric current flows in one direction, stops, and then flows in the opposite direction, we say it is

    1. rotating.
    2. vacillating.
    3. direct.
    4. alternating.

5. Wind, water, gasoline, and electricity are

    1. forms of power.
    2. magic ways of doing things.
    3. expensive to use.
    4. hard to get.

6. A permanent magnet can be weakened if it is

    1. used too much.
    2. put in a fire.
    3. not used for a long time.
    4. soaked in water.

7. An electromagnet is an example of a

    1. temporary magnet.
    2. partial magnet.
    3. permanent magnet.
    4. natural magnet.

8. The strongest magnets can be made from

    1. small pieces of metal.
    2. soft iron.
    3. large pieces of metal.
    4. hard steel.

9. In making static electricity, the materials become charged by the

    1. addition or subtraction of electrons.
    2. exchange of protons.
    3. transfer of neutrons.
    4. exchange of like particles.

10. When we change the direction of flow of electricity in an electromagnet,

    1. its magnetic attraction is reversed.
    2. the poles of the magnet are turned around.
    3. the magnetic attraction is stopped completely.
    4. the dry cells are weakened.

11. A dry cell is an example of generating electricity by

    1. mechanical means.
    2. chemical means.
    3. friction.
    4. solar energy.

12. A doorbell is operated by

    1. a small motor.
    2. static electricity.
    3. an electromagnet.
    4. a permanent magnet.

13. A material usually used as a heating element in toasters and electric heaters is

    1. tungsten.
    2. carbon.
    3. nichrome.
    4. aluminum.

14. A material used as a filament is

1. carbon.
2. tungsten.
3. nichrome.
4. aluminum.

15. Conductors allow electricity to pass through them. Of the following, the best conductor is

1. copper.
2. steel.
3. aluminum.
4. lead.

16. The fuse in a circuit prevents fires by

1. making the short circuit complete.
2. slowing the flow of electricity.
3. breaking the circuit.
4. cooling the circuit.

17. A magnet hanging from a string will turn to a north-south position because of

1. its attraction to a compass.
2. the magnetic attraction of the earth.
3. the rotation of the earth.
4. the tilt of the earth on its axis.

18. Porcelain is used for light bulb sockets because it

1. conducts electricity well.
2. is easy to keep clean.
3. is a good insulator.
4. will not break easily.

19. If we were to cut or break a magnet into two pieces,

1. each of the new pieces would have a north and south pole.
2. the magnetic attraction would be lost.
3. one piece would be a north pole and the other a south pole.
4. one piece would remain a magnet and the other would not.

20. An example of a natural magnet is a

1. permanent bar magnet.
2. horseshoe magnet.
3. lodestone.
4. rod magnet.

21. One objection to using incandescent light bulbs for lighting is that they

1. make heat and waste electricity.
2. are too expensive.
3. are hard to replace.
4. give off radiation.

22. In a hydroelectric plant, water comes in direct contact with the

    1. generator.
    2. alternator.
    3. turbine.
    4. galvanometer.

23. Static electricity is difficult to make on a humid or damp day because

    1. things are too wet.
    2. the air absorbs the charges.
    3. sparks need dry air.
    4. water makes things slippery.

DIRECTIONS: The information in the following statements will help you to answer the questions that follow. Read the paragraph first. Then, try to answer the questions. You may read the paragraph again if you wish.

MAGNETIC ATTRACTION

A magnet that is strong enough will sometimes attract magnetic things through a thin piece of certain materials.

24. If we place a strong magnet on one side of a thin sheet of glass and place some iron filings on the other side of the glass, the

    1. magnet will not attract the filings.
    2. iron filings will be attracted to the magnet through the glass.
    3. magnet will be attracted to the glass.
    4. magnetic force may break the glass.

25. If we were to use a thin piece of cardboard or fiberboard instead of glass in the above experiment, the

    1. magnet will not attract the filings.
    2. magnet will attract the cardboard or fiberboard.
    3. iron filings will be attracted to the magnet through the cardboard or fiberboard.
    4. magnet will repel the iron filings.

26. If we were to use a sheet of iron instead of the glass in the above experiment, the

    1. magnet will attract the iron filings through the iron.
    2. iron filings will stick to the sheet of iron.
    3. magnet will not be bothered by the sheet of iron.
    4. sheet of iron will be attracted to the magnet.

27. The reason for the answer in number 26 is that

    1. the force of the magnet is "short circuited" by the sheet of iron.
    2. iron is a good conductor.
    3. a magnet will attract iron filings through iron.
    4. a magnet will attract through non-magnetic materials.

POLES ON A MAGNET

Poles on a magnet are usually marked with an N or an S. This is most true of bar magnets.

28. If you had a magnet that was not marked and did not have another magnet to check it with, how could you determine the magnetic poles on a bar magnet?

1. Test it with some thumb tacks.
2. Hang the magnet from a stand and check direction with the known direction.
3. Use iron filings on paper to check the lines of force.
4. Test it with non-magnetic materials.

29. The reason for the answer in number 28 is that

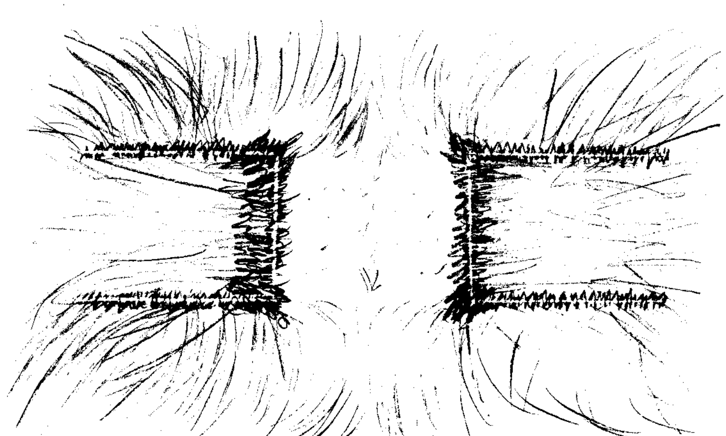
1. a magnet attracts objects of iron.
2. the north pole of a magnet that is hanging points to magnetic north.
3. a magnet can be moved by a compass.
4. north is always at the top of a map.

MAGNETIC LINES OF FORCE

There are lines of force around the poles of a magnet. These lines of force will affect magnetic materials that are near them. These lines of force can be made clear by placing a sheet of paper over the ends of magnets. Then, by putting iron filings on top of the sheet of paper, the iron filings will show the lines of force.

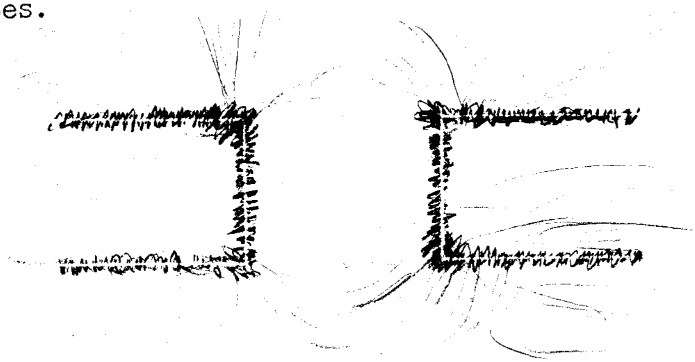
30. In the picture below showing the lines of force of two magnets, the

1. one on the left is a North Pole and the one on the right is a South Pole.
2. one on the left is a South Pole and the one on the right is a North Pole.
3. two poles are alike.
4. two poles are opposites.



31. In the picture below showing the lines of force two magnets, the two poles are

1. North Poles.
2. South Poles.
3. alike.
4. opposites.



32. If we were to cover the ends of a horseshoe magnet for this experiment, it would look the same as

1. unlike poles.
2. two North Poles.
3. two South Poles.
4. like poles.

GASOLINE TRUCKS

Many trucks that carry liquids that will burn such as gasoline, have a chain on the rear of the truck. This chain hangs from the truck and drags along the ground.

33. This chain on the truck

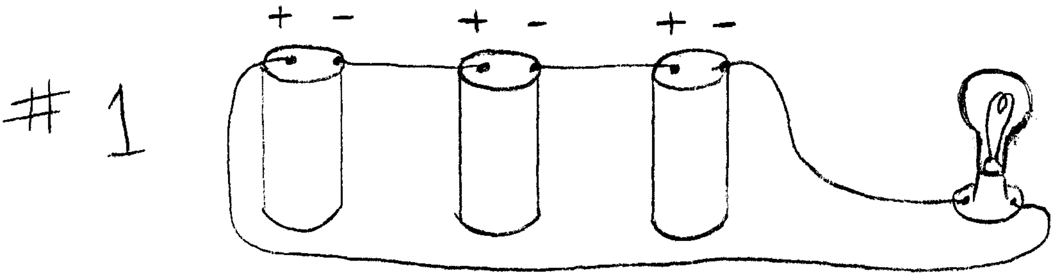
1. grounds static electricity.
2. picks up static electricity.
3. makes a complete circuit.
4. acts as an insulator.

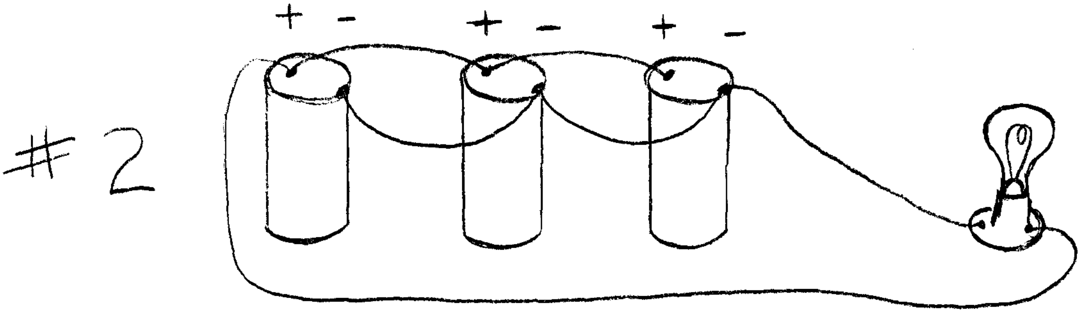
34. The purpose of having this chain is to

1. stop traffic accidents.
2. protect fumes from blowing up.
3. keep the driver from being shocked.
4. keep the driver awake.

ELECTRICAL CIRCUITS

Most of the dry cell batteries which we have in the classroom have an output of $1\frac{1}{2}$ volts. When we put three of these dry cells together, they can have an output of $1\frac{1}{2}$ volts or an output of $4\frac{1}{2}$ volts. It depends upon the way in which we connect the terminals of the dry cells. The drawings below show these two different ways of connecting the dry cells. One is called a parallel circuit and the other is called a series circuit.





35. In the drawings above,

1. Number 1 shows a series circuit, with an output of $1\frac{1}{2}$ volts.
2. Number 1 shows a series circuit, with an output of $4\frac{1}{2}$ volts.
3. Number 1 shows a parallel circuit with an output of $4\frac{1}{2}$ volts.
4. Number 2 shows a series circuit with an output of $1\frac{1}{2}$ volts.

36. A two-cell flashlight is an example of a

1. parallel circuit.
2. open circuit.
3. closed circuit.
4. series circuit.

37. Six $1\frac{1}{2}$ volt dry cells connected in a series circuit would have an output of

1. 6 volts.
2. $1\frac{1}{2}$ volts.
3. 3 volts.
4. 9 volts.

38. Six $1\frac{1}{2}$ volt dry cells connected in a parallel circuit would have an output of

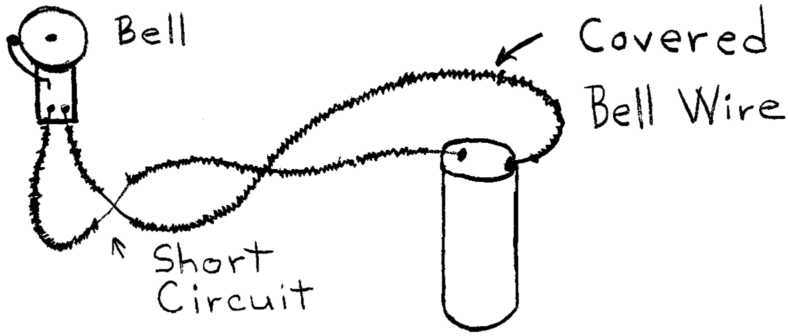
1. 6 volts.
2. $1\frac{1}{2}$ volts.
3. 3 volts.
4. 9 volts.

SHORT CIRCUITS

Short circuits can be dangerous when we are working with electricity. Many times, short circuits are caused by bare wires. A short circuit can cause fires or damage electrical equipment.

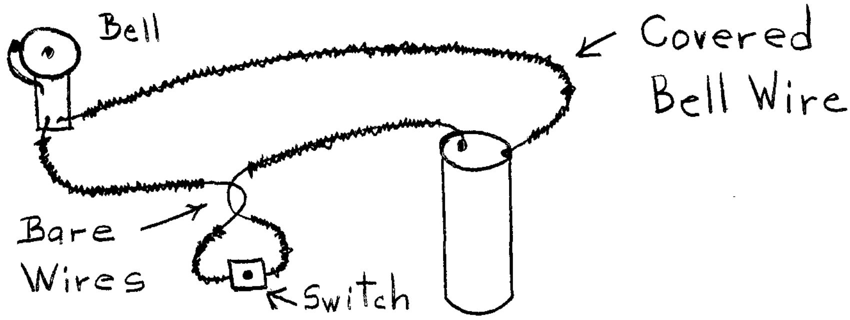
39. In the drawing showing a short circuit below, the

1. bell will ring continuously.
2. switch will burn.
3. wire will heat up.
4. circuit will operate normally.



40. In the drawing showing a circuit below, the

1. bell will keep ringing.
2. bell will not ring.
3. wire will heat up.
4. switch will burn



41. A fuse will protect wires from short circuits by

1. collecting the heat that is generated.
2. cooling the wires.
3. switching the circuit.
4. breaking the circuit.

Electromagnets are used in many toys, tools, and appliances. Some of them are very strong while others may be weak. Some of them can be seen while others are hidden from our view.

42. Which of the following would not have an electromagnet in it?

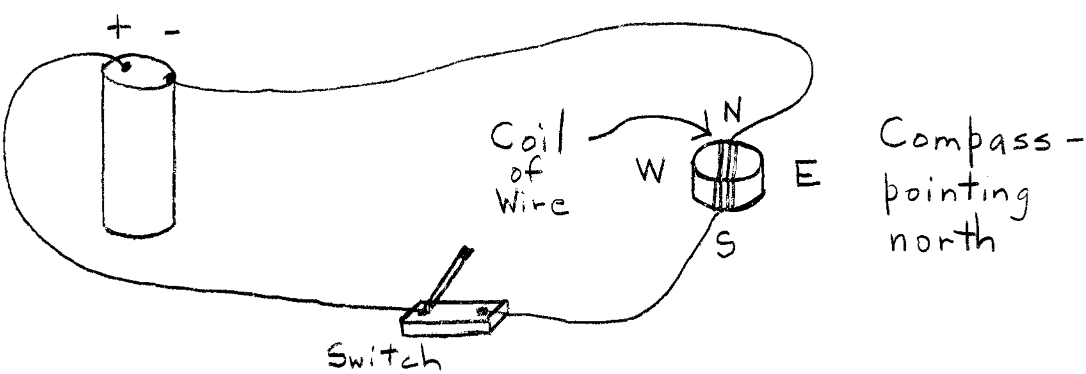
   1. record player.
   2. radio.
   3. electric toaster.
   4. electric mixer.

43. An electromagnet is used for loading and unloading scrap iron in a steel mill rather than a regular magnet because an electromagnet is

   1. stronger.
   2. less expensive.
   3. easier to control.
   4. always smaller.

DETECTING ELECTRICAL CURRENTS

It is easy to show that there is electricity in a dry cell, since all you have to do is wire up a light bulb, bell, or buzzer. If the bulb lights up or the bell or buzzer makes a sound, you know that you have an electric current. However, when the flow of electricity is so slight that it will not make a bulb light up or a bell ring, a better thing is needed to show that there is an electric current. Such instruments are called galvanometers. A compass galvonometer is shown below.



44. When the switch on the galvanometer is closed, the compass needle will

   1. spin continually.
   2. jump back and forth continually.
   3. turn at right angles to normal position.
   4. always point in a north-south position.

45. Electricity can be produced by a wet or "voltaic" cell. Which of the following would be used in such a cell?

1. A strip of copper, a strip of zinc, and an acid solution.
2 Two strips of zinc and an acid solution.
3. Two strips of copper and an acid solution.
4. A strip of copper, a strip of zinc, and distilled water.

46. Solutions which help to generate electricity in a wet cell are called

1. chlorides.
2. electrolytes.
3. transmitters.
4. commutators.

MAKING ELECTRICITY MECHANICALLY

A coil of wire moving in a magnetic field generates an electric current. This is the basic principle which is used in generating most of the electricity which we use in our homes.

47. Examples of putting to use the above idea includes

1. dry cells and magnetos.
2. electromagnets and generators.
3. dry cells and motors.
4. magnetos and generators.

48. We can increase the amount of electricity generated in this way by increasing the

1. strength of the magnet.
2. size of the magnet.
3. weight of the coil.
4. weight of the magnet.

MAGNETISM AND ELECTRICITY

TRUE - FALSE: Read the following statements. Decide whether they are true or false. If they are true, blacken the space under the T. If they are false, blacken the space under the F. Be sure to move to NUMBER 61 on your answer sheet.

T F 61. During a lightning storm, it is best to go indoors.

T F 62. When wiring on electric appliances becomes worn, it should be replaced at once.

T F 63. Experimentation with house current is very dangerous.

T F 64. Electrons cannot move if they are crowded.

T F 65. Light can push electrons.

T F 66. Electrons are found only in metals.

T F 67. A generator has no moving parts.

T F 68. Electric current can be generated by chemicals.

T F 69. Benjamin Franklin was knocked out when he did his kite experiment.

T F 70. A complete circuit is needed for an electric current to flow.

T F 71. Most electric current for our homes is alternating current.

T F 72. There is an electromagnet in every electric motor.

T F 73. The battery in an automobile is an example of a dry cell.

T F 74. Fluorescent lights have a filament that is very thin.

T F 75. The electric motor is a machine for producing electricity.

Name ______________________ School ______________________

Teacher ______________________ Date ______________________

YOUNG ANIMALS

PLANTS AND ANIMALS IN THE SPRING

DIRECTIONS: Read the question as your teacher reads it aloud. Choose the right answer and put its number in the blank space. Here is a practice question.

_____ A. The school we go to is in
1. Hammond
2. East Chicago
3. Gary
4. Hobart

Since the correct answer is Gary, and it has a number 3 in front of it, we write the number 3 in the blank space. We will mark the rest of these in the same way.

_____ 1. What is a pollywog when it grows up?
1. Big fish
2. Snake
3. Frog
4. Tadpole

_____ 2. A pollywog is hatched from
1. fish.
2. other pollywogs.
3. tadpoles.
4. frog eggs.

3. In what kind of a place would a frog like to live?
   1. In the water
   2. On dry land
   3. In a cage
   4. In the water and on land

4. An unhatched chick in an egg gets its food from
   1. the mother hen.
   2. the farmer.
   3. the egg yolk.
   4. the egg shell.

5. Food for plants and trees is made in the
   1. roots.
   2. leaves.
   3. stems.
   4. ground.

6. If we would plant some bean seeds in a dish with black dirt, keep them well watered, and keep them in a warm, dark closet, they would
   1. not begin to grow.
   2. grow to be big plants.
   3. start to grow.
   4. begin to bloom.

7. Some plants only grow for one year. At the end of the summer, they die, and we must plant new seeds the next year for these plants. They are called
   1. perennials.
   2. biennials.
   3. annuals.
   4. hardy plants.

8. When all of the minerals are taken out of the soil, it is
   1. good for farm plants.
   2. poor and useless.
   3. good for a flower garden.
   4. good for growing grass.

9. Some new plants start from the underground stems of old plants. Which one of these plants starts that way?
   1. Strawberry
   2. Carrot
   3. Bean
   4. Beets

10. A farmer who raises vegetables uses the greatest amount of his fresh water on the farm for
    1. drinking and cooking.
    2. the farm animals.
    3. watering his crops.
    4. washing and cleaning.

11. Which one of these plants or trees grows best where it is very warm and wet?
    1. Cattails
    2. Cactus
    3. Tumbleweed
    4. Pine trees

12. A special kind of garden in which we grow special plants is called
    1. a planetarium.
    2. an aquarium.
    3. a solarium.
    4. a terrarium.

13. How many legs do all insects have?

    1. 8
    2. 6
    3. 4
    4. 2

14. Of the following insects, which one sometimes builds its nest from mud?

    1. Wasp
    2. Bee
    3. Grasshopper
    4. Fly

15. A butterfly begins its life as a

    1. moth.
    2. worm.
    3. caterpillar.
    4. butterfly.

16. Which one of these animals has an outer covering that is hard like a shell?

    1. Crayfish
    2. Lizard
    3. Snake
    4. Toad

17. Which of these is not an insect?

    1. Spider
    2. Fly
    3. Bee
    4. Grasshopper

18. The drops of water that form on the glass lid of a terrarium come from

   1. the air in the terrarium.
   2. the plants in the terrarium.
   3. the soil in the terrarium.
   4. drops of rain.

19. Some plants have spores in place of

   1. leaves.
   2. roots.
   3. branches.
   4. seeds.

20. Which soil is best for growing flowers?

   1. Sand
   2. Clay
   3. Black Dirt
   4. Sand and clay together

21. Some flowers bloom early in the spring and others bloom late in the summer. Which one of these flowers would bloom first in your garden?

   1. Tulips
   2. Sunflowers
   3. Petunias
   4. Daisies

22. Which one of these animals is not hatched from an egg?

   1. Bird
   2. Snake
   3. Turkey
   4. Cat

23. The yellow part of a chicken egg is called the
    1. albumen.
    2. yolk.
    3. membrane.
    4. germ.

24. Plants have roots, stems, and leaves. The roots
    1. keep the plant from blowing over
    2. use the sunshine to make food.
    3. hold up the leaves.
    4. are usually green.

25. If you wanted to plant some seeds in your classroom garden that would grow very fast, which one of these would you choose?
    1. Grapefruit seeds.
    2. Radish seeds.
    3. Acorns.
    4. Apple Seeds.

26. Which one of these plants has spores to start new plants?
    1. Violets.
    2. Daisies.
    3. Mushrooms.
    4. Tulips.

27. Which one of these plants grows from a bulb?
    1. Potato
    2. Onion
    3. Bean
    4. Carrot

28. Mark the answer that tells what would happen to the leaf on a plant, if we covered it with black paper for a week.
    1. Nothing would happen.
    2. The plant would die.
    3. The leaf would turn yellow under the paper.
    4. The leaf would stay green under the paper.

DIRECTIONS: Read these sentences, as your teacher reads them aloud. If you think they tell things that are RIGHT put an X in the space. If you think they tell things that are WRONG, leave the space blank. Here is a practice question.

_____ A. There are only boys in our class.

Since there are boys and girls in your class, the sentence is WRONG. That is why we leave the space blank. If it was RIGHT, we would have put an X in the space.

_____ 29. A seed has a baby plant inside of it.

_____ 30. All insects hurt people and plants.

_____ 31. All seeds look the same.

_____ 32. A spider's web is used to trap insects.

_____ 33. All insects can fly.

_____ 34. An acorn is a seed.

_____ 35. We should kill all kinds of spiders when we see them.

_____ 36. Some spiders can kill people when they bite them.

_____ 37. Water will soak into all kinds of soil in the same way.

_____ 38. The farmer can use as much water on his farm as he wants.

_____ 39. All Spiders can spin webs.

_____ 40. A coconut is a seed.

41. Put an X in front of the sentences below which are signs of spring.

_____ The days get warmer.

_____ Squirrels collect acorns.

_____ The days are longer.

_____ Bears hibernate.

_____ We see more birds.

_____ Many dry leaves begin to blow.

_____ The ground gets warmer.

_____ The farmer picks his corn.

_____ The nights are longer.

42. Put an X in front of the sentences that tell ways by which we can study birds and learn to tell one kind of bird from another.

_____ See how big they are.

_____ See if they have wings.

_____ See what color they are.

_____ See if they can fly.

_____ Look at the kind of nest they build.

_____ Listen to the sounds they make or the songs they sing.

_____ See if they can walk.

43. Put an X in front of the sentences that tell ways that mother animals take care of their babies.

_____ Mother rabbit makes a nest.

_____ Mother bird looks for food.

_____ Mother dog barks to keep people away.

_____ Mother cat goes for a walk.

_____ Mother hen puts her chicks under her wings.

_____ Mother cow takes a rest in the shade.

_____ Mother deer walks in the field first.

44. Match the number of the parts of a plant below with the groups of words which follow:

1. BULB
2. STEM
3. ROOT

____ A round, soft, underground part of a plant.

____ The part of the plant above the ground which holds up the other parts.

____ A tree trunk and a cornstalk.

____ Onions, lilies, and tulips are grown from them.

____ It holds the plant in place.

____ It takes in water and food from the soil into the plant.

____ It holds the food to start a new plant.

45. Match the name of each animal with the place where it usually lives.

____ Squirrel	1. Lives under the ground.
____ Mole	2. Lives in trees.
____ Rabbit	3. Lives on the ground.
____ Racoon	
____ Deer	

46. Match the name of each animal with the name of the place where it lives on a farm.

____ Rabbit	1. Barn
____ Cow	2. Stable
____ Horse	3. Hutch
____ Chicken	4. Sty
____ Pig	5. Coop

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

1. THE GENERALLY ACCEPTED EXPLANATION OF THE NATURE OF MAGNETISM

   a. HEATING AND JARRING TEND TO WEAKEN A PERMANENT MAGNET.

   b. THE MOLECULAR THEORY OF MAGNETISM

   c. MAGNETS READILY ATTRACT IRON AND STEEL.

   d. THE ATTRACTION OF A MAGNET IS GREATEST AT THE POLES.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

COLLECTING MAGNETS

Ask the children to bring in examples of different kinds of magnets including bar magnets, horseshoe magnets, and an electric magnet. Discuss how each of them acts in much the same way even though their shape may be different. Discuss how some magnets are stronger than others.

TESTING FOR MAGNETIC ATTRACTION

Materials: Magnet; common objects found around the home or schools.
Procedure: Touch the magnet to each of these objects. Make a list of those objects that are attracted and another list of those that are not attracted. The magnet attracts those objects that are made of iron or steel. Test a small piece of cobalt and nickel. A Canadian 5¢ piece has nickel in it.

TESTING THE STRENGTH OF MAGNETS

Test the strength of the magnets brought into the classroom. Some have become very weak. Explain, using the molecular theory.

MAGNETIZING ITEMS

Materials: Bar magnet; tacks; nail.
Procedure: Place some tacks on the desk. Touch the nail to the tacks. They are not attracted to each other. Stroke the magnet with the nail, beginning at the center of the magnet and moving toward the end. Do this a number of times. Touch the nail to several tacks. The nail should now pick up the tacks. Try this with other metal items. Stroking magnetic materials on a magnet, magnetizes them.

TESTING MAGNETIC HOLDING POWER

Compare the ability of different materials to hold their magnetism as temporary magnets for a period of time. Make a chart to represent the findings. Hardened iron or steel will hold its magnetism for a long time. A nail or other object, made from soft iron, will not hold its magnetism long.

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

2. PERMANENT MAGNETS AND SOME OF THEIR CHARACTERISTICS

   a. IRON AND STEEL OBJECTS MAY BE MAGNETIZED.

   b. THE LAW OF MAGNETS: UNLIKE POLES ATTRACT; LIKE POLES REPEL.

   c. PERMANENT MAGNETS ARE USED IN MANY WAYS.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

MAKING A MAGNETIC BOAT

A variation in the novel aspects of magnetic force may be shown as follows: Using airplane glue, fasten a large needle to the bottom of a wooden ice cream spoon or a thin, flat, piece of wood. With a fairly strong magnet, this "boat" can be easily maneuvered over the surface of a pan of water. Discuss the fact that the force or energy from the magnet is doing the work.

SHOWING MAGNETIC ACTION

Materials: Two bar magnets; a piece of string; a support to hold the string.
Procedure: Suspend one of the bar magnets from the support with the string. Attach the string to the middle of the bar magnet. Hold the other magnet near each end of the suspended magnet. Observe its reaction. The like poles of the magnet should repel each other. The opposite poles of the two magnets should attract each other.

CHART IDEA

Make a list or collect pictures of uses for magnets or electromagnets. They are used locally for unloading scrap iron. Explain that they are also used in radios, telephones, telegraph sets, electric motors, and generators.

COLLECTING MAGNETS

Have the children bring in magnets of different kinds. Have them apply the law of magnets to discover the polarity of these magnets.

SHOWING MAGNETIC ACTION THROUGH GLASS

Materials: A paper clip; a strong permanent magnet; a thin piece of glass.
Procedure: Hold the piece of glass up on end on a table. Lay the paper clip on one side of the glass on the table. Place the magnet on the other side of the glass to attract the paper clip. Move the magnet toward the top of the glass. The paper clip will follow the magnet up the glass. The magnet does not attract the glass, but it will attract the clip through the glass.

SHOWING EFFECT OF HEAT ON MAGNETS

Make a magnet from a razor blade or other hard steel. (Use caution) Heat it in a flame and then test for magnetism. Heating lessens the magnetic attraction.

SHOWING EFFECT OF JARRING ON A MAGNET

Test the ability of a magnet to pick up tacks. Make a record of the number of tacks that it will pick up. Then strike the magnet several times on a heavy metal object. Then, test the magnetic power of the magnet. Jarring tends to weaken a magnet.

NATURAL MAGNETS

Discuss the reasons why some materials appear to have natural powers of magnetism such as lodestone.

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

3. A PERMANENT MAGNET HAS A MAGNETIC FIELD

   a. MAGNETIC FIELDS OF MAGNETS ARE MADE UP OF LINES OF FORCE.

   b. THE COMPASS IS INFLUENCED BY THE EARTH'S MAGNETIC FIELD.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

SHOWING THE MAGNETIC FIELD

Materials: Small quantity of iron filings; one magnet; piece of paper.

Procedure: Lay the magnet down on a desk. Lay the piece of paper flat over the magnet. Sprinkle iron filings on the paper. The iron filings will outline the lines of force and show where the greatest attraction is located. To pick up the iron filings simply pick up the paper. The iron filings will lose the attraction to the magnet. The iron filings will prove that the strongest lines of force are located at the poles of the magnet regardless of the particular shape of the magnet.

MAKING A MAGNET

Materials: A simple compass; horseshoe magnet; shallow dish; flat cork; a sewing needle.

Procedure: Pour some water into the dish. Magnetize the needle by stroking it with a magnet. Begin at the center of the magnet and move toward the end. Place the needle on top of the cork and float the cork in the dish of water. Mixing a sudless washing compound (teaspoonful) with water will prevent the cork from being drawn to one side of the dish. The needle will point in a north - south direction. Compare it with known direction or the direction shown by the simple commercial compass. A magnet left free to move, will position itself north and south. This results from the magnetic attraction of the earth itself.

COMPARING MAGNETIC FORCE

How does the force of the magnetic pull compare when a nail is held a short distance from the magnet, then moved away to twice the distance. Try to determine if there would be some magnetic force several inches or several feet away.

4. HOW ELECTROMAGNETS ARE MADE AND USED

a. A MAGNETIC FIELD SURROUNDS A WIRE CARRYING A CURRENT OF ELECTRICITY.

b. THE ELECTROMAGNET IS A TEMPORARY MAGNET CONSISTING OF A SOFT IRON CORE, A COIL, AND A SOURCE OF ELECTRICITY.

c. THE STRENGTH OF AN ELECTROMAGNET DEPENDS UPON:

(1) THE NUMBER OF TURNS OF WIRE IN THE COIL

(2) THE AMOUNT OF CURRENT PASSING THROUGH THE COIL

(3) THE SIZE OF THE CORE

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

MAKING AN ELECTROMAGNET

Materials: Iron nail or small bolt; a large dry cell; some doorbell wire.
Procedure: Using the nail or the bolt as a spool, wind several turns of doorbell wire onto it, keeping six inches of wire loose at each end, so they can be connected to the dry cell terminals. Before this is done, check the nail or bolt with several objects to determine if it is a magnet. After the electromagnet has been made, test its magnetic force with the same objects. Disconnect the magnet and try again. The electromagnet is only a magnet when a current of electricity is passing through the wire around it. The wires should be disconnected when the magnet is not in use.

STRENGTHENING AN ELECTROMAGNET

In continuing the above demonstration increase the number of times the wire is wrapped around the core. Try doubling the number of turns. Then, compare the ability of the electromagnet to pick up items such as thumbtacks. Keep a record of the number of turns on the core and the number of tacks that can be picked up by the electromagnet. The number of turns or coils on the core will increase the power of the electromagnet.

STRENGTHENING AN ELECTROMAGNET

In continuing the above test the ability of an electromagnet to pick up thumbtacks when the power source is from one dry cell. Make a record of this number. Then, attach a second dry cell, in series, to the electromagnet. Record the number of tacks that it will now pick up. Do this with more dry cells if they are available. Increased electrical power will increase the power of the electromagnet.

COMPARING EFFECT OF CORE SIZE

Make two electromagnets with the same number of dry cells and the same number of turns or coils on the core; however, on one use a thin core and on the other use a thicker core. Make a comparison of their ability to pick up tacks. The size of a core on an electromagnet will affect its magnetic power.

MAKING A TELEGRAPH KEY
Have the students make a simple telegraph key. Show how this is really an electromagnet in operation. Use the Morse code to send messages.

CHANGING POLARITY OF AN ELECTROMAGNET
Set up an electromagnet and have a compass on hand. Change the flow of the direction of the electricity through the electromagnet and show that this also affects the polarity of the electromagnet.

MAKING A BUZZER
Use the principle of the electromagnet to make a simple buzzer.

SHOWING A MAGNETIC FIELD
Attach a length of wire to both terminals of a dry cell. With the loop that remains attempt to pick up some iron filings. Discuss the fact that electric current passing through a wire develops a magnetic field.

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

5. ELECTRICITY CAN BE PRODUCED BY FRICTION

   a. STATIC ELECTRICITY MAY BE PRODUCED BY RUBBING.

   b. LIKE CHARGES OF STATIC ELECTRICITY REPEL, UNLIKE CHARGES ATTRACT.

   c. MATERIALS BECOME CHARGES BY ADDITION OR SUBTRACTION OF ELECTRONS.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

SHOWING STATIC ELECTRICITY

Materials: Test tube or glass rod; piece of silk or woolen cloth.

Procedure: Rub the test tube or glass rod briskly on the cloth. Bring the glass near bits of finely torn paper or pieces of cork. Note what happens. Paper is attracted because the glass and paper contain opposite charges (positive and negative) of static electricity.

SHOWING STATIC ELECTRICITY

Comb your hair rapidly with a rubber comb. Then, bring the comb near a fine, smooth stream of water. Observe the stream bend toward the comb. The unlike charges in the comb and the water are attracted to each other. Static electricity is a force.

SHOWING STATIC ELECTRICITY

Rub a toy balloon vigorously on a woolen coat sleeve. Then, release the balloon against a wall. Explain why it "sticks" to the wall. The opposite charges attract.

SHOWING STATIC ELECTRICITY

Materials: A square piece of glass; 2 books; a piece of silk cloth; tissue paper.

Procedure: Lay the books on the table a short distance apart. Cut small dolls or forms from the tissue paper and place them between the books. Lay the piece of glass on the books so that it covers the tissue paper forms. Rub the glass vigorously with the piece of silk. The tissue paper forms should jump up and down between the table top and the books. When the glass is rubbed, the silk receives electrons from the glass and becomes negatively charged. Since the glass is positively charged, the paper becomes negatively charged and is attracted to the glass.

SHOWING STATIC ELECTRICITY

Materials: A large, smooth sheet of tissue paper; a piece of fur or woolen cloth.

Procedure: Hold the sheet of paper against the blackboard. Rub it with the fur or cloth until it stays in place without your holding it. Fold the paper back from one edge. It will remain on the board while you fold it. Static electricity holds the paper to the board. This may not work well on a damp day since the charge of electricity on the paper is likely to escape through the air as fast as it is produced.

SHOWING STATIC ELECTRICITY

Materials: A sheet of thin paper; a piece of fur or woolen cloth.

Procedure: Cut a fringe along one side of the sheet of paper. Make the strips of the fringe about ½ inch wide and three inches deep. Hold the paper fringe down against the blackboard. Stroke the fringe downward with the fur or cloth a number of times. Then hold the paper in the upper corners and pull it away from the wall. The separate strips of fringe will stand out away from one another. The strips of paper all have the same kind of charge, and like charges repel one another. This helps to explain why our hair will sometimes "stand on end" when we comb it on a clear, cold day.

RESEARCH IDEA

Have children read the background of Ben Franklin's kite experiment with static electricity. Discuss the danger of this particular experiment.

CAUSING LIGHT

On a dry day in a darkened room, rub a fluorescent lamp with a woolen cloth. Explain the light that results.

SAFEGUARDS AGAINST STATIC ELECTRICITY

Discuss why it is dangerous to clean gloves or other material with gasoline, especially when you have to rub the material. Explain the relationship of static electricity to such cleaning. Discuss the reasons for a metal chain dragging behind a truck that is carrying gasoline. Discuss or make a list of the other ways in which man gets rid of troublesome static electricity.

SEEING STATIC ELECTRICITY

Materials: Roll of black, sticky bicycle tape.

Procedure: Darken the room. Pull a piece of tape away from the roll and observe closely. There should be a glow at the place where the piece of tape pulls away from the roll. Electrons are negative particles of electricity. Protons are positive particles of electricity. Neutrons have no electrical charge. Electrons move freely about in many substances, whereas protons and neutrons are generally stationary. Normally, a substance will have the same number of electrons and protons, and they will neutralize or cancel out each other. No electrical charge is then apparent. When objects are rubbed, electrons will move freely from one object to the other and upset the balance of electrons and protons.

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

6. ELECTRICITY CAN BE GENERATED THROUGH THE USE OF CHEMICALS.

   a. THE VOLTAIC CELL PRODUCES ELECTRICITY BY CHEMICAL ACTION.

   b. A DRY CELL IS A SOURCE OF CHEMICAL ENERGY

   c. THERE ARE VARIOUS METHODS OF DETECTING AN ELECTRIC CURRENT.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

CHART IDEA
Dismantle a large dry cell and make a large drawing of it, labeling each part. Explain the purpose of each part.

MAKING A WET CELL
Materials: Wide mouthed glass jar; a strip of copper 1"X5"; a strip of zinc 1"X5"; bell wire; flashlight bulb and socket; diluted sulphuric acid.

Procedure: Place the diluted sulphuric acid in the jar. Punch a hole in one end of the strips of metal and connect a length of bell wire to each of the strips. Connect the other ends of the bell wire to the flashlight bulb socket. Place the strips of metal in the jar of acid but do not allow them to touch each other. Some electrical energy should be produced to light the bulb. Explain that this is called a voltaic cell. Make a list of the other places where we use wet cells to produce electricity.

REVIVING A DEAD DRY CELL
Attempt to revive a "dead" dry cell by using a solution of water and vinegar or sal ammoniac.

DETECTING AN ELECTRIC CURRENT
Use a set of earphones to test the strength of dry cells. Earphones will detect small amounts of electric currents. List other ways of testing for an electric current.

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

7. ELECTRICITY CAN BE PRODUCED BY MECHANICAL MEANS.

   a. A CURRENT CAN BE PRODUCED AND WILL FLOW IN A CONDUCTOR IF THE CONDUCTOR IS PASSED THROUGH THE FIELD OF A MAGNET IN A CLOSED CIRCUIT.

   b. GENERATORS AND MAGNETOS PRODUCE ELECTRICITY BY MECHANICAL MEANS.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

MODEL IDEA

Have the children find plans for and build a working model of an electric motor. If this is not possible, pass a permanent magnet through a coil (20 turns) of wire. Use a compass or a set of earphones to detect the flow of electricity. Explain how this is related to the operation of an electric motor.

FIELD TRIP

Plan a visit to an electric power plant or have a resource visitor from the power company visit your class. Find out the source of power used to drive the generator in our power plants. Discuss other areas where water, coal, gasoline, or even nuclear energy is used to drive the turbines.

MAKING MODEL GENERATORS

Construct a wind-charger or water turbine to show how it is used to generate electricity.

RESEARCH IDEA

Have the children get information about or have a representative from the telephone company bring in a solar battery. Help the children to understand how we now can get electrical energy from the sun with the use of solar batteries.

8. SOME MATERIALS ALLOW A CURRENT OF ELECTRICITY TO PASS THROUGH THEM MORE EASILY THAN OTHERS.

   a. MATERIALS THAT ALLOW ELECTRONS TO FLOW THROUGH THEM EASILY ARE CALLED CONDUCTORS.

   b. MATERIALS THAT DO NOT ALLOW THE FREE FLOW OF ELECTRONS ARE CALLED INSULATORS.

   c. BOTH CONDUCTORS AND INSULATORS ARE IMPORTANT WHEN USING ELECTRICITY.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

TESTING MATERIALS AS ELECTRIC CONDUCTORS

Materials: Dry cell battery; electric bell; copper wire; a collection of materials and objects found in the classroom.

Procedure: Set up a complete circuit with the dry cell, the wire, and the bell. Cause the bell to ring. Then, disconnect one of the wires between the dry cell and the bell. Cut this wire in the middle and reconnect the ends to the dry cell and the battery. We now have a short circuit with one of the wires cut or broken. Then, insert each one of the items collected above between the two loose ends of the wire. When an item is inserted that is a conductor, the bell will ring. The conductors allow the electricity to pass through them. When the items will not allow electricity to pass through them, the bell will not ring. These items are called insulators.

CHART IDEA

From the above experiment make a chart listing all of those materials that are found to be good conductors of electricity. At the same time list all of those items that are good insulators. Try to list those qualities that are peculiar to conductors and those that are peculiar to insulators.

CHART IDEA

Collect pictures or make a list of all the things in our homes or schools which must serve as conductors of electricity. Make another chart or list of items which must serve as insulators. Explain why both of these kinds of materials are important to us in working with electricity.

RESEARCH IDEA

Have the children examine electric cords and old electric appliances to discover how conductors and insulators are used. A report of this might be written.

RESEARCH IDEA

Have the children look up references on the effect of very cold temperatures (supercooling) on the conductivity of materials.

RESEARCH IDEA

Have the children discover what transistors are and how they work.

RESEARCH IDEA

Have the children discover the difference between the "actual" flow of electrons in a current and our concept of the "conventional" flow of current.

9. ELECTRICITY CAN FLOW ONLY IN A CLOSED CIRCUIT.

   a. A SIMPLE CURCUIT CONSISTS OF A SOURCE OF ELECTRICITY, CONDUCTORS, AND A RESISTANCE.

   b. A SWITCH MAY BE USED TO CONTROL THE FLOW OF ELECTRICITY IN A CIRCUIT.

   c. CIRCUITS MAY BE WIRED IN SERIES OR PARALLEL.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

SHOWING A COMPLETE CIRCUIT

Materials: Flashlight bulb and socket; a dry cell; two pieces of bell wire about one foot long.

Procedure: Connect one wire to one of the dry cell terminals and the other end to the socket terminal. Check to see if the bulb will light. Try the single wire on the other terminals also. Then, use the second wire to make a complete circuit. Discuss and explain how two wires are needed to make a roadway for the electric current. One wire allows the current to flow from the dry cell to the bulb. The other wire allows the current to flow from the bulb back to the dry cell. A complete circuit is required to operate any electrical item.

EXAMINING A CORD

If an old electric cord and plug is available, take it apart so that the children can see that there are two wires inside of the cord. Also the plug has two prongs on it, and an electrical outlet has two holes in it. All electrical items require a complete circuit with two lines.

SHOWING HOW A SWITCH WORKS

Set up a complete circuit with a flashlight bulb and socket, bell wire, and a dry cell. Cut one of the wires between the dry cell and the bulb. Insert a knife switch and demonstrate its operation. Explain that when the switch is open, there is a broken circuit. When the switch is closed, there is a complete circuit.

COLLECTION IDEA

Have the children make a collection of the many different kinds of electrical switches. Explain how the basic operation of each of them is the same. If it is not possible to have the switches, make a picture collection of different kinds of switches.

MAKING A TELEGRAPH

As a class project, have the children make a simple telegraph set or an electric game board. Have them trace the flow of electricity through these circuits.

SHOWING PARALLEL AND SERIES CIRCUITS

Materials: Dry cell, two switches, two flashlight bulbs and sockets; bell wire.
Procedure: Using the above materials, demonstrate the difference between series and parallel connections for circuits.

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

10. WAYS IN WHICH CIRCUITS ARE USED IN OUR EVERYDAY LIVES

a. SOME CIRCUITS ARE VERY LONG. THE POWER LINES TO OUR HOMES ARE LONG CIRCUITS.

b. A SHORT CIRCUIT MAY CAUSE A FIRE.

c. FIRES MAY BE PREVENTED BY PLACING A FUSE IN THE CIRCUIT.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

TRIP IDEA

Visit a neighborhood power substation. Trace the power lines from the substation to a nearby home. Notice how more than one line enters the house. Discuss the reason for this. Have the children notice how the circuit from the power substation to some of the houses is very long. Have the children find out where the power line enters their own home.

SHOWING A SHORT CIRCUIT

Materials: Dry cell, flashlight bulb and socket; two pieces of insulated wire.
Procedure: Scrape some of the insulation from the middle part of each wire. Then, connect the two to make a complete circuit to light the bulb. Now, with a pencil push the two bare parts of the wire together so that they touch each other for a second. Discuss what happens to the bulb. You will find that the light goes out when the wires touch. This is because the current can flow easily across the short path from one wire to the other. Most of the current flows through the short path or circuit. Very little flows through the bulb. If we touch the bare parts of the wire together and hold them for a second or two, we can feel them become warmer and warmer. Don't hold them too long, for they can become red hot. Discuss the dangers of short circuits caused by frayed cords, loose plug connections, and the like. Emphasize that the amount of heat generated by a short circuit in our house current is many times more than that produced by the single dry cell.

SETTING UP A FUSE

Materials: Flashlight bulb and socket; dry cell; two lengths of insulated wire; a block of wood with two thumbtacks; several lengths of Christmas tinsel or icicles.
Procedure: Set up a complete circuit to light the bulb. Then, cut one of the lengths of wire. Place the two thumbtacks in the block of wood about two inches apart. Connect the free ends of the broken wire to the two thumbtacks. The bulb should light since the tinsel conducts the electricity. Then, disconnect the circuit and clean some of the insulation from the unbroken wire and also clean some of the insulation on the other wire. Do this between the tinsel and the bulb. Reconnect the complete circuit. Then, touch the two wires to form a short circuit. Hold them that way and watch the tinsel. You will see it heat up and melt at the center. When a fuse melts, it breaks the circuit. Electricity cannot flow across the broken space. There is no longer any danger of fire. The fuse is destroyed, but the wires have been protected.

COLLECTING FUSES

Make a collection of different types of fuses used in our homes or automobiles. Find the part of the fuse that will melt when it is overloaded or short circuited. Have the children make a large chart or picture of a fuse with all of the parts labeled.

WIRING SOCKETS AND PLUGS

Have the children collect old lamp sockets, wall plugs, or other electrical items and discuss the way in which they are wired. Emphasize the ways in which we must guard against short circuits in these.

FINDING A FUSE BOX

Have the children learn the location of fuse boxes in their home. Discuss what is necessary when fuses continue to blow on a circuit. Discuss the fact that some homes are now equipped with circuit breakers rather than fuses. Discuss how this is much the same as a fuse, but it does not require replacement when the circuit is shorted or overloaded.

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

11. HEAT AND LIGHT CAN BE PRODUCED BY AN ELECTRIC CURRENT.

    a. HEAT AND LIGHT ARE PRODUCED WHEN ELECTRICITY PASSES THROUGH CERTAIN SUBSTANCES.

    b. SCIENTISTS HAVE USED THIS INFORMATION TO DEVELOP MANY OF OUR APPLIANCES.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

GENERATING HEAT FROM ELECTRICITY

Materials: Thin insulated copper wire; six or eight penny nail; $1\frac{1}{2}$ volt dry cell battery.

Procedure: Make a tight coil with the wire around the nail. Make the coil about three inches long. Attach one end of the coil to the positive post of the dry cell and attach the other end to the negative post. Observe the heat that is generated.

CHART IDEA

Make a collection of pictures of appliances which are used to generate heat or light. Include such items as toaster, room heaters, electric frypans, and so forth. Attempt to identify the location of the filament on each one of them.

RESEARCH IDEA

Have the children accumulate information on Edison and the incadescent light. Have them discover that when a filament is heated to a high enough temperature, some of the energy is given off as light. Discuss the reason why metals such as nichrome and tungsten are used for this purpose. Attempt to discover what qualities they have that suits them to this purpose.

RESEARCH IDEA

Have children research and report to the class on the operation of a fluorescent light, a neon sign, and a mercury vapor lamp.

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

12. THE IMPORTANCE OF USING ELECTRICITY SAFELY

    a. MEN WHO WORK WITH ELECTRICITY HANDLE IT VERY CAREFULLY.

    b. THE CARELESS USE OF ELECTRICITY MAY RESULT IN THE LOSS OF PROPERTY, INJURY, OR EVEN DEATH.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

MAKING A CHECKLIST
Have the children prepare a checklist of the danger points around the house that might result in electrical fires. Have the children use the checklist to inspect their homes with their parents.

RESOURCE VISITOR
Invite a fireman to discuss the number of fires in our community that started through the careless use of electricity. The fireman might also assist with the checklist above.

RESOURCE VISITOR
Invite a lineman from the local power company in to explain the many ways in which he is careful in protecting himself in his work with electricity.

RESEARCH IDEA
Have the children discover why it is necessary to have a separate fuse for each of the circuits in a house. Find out why some appliances must be placed on a separate circuit. Discuss the idea of what an overload on a circuit is.

SUGGESTED RESOURCES

BASIC TEXT REFERENCE:

Schneider, Herman and Nina. Science in Our World. Boston: D. C. Heath and Company, 1959.
pp. 266-282 "How We Get Electricity"
pp. 282-308 "How We Use and Control Electricity"

SUPPLEMENTARY BOOKS:

Atkin, J. Myron and R. Will Burnett. Electricity and Magnetism. (Elementary School Science Activity Series) New York: Rinehart and Company, Inc., 1959.

Beeler, Nelson F., and Franklyn M. Branley. Experiments in Science. New York: Thomas Y. Crowell Company, 1950.

Beeler, Nelson F., and Franklyn M. Branley. More Experiments in Science. New York: Thomas Y. Crowell Company, 1956.

Branley, Franklyn and Eleanor Vaughn. Rusty Rings a Bell. New York: Thomas Y. Crowell Company, 1957.

Branley, Franklyn. Timmy and the Tin Can Telephone. New York: Thomas Y. Crowell Company, 1959.

Epstein, Samuel and Beryl Williams. The First Book of Electricity. New York: Franklin Watts, Inc., 1953.

Freeman, Ira M. All About Electricity. New York: Random House, Inc., 1953

Freeman, Mae. The Story of Electricity. New York: Random House, Inc., 1961.

Kennedy, John M. Making Electricity Work. New York: The Thomas Y. Crowell Company, 1959.

Mandelbaum, Arnold. Electricity. New York: G. P. Putnam's Sons, Inc., 1960.

Meyer, Jerome S. Picture Book of Electricity. New York: Lothrop, Lee, and Shepard Company, Inc., 1953.

Morgan, Alfred P. The First Electrical Book for Boys. New York: Charles Scribner's Sons, 1951.

Parker, Bertha M. Golden Book of Science. New York: Simon and Schuster, Inc., 1956.

Pine, Tillie and Joseph Levine. Magnets and How to Use Them. New York: (Whittlesey House) McGraw-Hill Book Company, Inc., 1958.

Podendorf, Illa. True Book of Science Experiments. Chicago: Children's Press, 1954.

ELECTRICITY AND MAGNETISM

SUGGESTED RESOURCES

SUPPLEMENTARY BOOKS: (continued)

Schneider, Herman and Nina. Let's Look Inside Your House. New York: William R. Scott Company, Inc., 1948.

Schneider, Herman and Nina. More Power to You. New York: William R. Scott Company, Inc., 1953.

Schwartz, Julius. I Know a Magic House. New York: McGraw-Hill Book Company, Inc., 1956.

Syrocki, Boleslaus. What is Electricity? Chicago: Benefic Press, 1960.

Tannebaum, Harold. We Read About Electricity and How It Is Made. St. Louis: Webster Publishing Company, 1960.

Wyler, Rose. First Book of Science Experiments. New York: Franklin Watts, Inc., 1952.

Yates, Raymond F. A Boy and a Battery. New York: Harper and Brothers, 1959.

Zim, Herbert S. Lightning and Thunder. New York: William Morrow and Company, Inc., 1952.

FILMS:

These films are available from the Central Audio-Visual Department. Check your A-V Guide for a more complete description of the films. Contact your building A-V Coordinator to arrange for the use of these films.

All films should be previewed to determine suitability for use with your particular class.

Electromagnets

Flow of Electricity

Michael Discovers Magnets

How We Get Our Power

Nature of Electricity

FILMSTRIPS:

These filmstrips are available from the Central Audio-Visual Department. Some of them may be available in your building collection of filmstrips. Check with your A-V Coordinator.

Filmstrips borrowed from the Central A-V Department are intended only for preview. If, after preview and use with your class, you find them to be helpful, recommend that your coordinator consider them for addition to your building collection.

ELECTRICITY AND MAGNETISM

SUGGESTED RESOURCES

FILMSTRIPS: (continued)

- #241 Magnets
- #242 Electricity
- #249 Light - Elementary Science Series-Set II
- #250 Frictional Electricity
- #281 Magnetism and Electricity
- #937 Power Moves Things
- #8041-#8046 Science at Work Series

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

1. POLLYWOGS (TADPOLES) DEVELOP INTO MATURE FROGS.

   a. POLLYWOGS HATCH FROM EGGS AND NEED FOOD AND AIR IN ORDER TO GROW AND CHANGE.

   b. FROGS LIVE PART OF THEIR LIVES IN THE WATER AND PART ON THE LAND.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

CARING FOR POLLYWOGS

Place some pollywogs in an aquarium with water (without fish). It may be necessary to change the water frequently to remove the excess carbon dioxide. The aquarium in which developing tadpoles are kept must have something on which the animals can crawl to get out of the water. As soon as the tadpoles start using their lungs they must take their air from the surface. A slanting board or a large rock will serve this purpose. Have the children watch the development of the tadpoles. When there is no further need for them in the classroom they may be placed in a pond. Pollywogs are usually available at some pet stores, science supply companies, and ponds, and often from children themselves.

SPECIAL ACTIVITIES

Have the children make periodic sketches of the tadpoles as they grow, recording information about their care. Have the children read and write stories about them.

OBSERVING FEEDING HABITS OF FROGS AND TOADS

The feeding habits of a toad or frog are interesting. The animal may be kept in a terrarium. Live flies released in the terrarium provide it with food. Sooner or later one of these flies will come near the toad and suddenly disappear. It is also amusing to watch the toad eat a live fishworm, stuffing the dangling ends in first with one front foot and then the other. Remember that the toad will only eat things it sees in motion . . . not dead food.

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

2. A DEVELOPING ANIMAL CAN BE INSIDE AN EGG AND WILL SOON COME OUT.

   a. THERE ARE FOUR PARTS TO EVERY EGG.

   b. SOME EGGS ARE RAISED FOR EATING.

   c. SOME EGGS CONTAIN A DEVELOPING ANIMAL AND A FOOD SUPPLY FOR IT.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

STUDYING AN UNCOOKED HEN'S EGG

Crack open the uncooked hen's egg into a bowl and allow the children to inspect it, looking for the four parts of the egg. These are the nucleus or germ, yolk, membrane, and shell.

RESEARCH IDEA

Have the children find out which animals come from eggs. Make a chart representing this information.

CHART IDEA

Review the four conditions all animals that hatch will need to live: food, water, air, and a suitable home. Make this information a part of the chart.

TRIP IDEA

Visit a pet shop or farm to see new little chicks. Watch what they do. Listen for the variety of noises they make. Have the children discuss the activities of the chicks.

RESEARCH IDEA

Have the children find out the different ways in which eggs can be cooked. In addition, have them find out the animals from which we get eggs that are usually eaten.

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

3. SOME MOTHER ANIMALS TAKE CARE OF THEIR YOUNG AND SOME DO NOT.

   a. SOME TAKE CARE OF THEIR YOUNG BY MAKING A NEST.

   b. SOME LOOK AFTER THEIR BABIES WHEN THEY ARE HELPLESS.

   c. SOME PROVIDE FOOD.

   d. SOME PROTECT THEM FROM ENEMIES.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

COLLECTING PICTURES
Find and display some pictures of animals and their babies. Look for examples of the above in the pictures.

CHART IDEA
From discussion and reading, make a class chart of animals that help and care for their young and another listing of those that do not help and care for their young.

RESEARCH IDEA
Have the children discover the various means that animal mothers use to protect their young from enemies. Include protective devices, disguises, and so forth.

TRIP IDEA
Take a neighborhood walk to observe signs of animals caring for their young. Look for the activities of birds particularly.

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

4. FARMERS HELP SOME ANIMALS TAKE CARE OF THEIR YOUNG.

    a. THE FARMER PROVIDES SHELTER AND FOOD FOR ANIMALS.

    b. SOME MOTHER ANIMALS PROVIDE THE MILK FOR THEIR BABIES.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

COLLECTING PICTURES
Collect pictures of farm buildings that would house farm animals. Discuss the different kinds of buildings that are used for each different kind of animals.

MAKING MODELS
Have the children construct model animal houses that could be found on a farm, e.g., dog house, rabbit hutch, stable, barn, coop.

RESEARCH IDEA
Have the children find the correct names for baby animals found on the farm. Include the usual as well as the unusual. Discuss the reasons why the young farm animals usually stay near the mother animal.

CHART IDEA
Collect pictures of adult and baby animals for a chart. Label them with their proper names.

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

5. ZOO KEEPERS PROVIDE THE FOOD, PROTECTION, AND SHELTER FOR ANIMALS REMOVED FROM THEIR NATURAL ENVIRONMENT.

   a. EACH TYPE OF ZOO ANIMAL REQUIRES A SPECIAL DIET.

   b. SOME ZOO BABIES HAVE TO BE REMOVED FROM THE CAGE AFTER BIRTH AND PUT IN THE CARE OF A ZOO KEEPER.

   c. THE ZOO HELPS US TO RECOGNIZE ANIMALS FROM FOREIGN COUNTRIES.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

FIELD TRIP IDEA

Plan a trip to the zoo, at feeding time if possible. Discuss safety precautions to be taken during the visit. If a trip is not possible, use stories or films about the zoo to broaden the background of the children

CHART IDEA

Collect pictures of mother and baby animals that are usually found in the zoo. Have the children note the similarities and differences between the mother and baby animals.

CLASS VISITOR

If possible, invite a zoo keeper, pet shop owner, or other person who raises animals to talk to the class about the care and feeding of animals.

CHART IDEA

Have the children collect pictures and prepare a chart of the animals that are usually found in the zoo. Help them to note the particular part of the world from which each of the animals usually come. Discuss the reasons why we have a zoo.

SUGGESTED RESOURCES

BASIC TEXT REFERENCE:

Schneider, Herman and Nina. Science Far and Near. Boston: D. C. Heath and Company, 1959. pp. 162-169.

SUPPLEMENTARY BOOKS:

Blough, Glenn O. and M. H. Campbell. When You Go to the Zoo. New York: McGraw-Hill Book Company, 1955.

Blough, Glenn O. Animals and Their Young. Evanston: Harper and Row Publishers, Inc.

Bridges, William. Zoo Babies. New York: William Morrow and Company, Inc., 1953.

Bridges, William. Zoo Celebrities. New York: William Morrow and Company, Inc., 1959.

Gregor, Arthur. Animal Babies. New York: Harper and Row Publishers, Inc., 1959.

Hagner, Dorothy. Frogs and Polliwogs. New York: Thomas Y. Crowell Company, 1956.

Leyson, Burr W. and Ruth Manecke. The Zoo Comes to You. New York: E. P. Dutton and Company, Inc., 1954.

Morton, Duryea. Who Lives in a Field. New York: Coward-McCann, Inc., 1959.

Podendorf, Illa. The True Book of Animal Babies. Chicago: Children's Press, 1955.

Selsam, Millicent. All about Eggs and How They Change into Animals. New York: W. R. Scott, Inc., 1954.

Sootin, Laura. Let's Go to the Zoo. New York: G. P. Putnam's Sons, 1959.

FILMS:

These films are available from the Central Audio-Visual Department. Check your A-V Guide for a more complete description of the films. Contact your building A-V Coordinator to arrange for the use of these films.

All films should be previewed to determine suitability for use with your particular class.

Baby Animals
Farmyard Babies
The Zoo

SUGGESTED RESOURCES

FILMSTRIPS:

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Filmstrips borrowed from the Central A-V Department are intended only for preview. If, after preview and use with your class, you find them to be helpful, recommend that your coordinator consider them for adding to your building collection.

#199-203 Animals of the World Series

GRADE THREE

Spring is synonymous with regrowth or awakening. It is a good time of year to direct the child's observations to the ingenious ways in which plants propagate themselves from seeds, roots, stems, leaves, and bulbs. In addition, it is the ideal season for a child to investigate the story of plant growth by caring for a plant of his own and watching it grow and develop.

Spring is also a time when the animal world stirs from its winter sleep. In a sense, it is a time of beginning: migrating birds begin their return flight; nest building begins; insects emerge from their wintering state to begin anew the cycle of life. As the sun warms the earth and new sights and sounds fill the air, the child has a wonderful opportunity to discover for himself some secrets of nature's creatures.

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

1. SPRING IS AN EFFECT OF LONGER HOURS AND MORE DIRECT RAYS OF SUNLIGHT UPON THE EARTH.

   a. THE SOIL, WATER, AND AIR WARM UP BECAUSE OF THE INCREASING HOURS OF SUNLIGHT.

   b. PLANT AND ANIMAL ACTIVITIES ARE INCREASED.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

TRIP IDEA
Take a science walk to observe the changes which are taking place in the plants, trees, and grass in the spring. Compare with earlier observations.

CHART IDEA
Keep a record of the temperature each day during the spring season. In addition, record the time of sunrise and sunset. Draw conclusions from your findings.

CHART IDEA
Collect pictures for a chart of the signs of spring. As each day passes and new signs are noted, add these to the chart.

WATCHING SHOOTS BUD
Where possible, collect shoots from bushes, and place these in water in the classroom. Observe the budding of the shoots.

CHART IDEA
Make a chart showing the different times when each kind of plant begins to bloom.

SOIL AND WATER TEMPERATURES
Place a pan of soil out in the sunlight and also a pan of water. Record the temperature of these on succeeding days and keep a record.

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

2. EACH PART OF A PLANT HAS A SPECIFIC FUNCTION.

    a. ROOTS OF A PLANT ARE FOR ANCHORAGE AND FOR TAKING IN FOOD MATERIAL.

    b. STEMS ARE FOR CARRYING WATER AND FOR HOLDING UP THE LEAVES.

    c. LEAVES MANUFACTURE THE PLANT'S FOOD.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

STUDYING ROOT HAIRS
Use a magnifying glass to observe the root and root hairs of a dandelion plant.

WATCHING SEEDS GERMINATE
Grass seed planted on damp blotting paper between two pieces of glass will sprout easily. This will help the child to understand what is happening during this season outdoors.

SHOWING PLANT TUBES
Experiment with a stalk of celery to trace the path of colored water. Observe the length of time it takes for water to reach the leaves. Discuss how the stems of all plants have tubes which carry liquids through them.

SHOWING PLANT REACTION TO SUNLIGHT
Leave a plant in a sunny window with its leaves facing the class. Do not move it for a week and observe what happens to the leaves. Discuss this with the class.

OBSERVING LEAF VEINS
Examine the veins of a maple or oak leaf with a magnifying glass. Discuss the function of these veins.

STUDYING EFFECT OF SUNLIGHT ON PLANTS
Place a plant in a sunny window and another in a dark closet. At the end of a week compare the health of both plants.

SHOWING PLANT'S NEED OF SUNLIGHT
Cut out a pattern from black construction paper. Use a paper clip to attach the pattern to the leaf of a healthy plant. Place the plant in a sunny place. After several days, remove the pattern and observe the results. It should be obvious from this experiment that without sunlight plants would die, because the plant needs the leaf to make its food.

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

3. THERE ARE PROPER CONDITIONS FOR PLANT GROWTH.

   a. MANY SEEDS ARE SUITABLE FOR CLASSROOM PLANTING.

   b. THE BABY PLANT REQUIRES FOOD, AIR, WARMTH, AND WATER IN ORDER TO GROW.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

STUDYING SEEDS
Have enough stringbean seeds to supply the whole class. Keep some dry and allow some to soak overnight. Compare the size of the soaked and the unsoaked beans. Have the children slip off the covers of the soaked beans to open and see the parts of the seed.

DISPLAY IDEA
Have a "seed show," displaying the seeds of various foods such as apples, oranges, beans, grapes, and so on.

STARTING SEEDS
Plant the stringbean seeds in a variety of containers for the start of a classroom garden. A variety of seeds including grapefruit and radish seeds might also be planted.

CONTROLLING NEEDS OF PLANTS
Start bean seeds in identical containers of soil. With one of the containers supply all of the needs for growth. With other seeds, eliminate one of the basic needs of plants and observe.

CHART IDEA
Make a chart to illustrate the basic needs of plants for food, air, warmth, and water.

CHART IDEA
Make charts showing the different uses of plants in modern medicine, foods, and industry.

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

4. CERTAIN FACTORS SHOULD BE CONSIDERED IN ORDER TO DERIVE THE MAXIMUM ENJOYMENT AND BENEFIT FROM A GARDEN.

   a. DEPTH AND SPACING OF SEEDS AND PLANTS IS IMPORTANT IN A GARDEN.

   b. IN ORDER TO INSURE A SEQUENCE OF BLOSSOMS, IT IS WISE TO CHOOSE PLANTS ACCORDING TO THE TIME THEY BLOOM.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

PLANNING A FLOWER GARDEN
List the various garden plants with which the children are familiar. Try to determine the times when they bloom. Use this information to plan a garden that will always have flowers in bloom.

CLASSIFYING PLANTS
Find out which plants can be left in the ground through the winter and those which must be transplanted indoors in the fall. Discuss why this is so. Consider what happens to plants that are annuals.

CHART IDEA
Make a vocabulary chart of gardening words. Include such words as annuals, perennials, biennials, hardy plants, and so on.

TRIP IDEA
If a greenhouse is near by or if a cold frame is in a nearby garden, plan a visit to observe the early starting of plants. Ask the person in charge to explain his work in starting plants in this way.

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

5. SOIL MUST BE SPECIALLY PREPARED FOR PLANTING.

   a. SOIL MUST CONTAIN PROPER FOOD MATERIALS.

   b. SOIL MUST BE POROUS TO HOLD THE PROPER AMOUNT OF MOISTURE.

   c. SOIL MUST BE MADE READY FOR PLANTING BY CULTIVATING.

   d. THERE ARE MANY DIFFERENT KINDS OF SOIL.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

STUDYING SOIL

Have soil samples for each child in a small container. Allow the children to examine the soil with a magnifying glass, looking at the color, different particles, and so on. Collect samples of soil from different places and examine. Discuss the differences found in the composition of soil.

STARTING PLANTS

Collect different kinds of soil samples. Plant bean seeds in the soil samples. Keep all other factors constant such as water and sunlight. Draw conclusions from your observations of the growth of the seeds.

CHART IDEA

Collect pictures showing differing soil types from the many parts of our country. Attempt to show how the kind of soil found will many times determine the amount and nature of farming that takes place in that part of the country.

CHART IDEA

Have the children prepare a chart which illustrates the steps which a farmer follows. Include plowing, fertilizing, seeding, cultivating, and possibly artificial watering.

TESTING POROSITY OF SOIL

Place equal amounts of different soil types into identical metal containers. Punch a hole in the bottom of each of the containers. Then, pour equal amounts of water into the containers. The containers should be suspended over other cans or pans. Continue to pour equal amounts of water into the soil samples. Compare the rate at which the water flows through each of the types of soils, and the amount of water held by each. Discuss how this information would help us in selecting soil types for different kinds of plants.

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

6. NOT ALL NEW PLANTS COME FROM SEEDS.

   a. NEW PLANTS CAN COME FROM BULBS.

   b. NEW PLANTS CAN COME FROM CUTTINGS.

   c. NEW PLANTS CAN COME FROM GRAFTING.

   d. NEW PLANTS CAN COME FROM SPORES.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

GROWING PLANTS FROM BULBS
Grow some plants from a bulb. Discuss how the bulb can continue to sprout plants for more than one year. Discuss the similarity of a bulb to a seed.

GROWING PLANTS FROM SLIPS
Begin some cuttings from a begonia or geranium leaf. Make sure to keep the new plants in an atmosphere of moisture and warmth.

GARDEN SHOW
Collect cuttings from different classrooms in the building. After a period of time, have a garden show of new plants that resulted.

CHART IDEA
Collect pictures that show examples of trees that have been grafted.

STUDYING SPORES
Take a mushroom and break off the stem and place the cap, gills down, on a piece of white paper. If you use an amanita or other white spored variety, black or brown paper will give you more contrast. Invert a glass or other bowl over the mushroom cap. Leave undisturbed for 24-48 hours; then remove glass and cap carefully. You should find that the spores have fallen out to make a radial design. The tiny round dots of which this design is made are the primitive equivalents of plant seeds.

RESEARCH IDEA
Have the children discover the other plants which reproduce by spores. They should include ferns, mosses, liverworts, and lichens.

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

7. WATER PLAYS AN IMPORTANT ROLE ON THE FARM.

   a. WATER IS AN ESSENTIAL REQUIREMENT FOR ALL LIVING THINGS.

   b. ABOUT HALF OF ALL THE FRESH WATER CONSUMED IS USED IN IRRIGATING CROPS.

   c. WATER SHOULDN'T BE WASTED.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

CHART IDEA

Make a chart showing all the different places that a farmer uses water in the operation of his farm. Discuss the effects of droughts on a farm.

CLASS VISITOR

If possible, have a nearby farmer visit the class to tell of his work in growing crops. Have the children prepare a list of questions to ask.

RESEARCH IDEA

Have the children find out the different ways in which the farmer tries to save or conserve on water in the operation of his farm. Discuss why it is important for him to do this.

RESEARCH IDEA

Make a survey to learn how much water is used in your school in one day. The custodian may help in this by checking the water meter for a certain time period. From your findings list the ways in which conservation can be practiced in the school.

RESEARCH IDEA

Have the children find out the many ways in which the farmer practices conservation of water and other resources on his farm.

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

8. PLANTS GROW IN MANY DIFFERENT KINDS OF ENVIRONMENTS ALL OVER THE EARTH, AND ADAPT THEMSELVES TO THIS ENVIRONMENT.

    a. PLANTS CAN BE FOUND GROWING IN:

        (1) COLD AND HOT PLACES.

        (2) DRY AND WET PLACES.

        (3) WARM AND COOL PLACES.

        (4) WATER AND ON LAND.

    b. SOME PLANTS GET THE MATERIALS THEY NEED FOR LIVING IN UNUSUAL WAYS.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

TRIP IDEA
Take a walk around the school grounds to notice the different kinds of plants. Consider how each of them is fitted for growing in that particular location.

CHECKING SOIL TEMPERATURES
Go into the school yard on a warm afternoon and take the temperature of some garden soil in a shady spot and of some in a sunny spot. Check the difference and discuss how this would affect the kinds of plants that could be grown there.

CHECKING RAINFALL
Build a rain gauge and place it in the school yard. Check to see how much rain falls in a given period of time. Have children check the average rainfall for different places. Discuss how this affects the kinds of plants that are grown.

RESEARCH IDEA
Have the children collect information of the kinds of plants that are most suited to hot and dry climates, those that grow well in hot and moist climates, those that grow well in other kinds of climates, and so on.

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

9. A TERRARIUM IS A KIND OF GARDEN WITH SPECIAL PLANTS, IN WHICH A COMPLETE WATER CYCLE IS TAKING PLACE.

   a. ONLY CERTAIN PLANTS ARE SUITABLE FOR TERRARIUMS.

   b. PROPER CONDITIONS CAN MAINTAIN A BALANCED TERRARIUMS.

   c. A COMPLETE WATER CYCLE WILL TAKE PLACE IN A COVERED TERRARIUM.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

BUILDING A TERRARIUM

A large pickle jar or a leaky aquarium can be used for housing a terrarium. Collect some woodland soil or leaf mold, some sand for drainage, and a few pieces of charcoal to go in the bottom. Use shade loving plants such as moss, ferns, wintergreen, liverwort, miniature ivy, or philodendrons. A local florist can help with your selection. Imbed a container for water, level with the soil base. Wet down the inside of the terrarium with water. After this it should not be necessary to water the terrarium. Moisture evaporating from the plants and the water dish will condense on the glass inside and precipitate, a perfect example of the water cycle which takes place in nature. It may be necessary to wipe the sides of the terrarium the first day or two to be able to see through the glass.

Also point out to the children that it is possible to construct a desert terrarium.

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

10. THERE ARE A VARIETY OF ANIMAL HOMES, EACH SUITED TO ITS INHABITANT.

    a. SOME ANIMALS LIVE IN UNDERGROUND HOMES.

    b. SOME ANIMALS BUILD NESTS ON THE SURFACE OF THE GROUND.

    c. SOME ANIMALS LIVE IN TREES.

    d. SOME ANIMALS ONLY LIVE TEMPORARILY IN THEIR HOMES.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

OBSERVING ANIMALS

Take a walk in the neighborhood and see how many different kinds of animal homes you can find. Include the birds, squirrels, ants, spiders, fish, and wild animals.

CHART IDEA

Have the children collect pictures of animals and make a chart of the animals that live underground, those that live in trees, those that make nests on the ground, and those that live in the water.

RESEARCH IDEA

Have the children find out which animals hibernate and how they prepare for this.

TRIP IDEA

Make a visit to the zoo and see if you can find an animal cage which has been arranged to resemble its natural home. If this is not possible, have some students construct a diorama of the homes of selected animals.

RESEARCH IDEA

Have the students make a list or chart of those animals which spend only a short time in their home or nest before they move on.

11. AN AWARENESS AND AN APPRECIATION OF FAMILIAR BIRDS CAN LEAD TO A DESIRE FOR FURTHER STUDY.

    a. BIRDS CAN BE RECOGNIZED BY THEIR PHYSICAL CHARACTERISTICS.

    b. INDIVIDUAL HABITS ARE ANOTHER WAY TO IDENTIFY AND BECOME ACQUAINTED WITH BIRDS.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

MAKING A BIRD CALENDAR
Help the children to begin a bird calendar, noting the name of the bird, the time of year it was first seen, the location of the spot seen, and what the bird was doing.

CHART IDEA
From the above gained information the children can make a chart of seasonal birds in their area.

MAKING BIRD FEEDING STATIONS
The children can make a bird feeding station outside the classroom window. This will allow close observation of bird coloring and habits.

MAKING A BIRD TREE
Have the children make a simple outline of a tree with many branches. As the children learn to recognize birds have them draw pictures to be labeled and placed on the tree.

LEARNING BIRD SOUNDS
Listen to bird calls or sounds and learn to identify several. Use the identification of bird sounds for a listening activity. Try to include several bird calls that are very similar.

FIELD STUDY OF BIRDS
Introduce the children to field study of birds which is carried out by interested persons. Help the children to gather the following information about the birds: coloration, habitat, outline and movements, and notes or songs.

CLASS VISITOR
Invite a person who raises canaries or other pet birds to the class. Help the children to formulate questions about the birds' feeding habits and general requirements for care.

CHART IDEA
Have the children collect pictures of the birds which are normally kept as pets.

RESEARCH IDEA
Have each child select his "own" bird and do intensive research on it. It can include a picture, habitat, feeding practices, and so on. These can be compiled in a class "Bird Book."

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

12. THE DISTINCTIVE CHARACTERISTICS OF AN INSECT.

    a. ALL INSECTS HAVE THREE PARTS TO THEIR BODY, THREE PAIR OF LEGS, AND ANTENNAE.

    b. INSECTS ARE BUILT TO LIVE ON LAND, WATER, OR IN THE AIR.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

STUDYING INSECTS

Place a living grasshopper or a praying mantis in a jar or screen wire cage. Supply the insect with food and study it to find features that are common to all insects. Release the insects after study.

COLLECTING INSECTS

Visit a nearby lot or park to look for and collect insects. Attempt to classify the insects according to the Table of More Common Insect Orders.

RESEARCH IDEA

Collect pictures and make charts showing which insects are helpful and which are harmful to man. Discuss the ways in which man tries to control the development of insects which are harmful to man.

RESEARCH IDEA

Have students find out about the social order which might be found in an ant colony or a bee hive. Discuss the work or task of each of the members of these groups.

STUDYING FLIES

Catch some live flies and place them in a closed jar with a piece of cotton soaked in fingernail polish remover. After the flies have expired; study them closely with a magnifying glass. Point out how their structure helps them to spread germs and disease.

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

13. SOME DISTINCTIVE CHARACTERISTICS ABOUT ONE OF NATURE'S MOST INTERESTING INSECTS.

    a. THE MUD DAUBER WASP LIVES ALONE AND BUILDS ITS NEST OF MUD.

    b. THE PAPER WASP LIVES IN COLONIES AND BUILDS ITS NEST OF WASP PAPER.

    c. WASPS BENEFIT MAN BY DESTROYING CATERPILLARS, HARMFUL INSECTS, MOSQUITOES, AND FLIES.

    d. MOST WASPS USE THEIR STINGER ONLY WHEN BOTHERED OR FRIGHTENED.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

STUDYING A WASP'S NEST

Find a deserted wasp nest and remove one side of the covering so that the combs are exposed. Observe the way it is made and discuss the reasons why this is so.

RESEARCH IDEA

Have children read and find pictures showing the nests of the different kinds of wasps. Have them draw pictures showing cross sections of each of the nests.

STUDYING WASP PAPER

Compare the paper that is used by the wasp in building its nest with the different kinds of paper which we have in the classroom. Decide how the wasp paper is different and why this is so.

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

14. BUTTERFLIES AND MOTHS BEGIN LIFE IN ONE FORM AND END THEIR CYCLE IN A COMPLETELY DIFFERENT FORM.

    a. A BUTTERFLY EMERGES FROM A CHRYSALIS.

    b. A MOTH EMERGES FROM A COCOON.

    c. BUTTERFLIES ARE COMMONLY SEEN DURING THE DAY, MOTHS AT NIGHT.

    d. BUTTERFLIES AND MOTHS CHANGE CONSIDERABLY AS THEY DEVELOP.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

COLLECTING COCOONS

Go on a cocoon hunt in vacant lots, parks, or woods. Keep the cocoons for observation in the classroom. Listen and look for the changes that will take place.

RESEARCH IDEA

Have the children find out about all of the animals that change markedly in appearance in their life cycle. Make charts or illustrations to show these changes.

RESEARCH IDEA

Have the children discover other creatures that come from cocoons. Include a study of the silkworm.

COLLECTING BUTTERFLIES

Have the students collect and mount butterflies. Help them to learn the identification of the major types of butterflies.

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

15. THE WORLD OF THE SPIDER.

    a. A SPIDER IS NOT AN INSECT, AS IT HAS EIGHT LEGS.

    b. SPIDERS CAN HELP OR HINDER MAN IN MANY WAYS.

    c. SPIDERS' WEBS ARE OF MANY DESIGNS.

    d. WEBS HELP SPIDERS CATCH INSECTS.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

RECOGNIZING SPIDERS

Spend some time learning to recognize harmless spiders. Find out how to keep them in the classroom. Collect some and observe them closely. Have the students keep a log of the spiders' activities. Have the children list other insects that get caught in spider webs.

STUDYING WEBS

Look at spider webs through a magnifying glass. Notice the intricate designs of the webs. Have the children try to make models or pictures of the webs.

MAKING SPIDER MODELS

Have the children use clay or other materials to make models of spiders.

COLLECT SPIDER EGG CASES

Collect spider egg cases. Place them in small jars and watch them hatch.

RESEARCH IDEA

Have the children find out how the spider got its name of arachnid.

COLLECTING AND COMPOSING SPIDER STORIES

Start a collection of stories about spiders. They may be the work of the children or of published works.

BASIC KNOWLEDGE, UNDERSTANDINGS, AND GENERALIZATIONS

16. HOW TO FIND AND IDENTIFY THE ANIMALS WHICH HAVE CRUSTY BODY COVERINGS.

    a. CRUSTY ANIMALS HAVE TWO BODY REGIONS, FIVE OR MORE PAIRS OF LEGS, AND TWO PAIRS OF FEELERS (ANTENNAE).

    b. THE OUTER COVERING OF THESE ANIMALS IS A HARD SKELETON THAT HAS LIME IN IT, GIVING THEM A CRUSTY APPEARANCE.

    c. CRUSTY ANIMALS ARE FOUND IN BOTH FRESH AND SALT WATER.

SOME SUGGESTED ACTIVITIES AND EXPERIENCES

OBSERVING A CRAYFISH

Get a crayfish for the classroom aquarium, which should be filled with fresh water. Observe the activities of the crayfish and discuss this with the class.

CHART IDEA

Collect pictures of animals that are relatives to the crayfish. Have the children note how they resemble one another.

MAKING MODELS

Have the children make papier mâché models of a crayfish.

RESEARCH IDEA

Have the children find out why this group of animals is called crustaceans.

GRADE THREE PLANTS AND ANIMALS IN SPRING

SUGGESTED RESOURCES

BASIC TEXT REFERENCE:

Schneider, Herman and Nina. Science Far and Near. Boston: D. C. Heath and Company, 1959.

pp. 189-210 "Forest Plants"
pp. 58-74 "Water for Farms and Homes"
pp. 23-38 "Plants and Animals of the Desert"
pp. 131-148 "Plants and Animals of the Sea"
pp. 162-188 "Lake and Stream"

SUPPLEMENTARY BOOKS:

Blough, Glenn. The Birds in the Big Woods. Evanston: Harper and Row, Publishers, Inc., 1953.

Cormack, M. B. The First Book of Trees. New York: Franklin Watts, Inc., 1951.

Fenton, Carroll and Herminie Kitchen. Plants that Feed Us. New York: John Day Company, 1956.

Hoke, Alice Dickinson. First Book of Plants. New York: Franklin Watts, Inc., 1953.

Mason, George. Animal Homes. New York: William Morrow and Company, Inc., 1953

Parker, Bertha. Animals We Know. Evanston: Harper and Row, Publishers, Inc., 1957.

Parker, Bertha. Birds in Your Back Yard. Evanston: Harper and Row, Publishers, Inc., 1953.

Parker, Bertha. Six-Legged Neighbors. Evanston: Harper and Row, Publishers, Inc., 1959.

Pettit, Ted. The Book of Small Mammals. Garden City: Doubleday and Company, 1958.

Pistorius, Anna. What Butterfly Is It? Chicago: Follett Publishing Company, 1949.

Podendorf, Illa. The True Book of Plant Experiments. Chicago: Childrens Press, 1960.

Rosner, Joan. Let's Go for a Nature Walk. New York: G. P. Putnam's Sons, 1959.

Selsam, Millicent. The Plants We Eat. New York: William Morrow and Company, Inc., 1955.

SUPPLEMENTARY BOOKS: (continued)

Selsam, Millicent. Play with Plants. New York: William Morrow and Company, Inc., 1959.

Selsam, Millicent. Play with Seeds. New York: William Morrow and Company, Inc., 1957.

Smith, Frances C. The First Book of Conservation. New York: Franklin Watts, Inc., 1954.

Sterling, Dorothy. The Story of Mosses, Ferns, and Mushrooms. Garden City: Doubleday and Company, 1955.

Tibbets, Albert. The First Book of Bees. New York: Franklin Watts, Inc., 1952.

Webb, Addison. Birds in Their Homes. Garden City: Doubleday and Company, 1947.

Weber, Irma E. Bits That Grow Big. New York: William R. Scott, Inc., 1959.

Zim, Herbert and Ira Gabrielson. Birds. Simon and Shuster, Inc., 1949.

Zim, Herbert and Alexander Martin. Flowers: A Guide to Familiar American Wild Flowers. New York: Simon and Schuster, Inc., 1952.

FILMS:

These films are available from the Central Audio-Visual Department. Check your A-V Guide for a more complete description of the films. Contact your building A-V Coordinator to arrange for the use of these films.

All films should be previewed to determine suitability for use with your particular class.

Adaptations of Plants and Animals
Animal Habitats
Animals and Their Homes
The Bird Community
Birds of the Dooryard
Camouflage in Nature Through Form and Color Matching
The Growth of Plants
How Seeds Are Scattered
Seeds Grow into Plants
Understanding Our Earth: Soil
Spider Engineers
Spiders
Spring on the Farm
Wonder of Grasshoppers

SUGGESTED RESOURCES

FILMSTRIPS:

These filmstrips are available from the Central Audio-Visual Department. Some of them may be available in your building collection of filmstrips. Check with your A-V Coordinator.

Filmstrips borrowed from the Central A-V Department are intended only for preview. If, after preview and use with your class, you find them to be helpful, recommend that your coordinator consider them for adding to your building collection.

#256-#259 Golden Nature Series: American Birds (with manual)
#277 The World of Living Things
#597 Mushrooms
#740-#749 Basic Nature Study Series
#791 Finding Out about Seeds, Bulbs, and Slips
#792 Finding Out How Animals Live

APPENDIX III.

STUDENT ATTITUDE QUESTIONNAIRE - "SIZING UP YOUR SCHOOL SUBJECTS"

TEACHER'S DIRECTIONNAIRE AND STUDENT ANSWER SHEET

TEACHER'S INSTRUCTIONS

for

"SIZING UP YOUR SUBJECTS"*

"Today I am going to ask you to tell me how you feel about the different subjects you study: arithmetic, spelling, science, and so on.

"I want you to give your answers in a special way. I am now going to pass out some sheets of paper and tell you how to mark them. (Pass out sheets.)

"At the top of the sheet print your name, last name first, (pause) then your first name. (pause) Then, at the right (show) put your middle initial. On the next line, where it says "School," put the name of this school (give it). Then, where it says grade, put the grade you are in (give it).

"Now read what it says, while I read it to you:

"Here is a list of subjects you are now studying:

A. Arithmetic   D. Science

B. Reading   E. Spelling

C. Language   F. Social Studies

"Now listen carefully while I tell you what to do.

"Find the first column with the cross (put X on blackboard) at the top. The word "When" is printed under it. Now, I want you to show <u>when</u> you study subjects in school.

"In space 1 in this column, write the letter of the subject we usually study <u>first</u> this morning. What subject do we study first? (Wait for answer) Yes, this class studies ________________ first. We will all put the letter ___ in space 1. Do it. (Check to see that students have put correct letter in correct place.)

"Now, in space 2, just below where you have just written, write the letter of the subject you usually studied <u>second</u> in the morning. What subject do you study second? (Wait for answer) All right, let's all put the letter ___ in space 2.

"Now, in space 5 in the same column, write the letter of the subject we usually study last before going home. (If they have other subjects last, e.g., music, have them indicate which of the six subjects listed they usually study last.)

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"In space 4, write the letter of the subject you usually study next to last in the afternoon.

"Never mind about space 3. We will fill that in later.

"Now let us check to see that everyone has marked the first column correctly. Under the X, you should have written ______________ in space 1, ___ in space 2, ___ in space 5, and ___ in space 4. Do you all have it that way?

"You will answer all the other questions the same way, marking in space 1 first, then in space 2, then in space 5, and finally in space 4. Do you understand? (Answer questions briefly.)

In the rest of the questions, you will not all mark the same answer, as you did in this first column. I will ask you what subjects you like best, what subjects are easiest, what subjects are explained most clearly, and so on, and each of you will give his own choice. Now follow my directions.

"Find the second column. At the top is a circle (Draw ◯ on blackboard.) Under it is the word 'Like.' Have you all found this column? (Pause and check. If certain students need a great deal more help than the rest of the class, you may want to give this to them individually after the others finish.)

"All right. The next question is 'How do you like the subjects you are now studying?' (Repeat question.) Now, in space 1 in this column write the letter of the subject you like best. Do it. (Pause.)

"Next, in space 2 write the letter of the subject you like next best. (Pause)

"Finished? O.K., in space 5 at the bottom of that column, write the letter of the subject you like least. (Pause)

"Now, in space 4 write the letter of the subject you like next to least. (Pause)

"Now I am going to ask you a different kind of question. Find the column with the dash at the top. (Write — on the blackboard.) Do you have it? It has the word 'Time' right below it.

"All right. The question is 'How much time do you actually spend on the subjects you are now studying - both at school and at home?' (Repeat question.)

"Now, in space 1, write the letter of the subject on which you spend the largest amount of time. (Pause)

"O.K. Now, in space 2 write the letter of the subject on which you spend the second largest amount of time. (Pause)

"Next, in space 5 at the bottom of the column, write the letter of the subject on which you spend the least time. (Pause)

"All right. In space 4, write the letter of the subject on which you spend the next to least amount of time. (Pause)

"Now I am going to ask you another question. Find the column with the arrow at the top. (Write ↑ on the blackboard.) It has the word 'Ask' right below it. Do you find it? (Pause)

"All right. The question is 'How often do you have a chance to ask the teacher questions in your different subjects?' (Repeat question.)

"In space 1, write the letter of the subject in which you most often have a chance to ask questions of the teacher. (Pause)

"In space 2, write the letter of the subject in which you next most often have a chance to ask questions of the teacher. (Pause)

"O.K. Now, in space 5 at the bottom of this same column, write the letter of the subject in which you least often have a chance to ask questions of the teacher. (Pause)

"All right. In space 4, write the letter of the subject in which you have a chance to ask questions next to least often. (Pause)

"Now, find the column with the square at the top. (Draw □ on the blackboard.) It has the word 'Keep' right below it. Have you found it? (Pause)

"All right. The next question is 'How often do your subjects - classwork and homework - keep you from taking part in outside activities you would rather do? (Repeat question.)

"In space 1 in this column, write the letter of the subject that most often keeps you from taking part in outside activities you would rather do. (Pause)

"In space 2 right below, write the letter of the subject that next most often keeps you from taking part in outside activities you would rather do. (Pause)

"O.K. Now, in space 5 at the bottom of the column, write the letter of the subject that least often keeps you from taking part in outside activities you would rather do. (Pause)

"All right. In space 4, write the letter of the subject that next to least often keeps you from taking part in outside activities you would rather do. (Pause)

"Now I am going to ask you another question. Find the column with the two lines at the top. (Write = on the blackboard.) Do you have it? It has the word 'Easy' right below it. (Pause)

"All right. The question is 'How easy to learn are the subjects you are now studying?' (Repeat question.)

In space 1, write the letter of the subject you find easiest to learn. (Pause)

"In space 2 right below, write the letter of the subject you find next easiest to learn. (Pause)

"Now, in space 5 at the bottom of the column, write the letter of the subject you find hardest to learn. (Pause)

"O.K. In space 4, write the letter of the subject you find next to hardest to learn. (Pause)

"All right. We will stop now for a two-minute break. You may stand at your seats and stretch or talk, but you must not move about. (Allow 2 minutes. Move about and check the papers to see that students are marking them correctly.)

"All right. Take your seats again and we will work on the last five questions. (Pause)

Find the column with the triangle at the top. (Draw △ on blackboard.) Do you all find it? It has the word 'Use' below it. (Pause)

Now, the next question is 'How useful do you think your different subjects are to you?' (Repeat question.)

"In space 1, write the letter of the subject that is most useful to you. (Pause.)

"In space 2 just below, write the letter of the subject that is next most useful. (Pause.)

"O.K. In space 5, at the bottom of the column, write the letter of the subject that is least useful. (Pause.)

"Now, in space 4 write the letter of the subject that is next to least useful.

"All right. Now find the column with the wavy line at the top. (Draw ~~~ on the blackboard.) It has the word 'Clear' right below. Do you have it? (Pause.)

"The next question is 'How clear and understandable is the teaching of the different subjects you are studying?' (Repeat question.)

"Now, in space 1 write the letter of the subject in which the teaching is most clear and understandable. (Pause.)

"In space 2 just below, write the letter of the subject in which the teaching is next most clear and understandable. (Pause.)

"O.K. In space 5 at the bottom of the column, write the letter of the subject in which the teaching is least clear and understandable. (Pause)

"All right. In space 4, write the letter of the subject in which the teaching is next to least clear and understandable. (Pause.)

"Now, find the column with the star at the top. (Draw  on the blackboard.) It has the word 'Discuss' right below it. Have you all found the column? (Pause.)

"All right. The question is 'How much do students discuss in class what you are taught in the different subjects?' (Repeat question.)

"Now, in space 1 write the letter of the subject in which there is the most class discussion among students. (Pause.)

"In space 2, just below, write the letter of the subject in which there is the next most class discussion among students. (Pause.)

"All right. In space 5, at the bottom of that column, write the letter of the subject in which there is the least class discussion among students. (Pause.)

"O.K. In space 4, write the letter of the subject in which there is next to least class discussion among students. (Pause.)

"Now, find the column with the diamond at the top. (Draw  on the blackboard.) It has the word 'Wander' under it. Do you find it? (Pause.)

"The next question is 'How much does your mind wander in your different subjects? (Repeat question.)

"In space 1 in this column, write the letter of the subject in which your mind wanders most. (Pause.)

"In space 2 just below this, write the letter of the subject in which your mind wanders next most. (Pause.)

"All right. In space 5 at the bottom of the column, write the letter of the subject in which your mind wanders least. (Pause.)

"In space 4, write the letter of the subject in which your mind wanders next to least. (Pause.)

"Now we come to the last question. Find the last column. It has a dot at the top and the word 'Learn' is printed just below. Do you all have the place? (Pause)

"The last question is 'How much do you learn in your different subjects?' (Repeat question.)

"All right. In space 1 in the last column, write the letter of the subject in which you feel you learn the most. (Pause.)

"In space 2, write the letter of the subject in which you feel you learn the next most. (Pause.)

"Now, in space 5 at the bottom of the last column, write the letter of the subject in which you feel you learn the least.

"In space 4, write the letter of the subject in which you feel you learn next to least.

"All right. Now we have finished. I am going to collect the papers. (Collect the papers.) Thank you for your attention to directions."

SIZING UP YOUR SUBJECTS*

Name of Student ____
Last First Middle Initial

School ______________________________ Grade ________________

Here is a list of subjects you are now studying:

A. Arithmetic D. Science

B. Reading E. Spelling

C. Language F. Social Studies

X When	○ Like	— Time	↑ Ask	□ Keep	= Easy	△ Use	~~ Clear	☆ Discuss	◇ Wander	• Learn
1.____	1.____	1.____	1.____	1.____	1.____	1.____	1.____	1.____	1.____	1.____
2.____	2.____	2.____	2.____	2.____	2.____	2.____	2.____	2.____	2.____	2.____
3.____	3.____	3.____	3.____	3.____	3.____	3.____	3.____	3.____	3.____	3.____
4.____	4.____	4.____	4.____	4.____	4.____	4.____	4.____	4.____	4.____	4.____
5.____	5.____	5.____	5.____	5.____	5.____	5.____	5.____	5.____	5.____	5.____

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APPENDIX IV.

TEACHER QUESTIONNAIRE "ON THE USE OF INSTRUCTIONAL TELEVISION"

TEACHER SURVEY ON THE USE OF INSTRUCTIONAL TELEVISION

INSTRUCTIONS: Read the following statements carefully, and indicate your degree of agreement or disagreement according to the following code:

1. Agree entirely
2. Agree, with qualifications
3. Neither agree nor disagree
4. Disagree, with qualifications
5. Disagree entirely

Mark your choice of the separate answer sheet.

1. Even though its value is not known, we should be willing to give television instruction a try.

2. An advantage of instructional television is that it tends to keep the classroom teacher on his (her) toes.

3. With the new emphasis on scientific achievement, we should try anything that might improve instruction in science.

4. The "master teacher" on television can't help making the classroom teacher seem inept at times.

5. Even if it proves to be a saving in instructional costs, televised instruction is too costly in terms of human resources.

6. Most communities stand to gain from instructional television, because it should bring about substantial savings in instructional costs in the long run.

7. Televised instruction in science can help to bring about the acceptance of course content change in science.

8. Television instruction tends to impair normal teacher-pupil relationships by making a celebrity of the television teacher.

9. One of the functions of television in the classroom is in helping schools to cope with increasing enrollments.

10. A good way to acquaint teachers with new science content is through television for elementary classes.

11. Having a "master teacher" on television backing her up strengthens the position of the classroom teacher with her pupils.

12. Television is a good means for a supervisory staff to make its work effective in the schools.

13. One of the dangers of television in the classroom is that it increases disciplinary problems.

14. My own feeling is that televised science instruction can bring about increased achievement.

15. Even if it costs more than conventional instruction, classroom television can make savings in terms of human resources.

16. In the long run instructional television can make important savings in instructional costs.

17. The television teacher can never replace the classroom teacher.

18. By bringing wider resources into the classroom, television instruction tends to foster the pupil's total intellectual growth.

19. Television lessons in science have a tendency to dull the pupil's interest in the subject matter.

20. Science instruction by television can retard the advancement of teachers in their professional careers.

21. Televised instruction tends to leave too much to the television teacher; the classroom teacher is not challenged.

22. An important value of science instruction by television is that it improves instruction.

23. An important value of science instruction by television is that it helps the schools to handle increased enrollments.

24. Instructional television, especially if expanded, threatens the classroom teacher with eventual unemployment.

25. Television instruction in science detracts from the quality of instruction.

26. Television instruction can serve as an in-service course for teachers in methods while at the same time serving as a content course for the students.

27. A function of television in the classroom is in bringing the classroom teacher new ways of teaching her subject.

28. A good way to acquaint teachers with new science content for schools would be to have television lessons for teachers after school hours.

29. A function of television in the classroom is in the improvement of instruction.

30. One of the advantages of television in the classroom is that it tends to reduce disciplinary problems.

31. For purposes of in-service education for teachers, television should be available to supervisory staffs.

32. It is doubtful that television science can have an important effect on achievement.

33. When there is a staff of well prepared science teachers, television should not be used in the schools.

34. Television instruction tends to impair the pupil's total intellectual growth.

35. The television teacher helps to produce positive attitudes toward science.

36. Widespread use of classroom television endangers the classroom teacher's chances of advancement.

37. From a community standpoint, instructional television is just another luxury that costs the taxpayers money.

38. Science instruction by television reduces teacher satisfaction by disrupting the normal teacher-pupil relationship.

39. Television instruction in science increases teacher satisfaction by serving as an additional stimulus to energizing the class.

40. Television instruction in science enhances the student-teacher relationship by introducing a new dynamic into the classroom.

41. Since its value is unknown, this is no time to experiment with things like science instruction by television.

42. Science instruction by television can increase the classroom teacher's chances for advancement by exposing him (her) to new developments in teaching.

43. Science instruction by television does not hold student interest as well as conventional instruction.

44. Television may have its place in providing entertainment in the home but does not belong in the classroom.

45. Instructional television is a help to the classroom teacher because it provides more time to devote to other important duties.

46. The celebrity of the television teacher in the eyes of the pupils tends to improve their attitudes toward science.

47. With the new emphasis on scientific achievement, this is no time to experiment with a subject as important as science.

48. Science instruction by television endangers the position of authority of the teacher in the classroom.

49. Television instruction in science reduces teacher satisfaction by subjecting him (her) to comparison with a "master teacher."

50. In the long run instructional television can only have an adverse effect on the caliber of teachers entering the profession.

51. A function of television in the classroom is in helping provide more uniform instruction.

APPENDIX V.

TEACHER QUESTIONNAIRE - "HOW DO I FEEL ABOUT TEACHING SCIENCE"

HOW DO I FEEL ABOUT TEACHING SCIENCE?

It seems to be generally agreed that most elementary school teachers feel less confident about the teaching of science than they do about teaching the "three R's." Part of this may be the result of the less adequate preparation of the teacher in science; part may come from the feeling of the teacher himself that he is inadequately prepared to teach science.

This questionnaire is designed to measure how confident you may feel in various situations involving several aspects of elementary science teaching. Please indicate your feelings with respect to the situations on the following pages by circling the appropriate number before each item on the answer sheet. For example, if you feel "very confident" about a certain situation, circle the number 5; if you feel "moderately confident" circle the number 4; and so on, utilizing the code shown below:

(5) Very confident
(4) Moderately confident
(3) Uncertain
(2) Moderately unconfident
(1) Very unconfident

SITUATION A

Your class is doing a unit on "Animals." The children ask the question, "How are plants and animals alike?" Below are some possible activities which you and the class may do. How confident would you feel about each?

1. Have children observe pets and plants at home to see how they are similar in basic needs.

2. Take the class on a field trip to notice the variations in plants and animals.

3. Do experiments to see if both plants and animals need water, food, etc.

4. Discuss with the class some of the similarities and differences between plants and animals.

5. Provide reference lists of children's books on plants and animals.

SITUATION B

A fourth-grade teacher is just a little afraid to do experimentation with her class. One day she attempted to demonstrate the presence of carbon dioxide in the breath. She had one of the pupils blow air through a straw which was immersed in a glass of lime water. The carbon dioxide in the pupil's breath should have made the calcium precipitate out and turn the water a milky color. However, much to the class's delight, the lime water stayed clear and the calcium did not precipitate. Below are some possible activities which could be undertaken. How confident would you feel about each?

6. Do the experiment over again using a new solution of lime water.

7. Discuss suggestions from the class to determine what was the reason for the failure in the experiment.

8. Try another experiment which will show the same body process as the one which failed.

9. Discuss some other related experiments which attempt to show the same results as the one which failed.

10. Encourage reading by children to discover possible reasons for failure in the experiment, provide reference materials for them to use.

SITUATION C

Your class is working on a unit study in "How do plants grow?" Below are some possible activities which may be carried out by the children and the teacher. How confident would you feel about each?

11. Read in books about plants and how they grow.

12. Observe a plant in a box or container to record growth changes.

13. Do experiments to show how a plant seed germinates.

14. Provide a list of references of children's books.

15. Have a sharing discussion about plants that children have in their homes.

SITUATION D

Your fourth grade class is studying a unit on weather. The question is raised, "How does the weather man know it's going to rain?" In looking at these possible activities, how confident would you feel about each?

16. Construct and use a model barometer or other equipment used by the weather man.

17. Use science kit to conduct experiments to determine causes of precipitation, condensation, etc.

18. Encourage children to read in reference materials to find information about weather (books, magazines, weather reports, etc.)

19. Help the children design and follow through with a daily weather chart.

20. Form a committee to investigate the question further and provide a list of resource materials for committee use.

SITUATION E

Your class is doing a unit study in "How simple machines help us." Below are some possible activities which may be carried out by the children and the teacher. How confident would you feel about each?

21. Observe the ways that simple machines are used in the school or community and record results of observations.

22. Provide a list of children's books on the uses of simple machines.

23. Discuss with the class the basic principles behind the workings of a pulley and some of its practical uses.

24. Have a sharing and discussion period about children's toys which resemble simple machines.

25. Discuss some of the uses of similar simple machines such as the lever, inclined plane, ball bearings, etc.

SITUATION F

While on a field trip, the school bus passes through an area where corn is planted. It has been a rainy year, and some of the corn fields are flooded in spots, and the corn is dying. The children, discussing the trip the next day, raise the question, "We have always been told that water is needed for plant life; why is the corn dying? It has plenty of water." In terms of the activities, how confident would you feel about each?

26. Discuss some experiments which the class may do to determine some of the requirements of plant life, and some conditions which may harm plants.

27. Do experiments with different kinds of plants (corn, water cress, wheat, bean, etc.) to show that each of them have slightly or greatly different environmental requirements for ideal growth.

28. Form a committee for further investigation of the problem; provide appropriate reference materials for them to use.

29. Have children observe plants in their homes and gardens to determine effects of the environment on the plants.

30. Make an observational chart of some local plants which live in the water, others which live on dry land. Observe local plants and record results.

SITUATION G

Your classroom is doing a unit study on the solar system. Below are some possible teacher-pupil activities. How confident would you feel about each?

31. Plan a trip to a nearby observatory or planetarium.

32. Find information about the solar system in materials other than the text which would be at an appropriate reading level for the children.

33. Design an observation chart of the visible planets. Observe the visible planets and keep a record of their positions in the night sky.

34. Construct a model of the solar system using balls, marbles, or beads to show the approximate relative sizes of the sun and the planets.

35. Have a class discussion on the importance of the sun.

SITUATION H

Your classroom is working on a unit study of "Electricity and what it can do." Below are some possible activities which may be carried out by the children and the teacher. How confident would you feel about each?

36. Construct a model electric motor from inexpensive materials.

37. Do experiments to show how a light bulb works.

38. Dismantle old or broken appliances to observe and learn more about how they work.

39. Provide a list of references of children's books on the uses of electricity.

40. Discuss some of the ways electricity is used in the school.

APPROVAL SHEET

The dissertation submitted by Norman R. Turchan has been read and approved by five members of the Department of Education.

The final copies have been examined by the director of the dissertation and the signature which appears below verifies the fact that any necessary changes have been incorporated, and that the dissertation is now given final approval with reference to content, form, and mechanical accuracy.

The dissertation is therefore accepted in partial fulfillment of the requirements for the Degree of Doctor of Education.

11-2-65
Date

Signature of Adviser