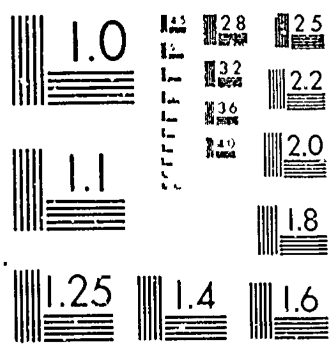
1 OF 2

ED 089 953



MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS

1 OF 2

ED 089 953

1.0 2.8 2.5 3.2 2.2 3.6 4.0 2.0 1.1 1.8 1.25 1.4 1.6

DOCUMENT RESUME

ED 089 953 SE 016 998

AUTHOR	Orgren, James R.
TITLE	The Effects of an Earth Science Curriculum Revision on Teacher Behavior and Student Achievement. Final Report.
INSTITUTION	State Univ. of New York, Buffalo. Coll. at Buffalo.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C. Regional Research Program.
BUREAU NO	BR-2-B-007
PUB DATE	Jun 73
GRANT	OEG-2-22B007
NOTE	176p.
EDRS PRICE	MF-$0.75 HC-$9.00 PLUS POSTAGE
DESCRIPTORS	Academic Performance; *Earth Science; *Educational Research; *Science Course Improvement Project; Science Education; *Secondary School Science; Student Ability; Teacher.Attitudes; Teaching Styles
IDENTIFIERS	Research Reports

ABSTRACT

A two-year study on the effects of adopting the 1970 revision of the New York State Regents Earth Science Syllabus on teachers' teaching strategies and educational opinions and students' abilities and performance was reported. A total of about 30 teachers and their classrooms were used. One group used the old syllabus in the first year and the new syllabus in the second year. The other two groups used the new syllabus in both years. Instruments employed included: a classroom activity checklist, classroom tapes, a process of science test, a teacher opinion scale, an earth science test, and the Regents Earth Science Examination. Results obtained indicated differences between teaching strategies, but not opinions, for teachers who changed to the new curriculum. Teachers participating in the development of the new curriculum held new opinions. No advantage to students' learning under either curriculum was observed concerning the ability to use the processes of science. Student achievement was specific to the material used in the classroom. (CC)

ED 089953

Final Report

Project No. 2B007
Grant No. OEG-2-22B007

James R. Orgren
State University College of New York at Buffalo
Through The Research Foundation of the State University
of New York
Box 7126, Albany, New York 12224

THE EFFECTS OF AN EARTH SCIENCE CURRICULUM REVISION ON TEACHER BEHAVIOR AND STUDENT ACHIEVEMENT

June 1973

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Office of Education

Regional Research Program

ABSTRACT

This study sought to determine the effects which adoption of the 1970 revision of the New York State Regents Earth Science Syllabus had on several teacher and student variables. The primary focus of the study, however, was on changes in teaching behavior which could be attributed to the adoption of this new science curriculum.

Approximately thirty teachers and their classrooms from each of three populations of Regents earth science teachers participated in this two year study. One group used the old syllabus in the first year of the study, and the new syllabus in the second year of the study. The other two groups used the new syllabus in both years of the study.

From the findings of this study, it can be concluded that teaching strategies employed under the old curriculum and the new curriculum differ. When teachers change to the new curriculum, they change their teaching strategies, but not their educational opinions. Teachers who participate in the development of a new science curriculum seem to hold educational opinions which differ significantly from those held by the general population of science teachers.

Student achievement on tests of earth science knowledge seems to be specific to the earth science teaching materials employed. There appears to be no advantage to learning under either curriculum, as far as improvement in ability to employ the processes of science is concerned.

Final Report

Project No. 2B007
Grant No. OEG-2-22B007

THE EFFECTS OF AN EARTH SCIENCE CURRICULUM REVISION ON TEACHER BEHAVIOR AND STUDENT ACHIEVEMENT

James R. Orgren

State University College of New York at Buffalo
thru Research Foundation of SUNY
Buffalo, N.Y. 14222

June 1973

The research reported herein was performed pursuant to a grant from the Office of Education, U.S. Department of Health, Education, and Welfare. Contracters undertaking such projects under Government sponsorship are encouraged to express freely their professional judgement in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Regional Research Program

ACKNOWLEDGEMENTS

The research which is reported here required the co-operation of over one hundred New York State Regents earth science teachers. These teachers and their classes contributed more than three hours of their class time each year during both years of the study. For the help of these dedicated teachers, I am deeply grateful.

The assistance provided by several staff members of the Bureau of Science Education of the State Education Department was also critical to the conduct of the study. Mr. Hugh Templeton, Chief of the Bureau, made possible selection of samples of the desired size through his letter to high school principals supporting the objectives of the study. Mr. Roger Ming, now Supervisor of the Bureau of Education for the Gifted, provided encouragement in the preliminary stages of the study. Mr. Douglas Reynolds, Associate in the Bureau of Science Education, lent his continuous assistance through the course of the study, by supplying lists of Regents earth science teachers, by obtaining samples of Regents examinations, helping on the construction of the "Earth Science Test", and generally maintaining an open line of communication between the researcher and the Bureau.

I am especially grateful to Dr. Rodney Doran of the State University of New York at Buffalo who contributed invaluable advice and assistance to this project over a period of three years. I am also grateful to Dr. Ronald Gentile, also of the State University of New York at Buffalo, and to Dr. Stephen Winter of Tufts University for the helpful suggestions they provided several times during the course of the study.

I am also indebted to Dr. Leonard H. Kochendorfer, Dr. Lehman W. Barnes, Jr., Dr. Fred N. Kerlinger, and Dr. Silas Schirner for the use of instruments which they had developed.

Finally, I wish to thank my wife, Sally, and my children, for their patient understanding during the many hours and days when the study precluded my full participation in family affairs.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

LIST OF APPENDICES

Appendix | Page

CHAPTER I

Introduction

Between 1958 and 1970, science education was radically affected by a new mode of science curriculum development, stimulated and largely funded by the National Science Foundation. Most of the products of this period of active curriculum development are nationally known by their alphabetic designations. For example, the Physical Science Study Committee produced PSSC physics, the Biological Sciences Curriculum Study produced BSCS biology, and the Earth Science Curriculum Project produced ESCP earth science. Such products will be referred to in this report as "the new science curricula".

The new science curricula differed from one another with respect to disciplinary concern, but were remarkably alike in several other respects. Hurd and Rowe (1964,p. 286) point out that the "developmental procedures for each project were substantially the same, even though each of the NSF curriculum groups worked independently".

The procedures used in the development of the new science curricula followed the pattern set up by PSSC. Scientists in the discipline, classroom teachers, and science educators were assembled at curriculum development centers, and charged with planning and writing a new curriculum which would have the potential for widespread adoption. After objectives were established and preliminary versions of curriculum materials, including text, teacher's guide and laboratory equipment had been prepared, these materials were tried out in the classroom and laboratory. Feedback from the trial period guided further curriculum revision, which ultimately led to production of the final version of the curriculum.

The new science curricula were also marked by commonality of overall objectives. Hurd and Rowe (1964, p. 286) list some of the objectives common to the various projects,

> The purpose of instruction is to develop an understanding of current scientific knowledge, its concepts and methods of inquiry. Textbooks were organized around large themes or principles of science to provide unity and sequential coherence. Laboratory activities were designed to be less illustrative and more investigative and quantitative than they had been.

Furthermore (pp. 286-7),

> A teaching style consistent with the purposes of the "new" science course was required. The new movement in science instruction is as much a matter of improved teaching methods as of new goals and up-to-date content.

With respect to this latter point, Ramsey and Howe (1969, p.62) point out that,

> The science course improvement projects are considered by their proponents to be more than just course descriptions: they are expected to define instructional procedures.

Blankenship (1967, p. 622) says, "The new science curricula are devised so that the suggested techniques of teaching are essential to the success of the program".

The large number of summer and in-service institutes funded by NSF for the specific purpose of training teachers in the utilization of the various new curricula attests to its desire to acquaint teachers with the teaching strategies considered to be in conformity with the objectives of the new curricula. Funding of the institute program, however, would not permit this type of in-service training for all the science teachers in the country, so the new science curriculum materials were accompanied by very complete and explicit "teachers' guides" which it was hoped would make the new curricula at least partially "teacher proof".

The Problem and its Significance

Unless the field of science curriculum development is to become a random series of untested theories and fads of the moment, it is crucial that curriculum implementation be accompanied and followed by research into attainment of the objectives which guided development of the curriculum in question.

Attainment of <u>all</u> the objectives of a curriculum movement as extensive and expensive as that of the sixties should be fully researched. As will be seen in Chapter Two, there has been uneven research attention given to the several objectives of the new science curricula. Particularly deficient has been the attention given to the objective of changing teaching behaviors. Even though techniques have been available for measuring changes in teaching behaviors, very little research has investigated the link between adoption of a new science curriculum and teaching strategies employed by the teacher. As will be evident in Chapter Two, those studies which have attempted to deal at all with this problem have done so by comparing the teaching behaviors of teachers using one of the new science curricula with those of teachers not using the new science curriculum. Those using the new science curriculum had ordinarily volunteered to teach the new materials; those not teaching from the new materials had often had the opportunity to try them, but had declined, and continued to teach whatever type of science course they happened to be teaching at the time. Differences found in teaching strategies employed by such groups of teachers have sometimes been ascribed to the curriculum used. This conclusion, however, is not fully warranted, considering the design used. Firstly, it is not clear against what the new curriculum is being judged. "Non-BSCS biology", "non-ESCP earth science", leave much to be desired in terms of specificity. Secondly, and more important, it is not at all clear whether it is curriculum factors, or initial selection factors that are being measured in such studies. It is quite possible that teachers who voluntarily adopt one of the new curricula may have previously employed different teaching behaviors from those used by teachers electing to continue using materials with which they are familiar. Are behaviors more "progressive" because of the curriculum or because of characteristics in the teachers trying the new curriculum? The review of research to be discussed in Chapter Two indicates that this question has not yet been answered.

To design a study which would control for these factors is not difficult. One requirement is that both the old and the new science curricula be clearly specified, preferably in terms of teaching materials, advocated teaching procedures and final exams given to students in each group. (The final exam may serve as a control on curriculum utilization.) A second requirement, of fundamental importance, is that a group of teachers be followed through the transition from use of traditional materials into their utilization of the new science curriculum. It would be most advantageous if the group making such a transition could consist of teachers who had not taken advantage of previous opportunities to use the new materials, and adopted them only when their use was mandated.

While designing such research is simple enough, obtaining relatively large samples of teachers and classrooms under the desired conditions is much more difficult. As will be seen in the following section, the desired groups and conditions were available for the research described in this report.

Before considering the specific curriculum and conditions of adoption with which this study will deal, it seems appropriate to briefly describe the scope of the problem to be dealt with by this study. The overall problem is, "What effects on teaching behaviors and on student achievement can be ascribed to the adoption of one of the new science curricula?" Since our educational system hinges on the assumption that what the teacher does in the classroom is a basic ingredient of the teaching-learning process, it is important to know whether the new science curricula are modifying the behaviors of the teachers who adopt them. Investigation of one of the new science curriculum's effect on teaching strategy will constitute the principal focus of this study.

Since conditions of adoption constitute part of the design of the study, and it is hypothesized that selection of teaching materials is partially a function of the educational opinions of teachers, it seemed desirable to measure these opinions at the beginning of the study. Measuring these opinions several times during the course of the study made it possible to determine if opinions changed after exposure to the new science curriculum.

Since the new science curricula include among their objectives the enhancement of student ability to employ the processes of science, and of growth in knowledge of a specific discipline, it was deemed desirable to include measurement of these abilities within the scope of this study. Inclusion of these latter variables permitted comparison of the results of this study with research on the effects of adopting other new science curricula. It also permitted a comprehensive analysis of the success of one of the new science curricula in attaining the major objectives which guided its development.

In summary, the problems dealt with in this study were concerned with the effects of adopting one of the new science curricula. The study sought to determine if adopting the revised version of the New York State Regents Earth Science Syllabus,

1. changed the teaching strategies used by the teacher
2. changed the educational opinions of the teacher
3. increased the student's ability to employ the processes of science
4. improved the student's performance on a test of earth science knowledge

Considering the energies that were expended in revising the Regents Earth Science Syllabus, and the number of students and teachers affected by their adoption, it seems essential to discover as much as possible about the total impact of this curriculum on the classrooms involved.

Setting of the Problem

During the years 1964-65, several schools in New York state served as trial centers for the materials being prepared by ESCP. In 1966, it was decided by the Bureau of Secondary Curriculum Development of the New York State Education

Department that a complete revision of the Regents Earth Science Syllabus should be undertaken. This revision was based in part on the experience of New York State teachers with the ESCP program, but curriculum materials were to be developed that would meet the needs of New York State students.

An Earth Science Syllabus Revision Committee was formed to guide the process of revising the syllabus. Guidelines developed by the Committee (Bureau of Secondary Curriculum Development, 1970, p. iii),

> described a philosophy and approach for a new course of study in earth science that would be:
>
> 1. student activity oriented--Students should be exposed to a learning environment in which they would be active participants. Laboratory and field experience should be the focal point of this program.
> 2. investigatory in approach--The learning activities should be oriented toward an inquiry approach, placing the student in the role of investigator.
> 3. interdisciplinary in content--The course content organization should integrate the traditional earth science subject areas. Emphasis should be placed on the analysis of the environment, and the processes affecting it. (Emphasis in the original)

A listing of the "Process-of-Inquiry Objectives" and "Course-Content Objectives" is found in the preface of the 1970 Syllabus. (See Appendix A). These objectives are in close agreement with the ESCP "themes" described in the teachers' guide to Investigating the Earth. (Earth Science Curriculum Project, 1967, v. 1, pp. 1-4)

The objectives in the 1970 Regents Earth Science Syllabus differ considerably from those expressed and implied in the 1962 Regents Earth Science Syllabus (Bureau of Secondary Curriculum Development, 1962). For example, the "Table of Contents" of the 1962 version of the syllabus is almost entirely topical, and is multidisciplinary rather than interdisciplinary. (See Appendix A). Although the earlier version stresses the importance of laboratory work ("laboratory work is an essential and integral part of the earth science course", Bureau of Secondary Curriculum Development, 1962, p.3), there is no curricular provision for integrating the "activities" with the "outline of topics.". Despite disclaimers to the contrary, a number of the "activities" described in the 1961 Handbook of Activities to Accompany the Course of Study in Earth Science (Bureau of Secondary Curriculum Development, 1961) are teacher demonstrations. Scarcely any of the investigations in the laboratory supplement to the 1970 version of the syllabus (Bureau of Secondary Curriculum Development, 1970) are designed for teacher demonstration. The activities in the earlier Handbook of Activities are mostly topical, fact-oriented, and have little relationship to one another. The investigations in the 1970 supplement attempt to develop knowledge of concepts and relationships. The laboratory investigations are closely integrated to each other through the structural framework of the syllabus. Probably the clearest indication of the integral part which the developers of the new syllabus assign to the laboratory is to be found in the "Matrix of Investigations" which precedes each "Topic" in the supplement to the syllabus. Following the conceptual outline of the syllabus, these pages are designed to help the teacher select laboratory investigations from the supplement which will develop the concepts and relationships outlined in the syllabus. The matrices serve to reinforce the admonition in the preface of the syllabus (Bureau of Secondary Curriculum Development, 1970, p.x),

> While the investigations have been placed in a "supplement", it should be clearly understood that they are not supplementary--they are essential, and comprise the core of the course. (Emphasis in original.)

Thus it is seen that the new syllabus not only proposes a new set of concepts to be learned by the student; it also supplies a conceptual structure within which these concepts are to be related. More importantly, beyond concept and structure, it strongly advocates that laboratory investigation be considered the normal and usual mode of instruction.

Because of the magnitude of the change in content and teaching strategies envisioned by the Revision Committee, it was decided that a large number of earth science teachers would be involved in the revision process. It was thought that this would help to ensure that the materials would be firmly based on classroom experience, and would acquaint as many teachers as possible with the new materials on an in-service basis during the period of their development. Under the direction of Roger Ming, then an Associate in the Bureau of Science Education, an ambitious plan was conceived which was to involve more than 150 Regents earth science teachers from all across New York state in the revision, trial and refinement of earth science curriculum materials over a period of four years. During this period, these teachers participated in writing conferences, discussion sessions, instruction periods, and practical experimentation with a large variety of new laboratory investigations in earth science. Statewide conferences combining these aspects of curriculum development were held as many as four times per year during the period of revision. Forty to fifty teachers usually attended these sessions. Between state-wide meetings, local centers of four to eight Regents earth science teachers met bi-weekly to exchange their experiences concerning the new syllabus, and to work out revisions of laboratory investigations, create test items and refine objectives. The feedback from these sessions guided the Revision Committee in its overall direction of the process of revising the new syllabus.

During the period of curriculum revision (1965-69), the new materials and the Special Regents Exams prepared for use with them could be used only by those teachers who were formally participating in their development. In 1969, the Bureaus of Secondary Curriculum Development and of Science Education decided that the revised materials would be offered to all high schools in the state on an <u>optional</u> basis in the fall of 1970, and that in the spring of 1971, two forms of the Regents Earth Science Examination would be offered, one for each version of the syllabus being taught.

Beginning in the fall of 1971, the revised version of the syllabus replaced the prior version, and in the spring of 1972, there was only one version of the Regents Earth Science Examination offered, constructed to measure attainment of the objectives of the new syllabus. Thus, beginning in the fall of 1971, all schools which wished to continue offering Regents earth science were required to offer the revised version of the course.

In the fall of 1970 then, there were to be three groups of Regents earth science teachers in New York state:

A. Those electing to continue teaching the regular version of the syllabus

B. Those electing to begin teaching the new syllabus in the first year that its use was open to any school which wished to use it

C. Those teachers who had previously helped to develop the new syllabus, and who were now using it for the second or more year.

In the fall of 1971, all teachers who wished to continue teaching Regents earth science were expected to use the new syllabus. Thus, the teachers of Group A went through a mandated transition from the old (regular) syllabus to the new (revised) syllabus in the fall of 1971.

The revision and adoption of the Regents Earth Science Syllabus of New York state thus provided a unique opportunity to engage in a controlled study of the adoption of one of the new science curricula. In this study, both "new"and "old" curricula are clearly defined. More importantly, an identifiable group of teachers and classrooms can be studied both before and after curriculum adoption.

CHAPTER II

Review of the Literature

Introduction

Evaluation of the effectiveness of the new secondary science curricula has been guided, at least partially by the stated objectives of the various projects. Three kinds of evaluative effort are especially pertinent to this study. Since certain kinds of student understandings and behaviors were stressed by each of the new programs, evaluation of the new programs quite naturally analyzed student performance on measures of these understandings and behaviors. Since the new programs prescribed specific methods of instruction, a few studies have analyzed the effects of adoption of the new curricula on classroom instructional procedures and instructional climates. Since teacher educational opinion is presumed to be related to teaching style and curriculum adoption, a review of research in this field will be reported.

Finally, because this study undertakes a rather comprehensive summative evaluation of one of the new science curricula, a brief review of other comprehensive science curriculum evaluations will be presented.

Effectiveness of the New Science Curricula Relative to Student Variables

Of all the studies conducted on the effectiveness of the new science curricula, those which have focused on knowledge outcomes on the part of students constitute the largest single fraction. Ramsey and Howe (1969) surveying the literature in 1969 found about twenty studies devoted to this aspect of the new curricula. By and large, the studies found that students who have been exposed to one of the new curricula outperformed students using traditional materials on tests devised for the new materials, and that students using the new materials did approximately as well on tests of traditional material as did students taking a traditional course. In earth science, however, Schirner (1967, p. 61) found that,

> ESCP students do significantly better on the ESCP final examination. The non-ESCP students do significantly better on a general earth science final [traditonal] examination.

The Psychological Corporation (Champlin, 1970) obtained similar results in an early (1964-65) study with ESCP and traditional classrooms. Champlin and Hassard (1966), however, found no significant differences on the ESCP final between ESCP and traditional groups. A study by Sargent (1966) controlled for the teacher variable, insofar as it distinguished authoritarian from permissive teachers with the McGee F Scale, and reached the same conclusion as Sargent: the achievement of students in ESCP and traditional classrooms showed no significant difference on the ESCP final examination.

Except for the area of earth science, it appears that not only do students under the new science curricula do better on tests designed for the new programs; they also generally do as well as the students under traditional programs on traditional tests. The lack of consistency with respect to earth science remains unresolved. Part of the problem, as Champlin (1970) points out, is that none of the earth science studies reported above clearly defined the "traditional course", hence tnis constitutes an uncontrolled variable. Champlin (1970, p. 38) goes on to suggest, "Comparative studies will become more meaningful when this factor is given greater attention". The present study will control this variable, since the "traditional group" will be defined as those teachers and students using the regular version of the New York State Regents Earth Science Syllabus.

It is obvious from the prior description (See Chapter I) of the objectives of the new curricula, that student understanding of the nature of the scientific endeavor and of the processes of science were of prime importance to the curriculum developers. Yet, by the end of the sixties, Ramsey and Howe (1969) reported that less than a dozen studies had examined problems related to these objectives. Tests were devised which attempted to measure these understandings on the part of the students taking science courses. Some commonly used standardized tests were: Test on Understanding Science (TOUS) (Cooley and Klopfer, 1963) and the Processes of Science Test (Psychological Corporation, 1965). Yager and Wick (1966) and Gennaro (1964) found that BSCS students in a multi-reference, laboratory oriented course made greater gains on TOUS than students in a course which did not emphasize these aspects of instruction. Troxel (1968) found that students in CHEM Study and CBA chemistry classes made significantly greater gains on TOUS than students in traditional chemistry courses.

Only three curriculum evaluation studies were found which related student ability to employ the processes of science to type of curriculum employed. Two used the Processes of Science Test (POST); both of these studies compared BSCS classrooms to non-BSCS classrooms. Wallace (1963) reports that while mean fall to spring gains on this instrument only ranged as high as .55 on a forty point scale, there was a slight, but statistically significant difference in favor of the control group. Kochendorfer (1967, p. 82) on the other hand reports that,

> Those classes using BSCS materials and employing practices advocated by BSCS had significantly greater gains in pupil understanding of the nature of science as measured by POST than those classes using other materials and employing other classroom practices.

Welch (1972c) reports that PSNS (Physical Science for Non-Science Majors) students did not make significantly greater gains on the "Science Process Inventory" than did non-PSNS students.

On the whole, the research would tend to support the hypothesis that students taking the new science courses tend to develop better understanding of the scientific enterprise. There is uncertainty, however, about the effectiveness of the new curricula in promoting the ability to employ the proces-ses of science; further research is needed to resolve the issue.

Effectiveness of the New Science Curricula Relative to Teaching Behaviors

As was shown in Chapter I, a prime objective of the new science curricula was to accomplish a change in the instructional procedures employed by the teachers who used the new science curricula. The major purpose of the present study is to determine whether one of the new curricula accomplished this objective. Before reporting the findings of the few studies which have investigated curriculum effects on science classroom behavior, it seems appropriate to briefly review the broader field of classroom behavior research.

The assumption of all classroom behavior research is that behaviors of both teacher and student are observable, and that they can be categorized. Classroom behavior can be observed and categorized by an outside observer who is present in the classroom, but who is not participating in the interaction between teacher and students. Behavior can be recorded on audio or video tape for later analysis by an outside observer. Teacher behavior can also be observed and categorized by an observer (e.g. students) who regularly participate in the activities of the classroom. The first two methods of observation may be called external because they are accomplished by observers external to the classroom. The latter method of observation may be called internal, since a member or members of the classroom report on the activities occuring there.

Among instruments for external measurement of classroom behaviors, Medley and Mitzel (1963) distinguish between category systems and sign systems. Category systems consist of a finite set of categories constructed in such a way that every item of behavior may be categorized under only one of the categories. At the end of an observation session, tallies can be made of the frequency of occurence of each behavior.

Sign systems do not require that each item of behavior be categorized. Their concern is to discover if certain preselected behaviors occur in the classroom under observation. Sign systems usually have a larger number of items than category systems, and can thus report on more specific types of behavior, but they are not able to report the relative frequency with which behavior in each of the categories occurs.

The most widely used category system is the interaction analysis system devised by Flanders (1967), which focuses primarily on the mode of influence, direct or indirect, used by the teacher. Data obtained by use of the Flanders instrument may be summarized in several ways, but the most commonly used summary statistic is the ratio of Indirect to Direct behavior time, called the ID ratio.

Several science education researchers have used the Flanders instrument, but much science education research has focused on problems for which the Flanders instrument is not appropriate. For this reason, several science education researchers have devised their own instruments for observation of science classroom behaviors. Evans and Balzar (Evans, 1969) for example, devised the "Biology Teacher Behavior Inventory", a category system with the following categories: Management, Control, Release, Goal Setting, Content Development, Affectivity, and Undecided. Fischler and Zimmer (1967-68) constucted a sign instrument having three dimensions of classroom analysis: Teaching Techniques, Teacher Questions, and Characteristics of Teaching. There were sixteen categories of Teaching Techniques, five categories under Teacher Questions, and three categories under Characteristics of Teaching.

Parakh (1968) developed a "Category System for Interaction Analysis in Biology Classes" which had seventeen major categories of behavior, distributed in five dimensions: Evaluative, Cognitive, Procedural, Pupil Talk, and Other. Hassard developed the "Science Teacher Behavior Code" (1970) which has five major categories, twenty-nine subcategories and four indices of teacher behaviors. It was developed primarily for analysis of video-taped science classes. Smith (1970) developed the "Classroom Observation Instrument Relevant to the Earth Science Curriculum Project" for use in his study. There are ninety categories in this instrument distributed among four major instructional groupings: Text, Pre-Laboratory, Laboratory, and Post Laboratory.

The instruments described so far were devised to be used by external observers of the classroom. Internal observations of classroom procedures are most commonly obtained from students in the classroom being observed. Most instruments used in this type of research in science education have been based on Kochendorfer's (1967) "Biology Classroom Activity Checklist". This instrument will be described at some length in the "Instrument" section of Chapter III of this report, so attention will now be directed to the rationale supporting the use of such an instrument to measure teacher classroom behavior.

Reed (1962) found student reports of teacher behaviors to have reliabilities in the range of .80 to .90. His conclusion on reliability of student reporting on teacher behaviors is (1962, p. 475),

> The stability of pupils' responses concerning these teacher characteristics clearly indicates that pupils do perceive the teacher in a fairly uniform fashion, and can report their perceptions if given an opportunity to respond to specific behavior items. Certainly one implication is that regardless of the many differences among pupils in the classroom, the image the teacher establishes is surprisingly uniform.

Remmers (1963) approached the reliability of student ratings from several points of view. He found that reliability of student ratings of teachers was a function of the number of raters. He found twenty-five or more students to be as reliable as the better educational and mental tests available. He found that there seemed to be little relationship between ratings and grades awarded by the teacher. Alumni after ten years agreed with students currently rating the same teacher. The halo effect was found to be negligible; students discriminated reliably between the different aspects of the teacher's personality and of the course. The popularity of the teacher, or participation in extra-class activities had little relationship with the ratings.

Cogan (1958) found that students were able to discriminate reliably among a variety of teacher behaviors. Using split-half techniques, Leeds (1947) found that the reliability of student reporters of teacher behaviors was .936. Korth, Czelan and Moser (1971) report a study in which they compared measurements obtained using the"Science Classroom Activity Checklist" (a modification of Kochendorfer's"Biology Classroom Activity Checklist") with those obtained from use of a modified form of Parakh's "System of Interaction Analysis". Using a Spearman Rank-Order Correlation, they found a correlation of .79 between per cent of teacher talk, as measured by Parakh's instrument, and the total score of the Activity Checklist. The correlation between the total Checklist score and teacher questions, measured by Parakh's instrument, was +.90. Thus on several classroom variables, the measurements obtained by the reports of students (from the Checklist) agreed quite well with those obtained by external observation techniques.

It appears then that students are reliable, unbiased and discriminating reporters of teacher behaviors. The study by Korth et al suggests that a valid report of these behaviors can be provided by the "Science Classroom Activity Checklist.

Findings of classroom behavior research

Classroom behavior research is a rapidly expanding field of study. For the sake of brevity, only a few of the findings in science classrooms will be reviewed here. Generally it has been found that science teachers, like all teachers talk approximately 75% of the time, although the percentage may be somewhat lower in the laboratory (Parakh, 1968). Schirner (1967), using Flander's instrument found that students of a direct teacher (i.e., having a low ID ratio) had higher gains on tests of science knowledge if their teacher used a traditional curriculum than if he used the ESCP materials; for students of an indirect teacher, the reverse was true.

Kochendorfer (1967) found that students whose teachers employed the teaching behaviors advocated by BSCS performed better on the "Processes of Science Test" than students whose teachers did not use these behaviors. Overall, however, there is not a great deal of research linking the teacher's classroom and laboratory behaviors with student achievement outcomes, particularly when one discounts the studies carried out with very small samples.

Surveys by Ramsey and Howe (1969), Champlin (1970), and Balzer (1970) have shown that very few studies have investigated the effects which adoption of one of the new science curricula may have on the teaching strategies employed by teachers. Balzer (1969), using the "Biology Teacher Behavior Inventory" analyzed the behaviors of four BSCS biology and four non-BSCS biology teachers. He found no significant difference between the two groups in the various behavior categories. Schirner (1967) drew no conclusions concerning the possible effects of the ESCP curriculum on the classrooms he studied, even though he had data from Flanders interaction analysis of classrooms in which ESCP was being taught and of classrooms in which non-ESCP earth science was being taught.

Barnes (1967) studied the laboratory behaviors of biology teachers: non-BSCS biology teachers; first year BSCS teachers; and experienced BSCS teachers. Each sample consisted of twenty-one teachers and their classes. He analyzed teachers' laboratory behaviors with the "Biology Laboratory Activities Checklist". This instrument gives an overall score which indicates the level of similarity between the practices employed by the teacher and those recommended by the BSCS curriculum developers. Significant differences were found between all groups. The behavior of experienced BSCS teachers was most in agreement with those behaviors recommended by BSCS curriculum developers. First year BSCS teachers employed strategies less in accord with those advocated than did experienced BSCS teachers, but more in accord with the advocated procedures than those used by non-BSCS teachers. Non-BSCS teachers used the advocated procedures least often.

Kochendorfer (1967), studying the classroom behaviors of the same groups of teachers studied by Barnes found differences similar to those reported by Barnes. He found these differences on the overall score provided by his instrument (the"Biology Classroom Activity Checklist"), and also in the categories of "Teacher in the Classroom", "Students' Participation in the Classroom", "Use of Textbook and Reference Materials", "Design and Use of Tests", "Type of Activities", and "Laboratory Follow-up Activities". In "Preparation for Laboratory", the experienced group and the new BSCS teachers exhibited about the same level of BSCS desirable behavior. Kochendorfer concludes that (1967, p. 81),

> The BSCS program has made a definite impact on biology classroom teaching practices; however, it is also apparent that some teachers have been using the practices in agreement with BSCS philosophy and rationale for many years.

It should be kept in mind that Barnes and Kochendorfer studied extant groups of BSCS and non-BSCS teachers. No follow-up is reported to this study which might indicate whether gains were made by the experienced or first year BSCS teachers in subsequent years of experience with the new materials, or whether teachers coming into the BSCS program changed their teaching behaviors after starting to use the new materials. Hence the question remains as to how much of the difference in teaching strategies can be ascribed to the use of the BSCS curriculum and how much to the effect of pre-selection.

A study by Vickery (1968) contains the only report to date of an attempt to search for longitudinal differences in the classroom and laboratory behaviors of teachers which could be ascribed to the use of a new science curriculum. Vickery studied the seventh grade classrooms of nine teachers assigned to the use of traditional materials, and nine teachers assigned to use materials developed by the Intermediate Science Curriculum Study (ISCS). The non-ISCS teachers all used the same state-adopted (traditional) general science text. The study sought answers to the questions:

1. Are teaching strategies as measured by the observation schedule (devised by Vickery) different for the two

groups?

2. Are changes of teaching procedure made in the first year of teaching with the new materials?

Data were gathered in each of the classrooms under study for two days early in the year, again in the middle of the year, and finally at the end of the year. Significant differences were found in the amounts of time devoted to individualized instruction and to laboratory instruction between the two groups (ISCS and non-ISCS). Significant longitudinal differences were found in the behavior of ISCS teachers only with respect to individualized instruction. There was a non-significant trend among the ISCS teachers to increase their employment of laboratory instruction through the year.

In 1969, Hurd (1969 , p. 117) concluded that,

> The [science curriculum] reformers recognized the need to have their courses taught in special ways if they were to achieve the goals set for them. That they did not give enough attention to this problem is now evident. After a decade of curriculum reform and 'up-grading' of teachers it appears at this time that perhaps as many as two-thirds of the teachers using the textbooks of the new curricula are <u>not</u> teaching the course in the mode envisioned by the authors.

Research on the implementation of the new science curricula is so sketchy that there is really no way of supporting or rejecting the assertion that two-thirds of the teachers using the new materials are not teaching the course in mode envisaged by the authors. After describing twenty studies on <u>all</u> aspects of science classroom behavior analysis (not only as related to employment of the new science curricula), Balzer (1970, p. 21) concluded that, "It is apparent that science classroom behavior at the various levels of classroom instruction has been very lightly researched". Elsewhere (Balzer, 1970, p. 26) he suggests that broad based, descriptive studies are needed which attempt to describe teacher behaviors under various conditions, "including teacher training and the use of various curriculum materials".

Particularly conspicuous by its absence among the reported studies of classroom teaching behavior is an attempt to follow a group into and through the curriculum adoption process to determine if teaching behaviors change following the adoption. Such a study would bring us much closer to answering questions about the effectiveness of the new curricula in bringing about desired changes in teaching behaviors.

Research on Educational Opinions

Among the factors which affect the extent to which a teacher adopts the strategies suggested by a new curriculum, teacher educational outlook and attitudes may constitute some of the strongest influences. It is necessary then to find what the literature has to say about teacher opinion and its relation to classroom implementation of the new science curricula.

For the purposes of this review, the broad field of teacher attitude research has been narrowed to the teacher's opinion about the educational process.

Ryans (1960, p. 78), after a comprehensive factor analysis of teacher attitudes found that,

> The factorial representation of educational viewpoints that emerged was not clear cut; there seemed to be justification for considering teachers' educational beliefs from the standpoint of a single continuum, rather than several factors. This variable has been oversimplified perhaps by designation simply as an "academic content-standards oriented" versus "flexible permissive, 'pupil-oriented' dimension".

Elsewhere Ryans (1960, p.69) characterizes the extremes of the scale just described as what "we sometimes call traditional versus permissive viewpoints".

Schirner (1967) developed the "Teacher Educational Credo Preference Checklist for his study of earth science teachers. This instrument consists of twenty-five pairs of statements related to the educational process. One member of each pair is "traditional", the other "non-traditional". Kerlinger and Pedhazur (1967) in their comprehensive teacher attitude study, developed several teacher attitude inventories. "Educational Scale VII", the most recently developed, contains thirty statements about educational practice with which the teacher is asked to agree or disagree on a seven point scale.

Blankenship (1967) developed an "Attitude Inventory" to measure attitudes of biology teachers toward the curriculum materials and the teaching processes advocated by BSCS. Barnes (1967) used Blankenship's "Attitude Inventory" to determine the attitudes of BSCS and non-BSCS teachers toward BSCS objectives. He also determined the degree to which these teachers employed the teaching procedures advocated by the developers of the BSCS curriculum, by means of his own Biology Laboratory Activity Checklist. He found these two measures to be significantly correlated. The Blankenship instrument does not specifically measure teacher attitude toward the educational process, but since many of the BSCS objectives are concerned with a particular kind of educational procedure, Barnes' findings can be used to suggest a direction for further research of the problem: Is the teacher's employment of teaching practices demanded by the new curricula dependent on his attitude toward the educational process? A second question was not even found in discussion in the science education literature: Do teacher's opinions about the educational process change after using one of the new science curricula for some time? The present study will seek answers to these questions.

Comprehensive Evaluations of New Science Curricula

The present study seeks to provide a broad-spectrum evaluation of one of the new science curricula. Therefore it seems appropriate to conclude this review of research with a brief survey of those summative evaluations of other science curricula which have dealt with a variety of variables associated with the adoption of a new science curriculum. The focus here will not be on results, but on the types of variables studied.

In his survey of evaluations which had been done on the new science curricula, Welch (1969) pointed out that very little summative curriculum evaluation had been undertaken by the curriculum development projects themselves. He further indicates that most research carried out by persons not associated with the projects has focused on a very few variables, in most cases student achievement, attitude and behavior. Elsewhere (Welch, 1972a) he notes that achievement outcomes have been the chief focus of curriculum evaluation in the sixties.

There are, however, a few studies which have examined several aspects of curriculum effectiveness. Prominent among these is the research on Harvard Project Physics, conducted by Welch (1971) and others. Variables measured in this carefully conducted study included: student ability to employ science processes, student interest in science, student achievement outcomes, teacher characteristics, and classroom climate.

Welch (1972b) reports a study of the effectiveness of PSNS. Variables measured in this study were: student attitude, understanding of science process, and interest in school subjects.

Under the direction of Addison Lee, the Science Education Center of the University of Texas at Austin focused a series of studies on new programs in biology, particularly BSCS biology. In a report edited by Lee (1967), nine researchers reported on their studies of several variables relative to the adoption and employment of BSCS. As described earlier, Barnes (1967) and Kochendorfer (1967) studied instructional procedures, ability to employ the processes of science, and teacher attitude toward the BSCS materials. Stanko (1967) investigated the use made of teachers' manuals.

In his study of ESCP and non-ESCP classrooms, Schirner (1967) measured the following variables: classroom interaction (by means of ID ratios), teacher educational opinion, student knowledge of earth science (two tests), student knowledge of science, and student critical thinking ability. Unfortunately, Schirner's report does not consistently link these variables to curriculum utilization, but rather relates the variables one to the other, so that the effect of ESCP on the several variables is difficult to ascertain.

Welch (1969) suggests that discernible advancement in curriculum eveluation is largely dependent on a concentrated effort to investigate many facets of a given curriculum. The present study is an attempt to investigate several possible effects of adopting the revised version of the New York State Regents Earth Science Syllabus.

CHAPTER III

Procedure

Sample Selection

In the spring of 1970, the Bureau of Science Education of the New York State Education Department sent each junior and senior high school principal in the state a form requesting information on his school's plans for Regents earth science for the year 1970-71. Response from the schools indicated that between four and five hundred Regents earth Science teachers would be using the new syllabus during the year of optional adoption, and that between five and six hundred teachers would continue using the older version during 1970-71. Of those using the new syllabus, approximately one hundred teachers had used it previously, during the period of its development. In the fall of 1970 there were to be three populations of Regents earth science teachers in New York state:

A. Population A, teachers electing to continue teaching the older version of the syllabus

B. Population B, teachers electing to use the new syllabus for the first time

C. Population C, teachers who had previously used the new syllabus while participating in its development.

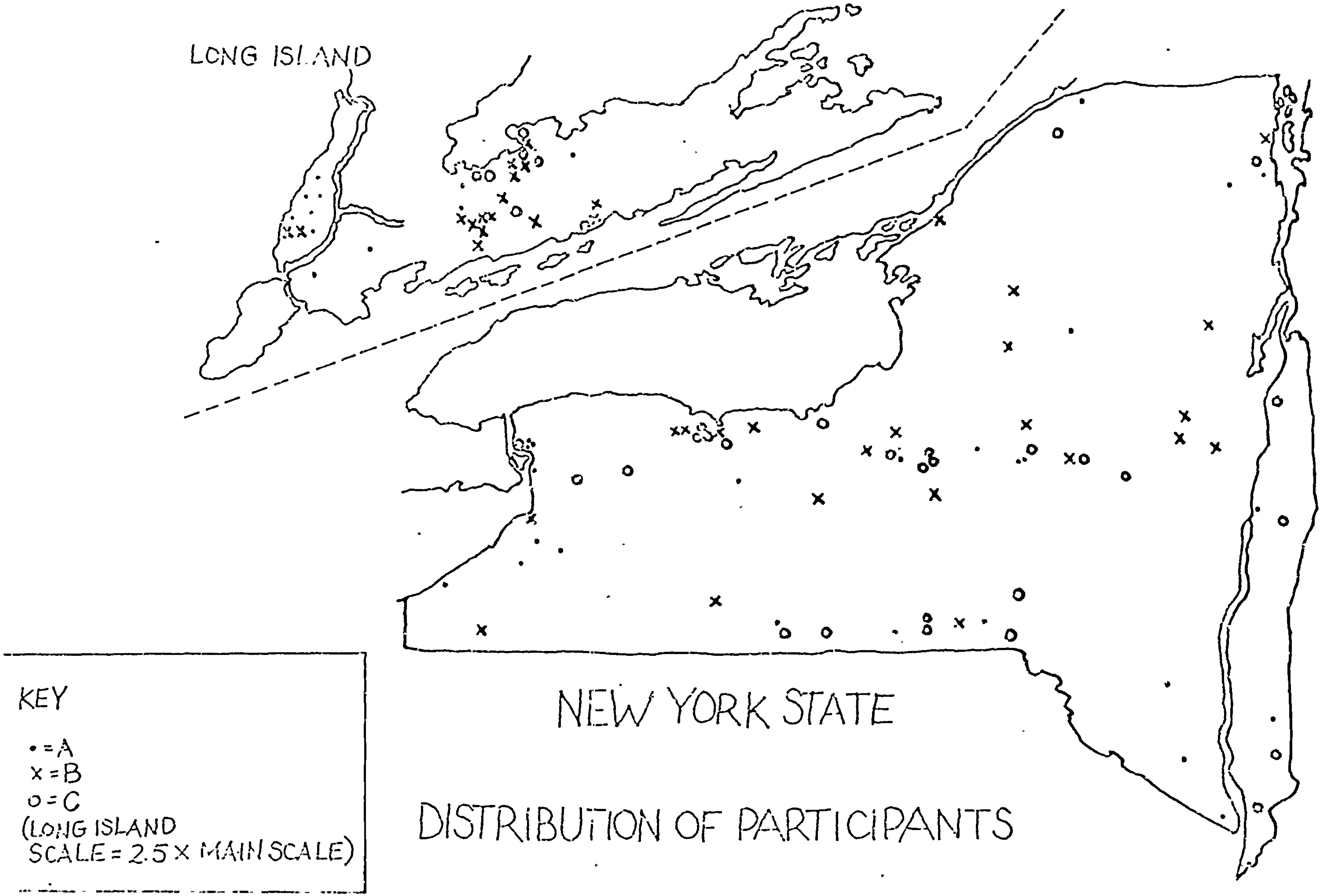
In late August, 1970, names and school addresses of teachers in each of the three populations were made available to the researcher by Mr. Douglas Reynolds, Associate in the Bureau of Science Education. It was determined that the desired initial sample size would be forty classrooms from each of the three populations. It was estimated that in a study which was to span two academic years, there would be an attrition rate of approximately 25%, and that approximately thirty classrooms in each sample would be desirable for statistical validity. Since there was no way in which participation in such a study could be required, it was necessary to request voluntary cooperation. It was estimated that about one-fourth of those asked would agree to participate in the study, so approximately one hundred sixty teachers in each population were randomly selected to receive letters requesting their participation in the study. Since there were only about 100 teachers in Population C, all teachers in that group were invited to participate. The researcher composed a letter of invitation which described in detail the assistance that would be required of teachers who volunteered to participate in the study. Mr. Hugh Templeton, Chief of the Bureau of Science Education, consented to write a cover letter to the principal of each teacher invited to participate in the study, urging him to support the teacher in his efforts if he chose to volunteer for the study. These letters were sent out in late September, 1970. Copies of the letters, and of the form returned by the teacher are found in Appendix B.

By late October, volunteers from each of the populations had responded in the following numbers: Population A, thirty-eight; Population B, forty-one; Population C, thirty-nine. These teachers were selected to comprise the samples used in the study. Geographic distribution of the teachers in each sample is shown in Figure 1.

Each of the respondents had indicated on his response form how many Regents earth science classes he was teaching, and at what periods in the day he met them. For each teacher, the researcher randomly selected one class to participate in the study.

Since they were volunteers, it was of interest to know if the teachers participating in the study differed significantly from the populations of teachers they were selected to represent. In the spring of 1971, a random sample of Regents earth science teachers from populations A, B, and C who were not participating in the study were asked to respond to the Educational Opinion Scale. Group by group, the Opinion Scale scores of those who responded were compared to the scores ob-

FIGURE 1



DISTRIBUTION OF PARTICIPANTS

tained from each of the three samples of volunteers. Table 1 shows that none of the samples of volunteers differed significantly from its parallel group in the population on Opinion Scale scores. Hence, there is some support for the assumption that the samples of volunteers were representative of their respective populations.

Table 1

T-TEST OF DIFFERENCES BETWEEN SAMPLES AND "POPULATIONS" IN RESPECT TO EDUCATIONAL OPINION

Group	Sample Mean	"Population Mean"	t-value	Degrees of Freedom
A	1.514	1.399	1.091 ns	34
B	1.671	1.622	.332 ns	42
C	1.917	1.716	1.206 ns	14

Comments on sampling procedures

In any classroom study, it is impossible to measure or control for all student and teacher variables. It is hoped that by using the classroom as the unit of study, and by including a reasonably large number of classrooms in each sample, that much of the effect of extraneous variables can be mitigated. Random assignment to treatment was not part of the design of this study. In fact, teacher self selection of the treatment was part of the design, since it represented one of the variables in the population whose effect was of research interest.* Nevertheless, it would have been desirable to randomly select subjects from the three populations for participation in the study. This was possible only insofar as the invitation to participate was concerned. There was no procedure available by which teachers could be mandated to take part in the study. There always exists the possibility that volunteers for an educational study do not fully represent the populations from which they are drawn. An estimate

*One of the aims of the study was to discover if teachers who elected to teach the new syllabus when its adoption was optional differed from teachers who elected to continue teaching the old syllabus.

of "representativeness" was obtained in respect to teacher opinion, but the possibility remains that the samples did not fully represent their respective populations in other respects.

Design

The blocking variable in this study is use of and experience with the revised version of the New York State Regents Earth Science Syllabus. The categories of this variable, in the first year of the study are: A) control, i.e. no previous experience with the new syllabus and not using the revised version in 1970-71; B) no previous experience with the new syllabus, but using the new syllabus for the first time in 1970-71; C) previous experience with the new syllabus and using it again in 1970-71.

In the second year of this study, the categories become: A) no previous experience with the new syllabus, but using it for the first time in 1971-72; B) one year previous experience with the new syllabus and using it again in 1971-72; C) two or more years previous experience with the new syllabus, using it again in 1971-72. It should be noted that except for attrition from one school year to the next, the same set of subjects remained in each group for the first and the second year of the study.

Principal dependent variables were represented by the following scores obtained during each year of the study:

A. Overall Activity Checklist scores*

B. Teacher Educational Opinion Scale score--spring

C. Students' POST score--spring

D. Student achievement scores on "old content and "new content".

* Scores on the Tape Analysis Instrument were not entered into the overall analysis because they were obtained only from a sub-sample of each group. The results of the tape analysis were used chiefly to compare with, and to validate the findings of the Checklist.

Covariates used in the analysis were represented by

A. Students' POST score--fall

B. Teacher Educational Opinion Scale score--fall

Major hypotheses

Eighteen specific hypotheses guided the conduct of this study. Although they were tested in the null form, they are presented here in their experimental form. They are grouped on the basis of the dependent variable with which they are concerned.

A. Hypotheses concerned with teaching strategies

1. Teachers having prior experience with the new course materials will employ classroom and laboratory strategies more in accord with the objectives of the new course than will teachers not having this prior experience, but trying the new course for the first time.
2. Teachers with prior experience and those trying the new syllabus for the first time will both employ strategies more in accord with the objectives of the new syllabus than will teachers using the traditional syllabus.
3. Teachers in their second year of experience with the new syllabus will employ strategies more in accord with the objectives of the new syllabus than they did in their first year of experience with it.
4. Teachers in their first year of experience with the new syllabus materials will employ strategies more in accord with the objectives of the new syllabus than they did in the previous year when using the traditional syllabus.
5. In their first year of experience with the new materials, teachers electing to use the materials in 1970-71 will employ strategies more in accord with the new syllabus than will teachers adopting the new materials in 1971-72.

B. Hypotheses concerned with teacher educational opinions

1. Teachers having experience with the new materials prior to 1970-71 will have more progressive educational opinions than the other two populations.
2. Teachers electing to begin use of the new materials in 1970-71 will have more progressive educational opinions than those electing to continue teaching the traditional materials that year.
3. Educational opinion change, over the two year period will be in the progressive direction for all groups. This change will be greatest for teachers beginning to teach the new materials for the first time in 1971-72.

C. Hypotheses concerned with student ability to employ the processes of science.

1. When spring POST scores are adjusted for fall POST scores, students using the new syllabus will obtain higher scores than will students in classrooms using the traditional syllabus.
2. When spring POST scores are adjusted for fall POST scores, students whose teachers adopted the new syllabus in 1970-71 will obtain higher scores than will students whose teachers adopted the new syllabus in 1971-72.
3. When spring POST scores are adjusted for fall POST scores, students whose teachers adopted the new syllabus in 1971-72 will obtain higher scores than will the students of the same teachers in the previous year.
4. When spring POST scores are adjusted for fall POST scores, students whose teachers had more progressive educational opinions will obtain higher scores than will students whose teachers had less progressive educational opinions.

D. Hypotheses concerned with student achievement on tests of earth science

1. All students will achieve best on the test instrument devised for use with the syllabus version used by their teacher.
2. On the "new content" subtest* students whose teachers use the revised syllabus will outperform students whose teachers use the traditional syllabus.
3. Students whose teachers use the traditional syllabus will outperform students whose teachers use the revised syllabus on the "old content" subtest.*
4. On the "new content" subtest, students whose teachers have one or more years experience with the new materials will ouperform students whose teachers began use of the new materials only when such use was mandated.
5. On the "new content" subtest, students of teachers using the new syllabus for the first time when its use was optional will outperform students of teachers using the new syllabus for the first time only when its use was mandated.

Statistical Analyses Employed

Prior to testing each of the hypotheses individually, it was considered desirable to determine if there were overall effects in respect to the several variables measured in the study. A three by two factorial design was employed with the factors utilized in this design being treatment groups and years. This design was selected because the study was concerned not only with comparisons between treatment groups on the several measures taken in the study, but also with longitudinal comparisons within groups on these same measures.

To test for overall effects, a multivariate analysis of variance was employed on the factorial design. Variates in the design were overall Checklist scores, spring Educational Opinion Scale scores, spring POST scores, "old content" scores and "new content" scores. Covariates for the analysis were fall POST scores, and fall Teachers's Educational Opinion

*cf p. 48 below for description of sub-tests.

Scale scores.

Since most "across groups" comparisons of interest contrasted Group A with Groups B and C, or Group B with C, these two planned independent contrasts were entered into the multivariate analysis of variance. The contrast across years was used to obtain some insight into longitudinal effects.

For testing of individual hypotheses, several different statistical tests were employed, dependent on the type of comparison desired. Most comparisons between groups utilized one way analysis of variance, with planned comparisons of Group A with Groups B and C combined, or between Groups B and C. Hypotheses B1 and B2 were exceptions to this type of contrast, since B1 required a contrast of Groups A and B with Group C, and B2 required a contrast of Group A with Group B. Hypotheses involving only two different groups utilized the t-test of unrelated groups. Hypotheses involving the same group at different times utilized the related groups t-test. The related groups test was used because the hypothesis compared the same group of teachers at two times. Thus, in a sense, the design is one of repeated measures. However, even though the variables, with the exception of the opinion scale, were related to the same teacher at two different times, the measurements were obtained from two different groups of the teacher's students. Thus it appeared safe to assume that the sequential effects frequently associated with repeated measures were not a problem in this case.

For hypotheses which were concerned with differential gain scores, such as C1, C2, etc., analysis of covariance was used, treating results of the fall administration of the test as a covariate, the spring results as the dependent variable. Thus, comparisons between groups were made on the basis of spring scores, as adjusted for fall scores.

The specific test used for each hypothesis will be identified on the table of results for that test.

Data Collection

The time table for gathering of data from the samples selected for study is shown in Table 2. Respondents were notified of their selection to participate in the study in early October, 1970. At this time they were asked if they wished to take part in the classroom audio recording aspect of the study. Thirty-one teachers responded affirmatively; eleven from Group A, ten from Group B, and ten from Group C. These teachers constituted the tape analysis subsamples. In addition to administering the same instruments as all other teachers in the study, these teachers consented to record six days of classroom proceedings at the times specified during the course of the study.

In late October 1970, all materials necessary for administration of POST, the Opinion Scale (and for classroom recording) were sent to each teacher in the study. Copies of instructions which were sent for administration of the various instruments are found in Appendix C . Teachers returned by mail all completed materials to the researcher in the self-addressed packages provided.

Materials for the spring 1971 data collection (Educational Opinion Scale, Activity Checklist, Content Test and audio tapes) were sent to participants late in April. They were returned to the researcher in May.

In September 1971, letters were sent to the participants to request their continuation in the study for the second year. The greatest attrition from the study occured at this time. In the majority of cases, the reason for dropping out was unrelated to the study itself. In most instances, the teacher who dropped out could not continue because he was no longer teaching Regents earth science. Two teachers had obtained administrative positions, one teacher had entered the Peace Corps, and another had gone to teach in Australia. Some teachers had transferred into junior high science teaching, and others had simply quit teaching. Total attrition through the fall of 1971

TABLE 2

SCHEDULE OF DATA COLLECTION

YEAR	MONTH	SOURCE OF DATA					
		Activity Checklist	Opinion Scale	Content Test	POST	Tapes of Classroom[1]	Regents Exam[1]
1970-71	November		X		X	X	
	May	X	X	X	X	X	X
1971-72	November		X		X	X[2]	
	May	X	X	X	X	X	X

[1] Sub-samples only

[2] Group A only

numbered twenty-four; ten from Group A, seven each from Groups B and C.

Procedures for the year 1971-72 were identical to those in 1970-71. By June 1972, all materials from all phases of the study were in the hands of the researcher and ready for analysis.

Since the classroom was the appropriate unit for statistical analysis in this study, all student data were scored and combined to yield classroom means on the several measures on which data were obtained. Appendix D lists the classroom means for each of the variables at each administration.

Instruments

<u>The Earth Science Classroom Activity Checklist</u>

The primary instrument to be used in this study is a modification of Kochendorfer's Biology Classroom Activity Checklist (1967) and Barnes' Biology Laboratory Activity Checklist (1967). These instruments were developed by their authors to study the effect of the BSCS curriculum on teacher-student behaviors in biology classrooms and laboratories. After analysis of the curriculum materials and the written statements of those responsible for their development, the authors constructed a list of specific behaviors which they considered to be either positively or negatively related to the objectives of BSCS. The behavior descriptions were then submitted to educators and scientists associated with the BSCS project for validation. These writers, scientists and educators also identified behavior descriptions as being either positively or negatively related to BSCS objectives. The items on which the panel generally agreed were retained. Kochendorfer calculated the reliability of his instrument by comparing the variance between classrooms with the variance within classrooms. Using a reliability procedure developed by Horst, he arrived at a reliability coefficient of .96. Barnes checked the reliability of his instrument by administering it to two classes for each of ten teachers. A test of the differences between scores assigned to each teacher by his two classes showed that the groups did not disagree about the nature and frequency of behaviors in the laboratories conducted by their respective teachers. As previously reported, subsequent studies by Kochendorfer and Barnes found significant differences between samples of experienced, inexperienced and non-BSCS teachers, with respect to their employment of classroom and laboratory procedures related to objectives of BSCS.

The author of this study has combined and modified the above instruments to make them appropriate for use in earth science classrooms. The rationale for this modification is provided by Hurd (1964) and others who point out the uniformity of the various curriculum projects with respect to objectives and prescribed classroom procedures.

The revised instrument was submitted to several of the authors of the revised version of the New York State Regents Earth Science Syllabus for criticism and selection of items positively and negatively related to the objectives of the new syllabus.

For most items on the checklist, the following scale of responses was offered to the student: 1) Very Often, 2) Often, 3) Sometimes, 4) Seldom, 5) Hardly Ever. In scoring, an item that was positively related to objectives of the new syllabus was given a weight of five for "Very Often", four for "Often," three for "Sometimes", two for "Seldom", one for "Hardly Ever". For items that were negatively related to the objectives of the new syllabus, weights were assigned in the reverse order. For positively related true-false items, a weight of five was assigned to a "true" response, a weight of one to the response "false". For negatively related true-false items, the reverse weights were assigned. For each class, a mean weighted score was obtained for each item.

The first five categories were composed of items that related to: 1) the text, 2) classroom activities, 3) tests, 4) laboratory activities, and 5) amounts of time spent in specific kinds of activities. The sixth category was composed of twelve true-false items from the Kochendorfer Checklist which could not be phrased so that the five point scale of frequency provided a reasonable set of responses. Examples would be: "During labs, I get help more often from the teacher than from other students"; "We have laboratory only on a regularly scheduled basis (such as every Friday, etc.)". Such items held the promise of providing highly desirable information, so it was decided to retain them in their "true-false" form.

An <u>overall score</u> was obtained by calculating the mean weighted response for all items for the entire class.

Because the number of items on this instrument was too great for careful student response within a class period, three forms of the Checklist were formed by randomly assigning items from each of the above categories to each of the three forms, A, B and C. These forms, with 29 items each, were randomly distributed to students in each classroom by the classroom teacher.

Using analysis of variance techniques described by Kerlinger, (1965, pp. 433-439) the reliability of the Checklist was found to be .93.

Several steps were taken to ensure the validity of the Earth Science Classroom Activity Checklist. As items from the Kochendorfer Biology Classroom Activity Checklist were modified to make them appropriate for the earth science classroom, an effort was made to retain the original substance of the items so that they would continue to reflect the intent of the new science curriculum developers expressed in Kochendorfer's instrument. Secondly, the newly revised items were submitted to seven authors of the revised Regents Earth Science Syllabus for their assistance in assigning weights to each item. Finally, Pearson product-moment correlations were calculated between subscales on the Checklist and on the Tape Analysis Instrument. Table 3 shows these correlations. It should be noted that nearly all behaviors on the Tape Analysis Instrument whose frequent employment is encouraged by the new science curricula are positively related to the Checklist subscores (which are all weighted in the advocated direction); nearly all behaviors on the Tape Analysis Instrument whose frequent employment is discouraged by the new science curricula correlate negatively with the Checklist subscores. Thirty-four of the forty-nine correlations are significant. (As might be expected, most of the correlations between the Time category on the Checklist and the subscales on the Tape Analysis instrument are especially high.) The pattern of correlations reported here suggests that students are valid reporters of the frequency of several kinds of behaviors and strategies employed by their teachers.

TABLE 3

CORRELATIONS BETWEEN CHECKLIST SUB-SCORES AND SELECTED TAPE ANALYSIS SCORES

Tape Analysis Scores	Checklist Scores						
	Text	Classroom	Test	Lab	Time	True-False	All
Student Verbal Behavior[1]	.37*	.36*	.22	.15	.21	.08	.21
Higher Level Discussion[1]	.08	.41*	.47*	.41*	.38*	.45*	.47*
Lab Related Behavior[1]	.03	.43*	.58*	.69*	.77*	.75*	.75*
Teacher Verbal Behavior[2]	.37*	-.36*	-.22	-.15	-.21	-.08	-.21
Knowledge & Translation[2]	.09	-.39*	-.49*	-.72*	-.70*	-.76*	-.74*
Lecture-Discussion[2]	-.03	-.43*	-.58*	-.69*	-.77*	-.75*	-.75*
General Index Score[1]	.13	.47*	.56*	.56*	.59*	.61*	.63*

[1] Behaviors whose frequent employment is advocated by the new science curricula

[2] Behaviors whose frequent employment is <u>not</u> advocated by the new science curricula

Copies of the three forms of the Earth Science Classroom Activity Checklist are found in Appendix E.

* correlations marked with an asterisk were found significant at $\alpha = .05$.

The Earth Science Classroom Tape Analysis Instrument

A classroom observation instrument was sought which would measure the relative amounts of time allocated to several of the kinds of teaching strategies which were either advocated or discouraged by the developers of the new science curricula. The new curricula stressed the frequent use of laboratory instruction, so the instrument should measure the proportion of time spend in this form of instruction. The new curricula stressed reasoned understanding of the principles of science, so the instrument should determine the relative amounts of time spent in the higher cognitive levels of discussion. The new science curricula stressed student involvement in the instructional process, so the instrument should measure the amount of time during which the students were speaking, relative to the time during which the teacher was talking.

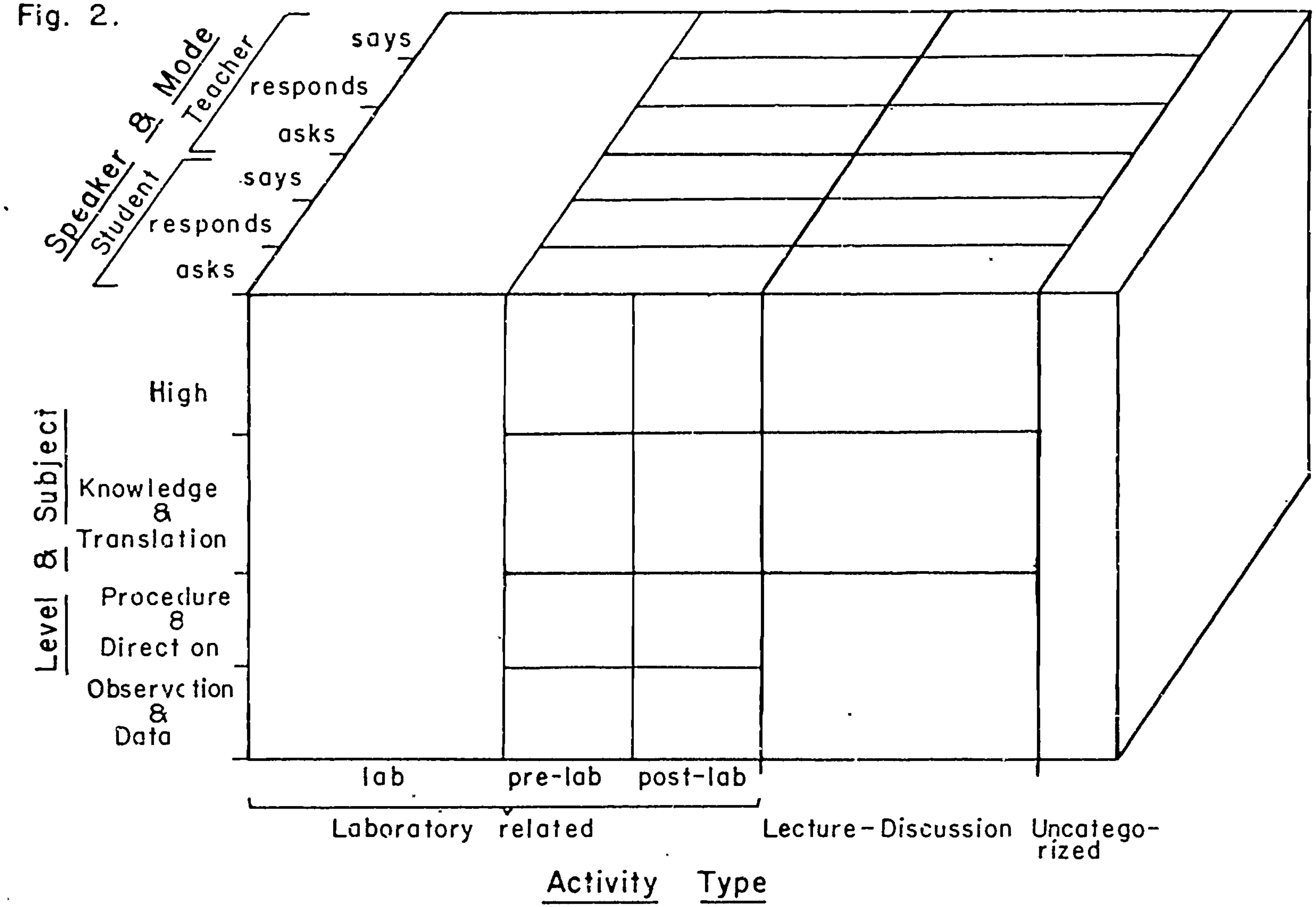
No single classroom observation instrument reviewed in the literature focused on these three aspects of science classroom instruction, so the researcher devised the "Earth Science Classroom Tape Analysis Instrument" (hereafter referred to as the Tape Analysis Instrument) for use in this study.

This instrument categorizes classroom verbal behavior under three dimensions related to the three major objectives described above: 1) Activity Type, 2) Level and Subject, 3) Speaker and Mode. Figure 2 demonstrates the categories measured in each dimension.* Appendix F contains copies of the coding Sheets used to categorize behavior from the recordings of classroom sessions gathered during the course of the study. Recording of behavior was accomplished by entering a code number for speaker and mode in the appropriate category on the

* The work of Moser and Feldgoise (1968) provides precedent for selection of these factors as indicators of the "inquiry" teaching advocated by developers of the new science curricula. They used as criterion for increased inquiry teaching, "a decrease in teacher outputs (teacher-talk) and the shift from lecture recitation into a higher representation in the inquiry mode". (in Korth, 1971, p. 3)

DIMENSIONS OF TAPE ANALYSIS INSTRUMENT

Fig. 2.



coding sheet every five seconds during the entire session to be analyzed. (Speaker and Mode Key appears at the bottom of the coding forms in Appendix F .) Category distinctions and instructions for use of the coding system are found in Appendix F .

Examination of Figure 2 shows that the three dimensional matrix of the Tape Analysis Instrument provides sixty-nine data cells. For scoring purposes, data from these cells were combined into thirty-five ratios of research interest. Each ratio summarized the proportion of a week of classroom time which was spent in a particular type of instructional procedure, as related to some larger grouping of behavior types. Appendix F describes the specific scores provided by the instrument.

In order to synthesize the detail into an overall measure of the teacher's utilization of the procedures advocated by the developers of the new science curricula, a "General Index Score" was calculated. This score combined measures from each of the three dimensions reported on by the instrument. From each dimension, two categories of behavior were selected: one which the developers of the new science curricula would wish to find more frequently, another which they would hope to find less frequently in classrooms utilizing the new curricula. The behaviors selected from each dimension are shown in Table 4.

TABLE 4

DESCRIPTION OF GENERAL INDEX SCORE
TAPE ANALYSIS INSTRUMENT

Dimension	Occurence Advocated	
	More Frequently	Less Frequently
Activity Type	Laboratory Related	Lecture Discussion
Level and Subject	Higher Level Discussion	Knowledge & Translation
Speaker & Mode	Student Verbal Behavior	Teacher Verbal Behavior

Prior to calculating General Index Scores, the AVERAGE relative frequencies with which each of the six selected categories of behavior occured in the entire group under study were computed. So that each of the six categories of behavior would, on the average, have approximately equal influence on the combined score, the inverses of these frequencies were used as coefficients to weight each subscore in the computation of a teacher's General Index Score. The three subscores of desired high frequency were added, then divided by the sum of the three subscores of desired low frequency. The ratio thus formed constituted the General Index Score.

Procedures employed with tape analysis

When volunteers were sought for the study, they were asked if in addition to the other requirements of the study they would be willing to record several classroom sessions on audio tape. Ten teachers in each of the three groups consented to take part in this phase of the study. Each teacher in these subgroups recorded six successive classroom or laboratory session in November of 1970, late April or early May of 1971, and late April or early May of 1972. The teachers in subgroup A recorded an additional sequence in the fall of 1971.

The decision to base analysis on a sequence of taped classroom sessions, rather than on a single session for each teacher, was founded on two considerations. Teachers tend to change their teaching strategies from day to day. It was assumed (cf. Medley and Mitzel, 1963, p. 268) that daily fluctuations in teaching behavior would affect the reliability of the analysis less if behaviors were averaged over the period of a week. Also, since the occurence of laboratory was of prime concern to the developers of the new science curricula, and since laboratory instruction does not occur daily in most science classrooms, it was considered that recording a week of classroom sessions would provide enough time for laboratory to occur in most classrooms.

Although teachers recorded a sequence of six classroom sessions, only five recordings were selected for analysis. The first tape recording in each sequence of six was eliminated from the analysis so that the classroom would have some time to adjust to the presence of the tape recorder.

All tapes were returned to the researcher who coded them as to classroom, taping period, and day within taping period. When all data had been collected, five analysts were selected for training in use of the Tape Analysis Instrument. Selection from a group of 15 college students was made on the basis of competence during trial analysis sessions, and a comparison of the reliabilities of observers, relative to the researcher, and to one another.

After 20 hours of training and practice, the five analysts were tested for reliability using Scott's (1955) reliability formula. The inter observer reliabilities obtained in this way ranged from .68 to .72 for the five observers, for the instrument as a whole. To partially compensate for the variance introduced by the observers, it was decided to have each of the five observers analyze one day of the sequence for each teacher during each taping period. Thus the weekly composite score which was used for statistical comparison included one analysis from each of the five analysts. For each of the weeks analyzed, each classroom provided 35 sub scores and one General Index Score for statistical analysis.

Processes of Science Test (POST)

The manual (Psychological Corporation, 1965, p.3) for this test describes the objectives of this test as follows:

> The concerns of the authors were with the methodology of science; the bases for judging facts, principles, and concepts; the extent to which the student had developed standards for judging or appraising data; the student's ability to screen and judge the design of experiments. The test measures the ability of students to recognize adequate criteria for accepting or rejecting hypotheses, and to evaluate the general structure of experimental design in science, including the need for controls, repeatability, adequate sampling, and careful measurement.

The instrument was created by BSCS, but was not considered by its authors to be biology specific: (Psychological Corporation, 1965, p.2)

> Since the test was specifically prepared to appraise a student's understanding of GENERAL scientific principles and scientific reasoning ability, it is also useful for courses other than biology in which understanding of the processes of science is important (emphasis in original).

The fact that the examples used in this test were biologically oriented (but avoided reliance on specific facts of biology) rather than earth science oriented, was considered by the researcher to be an asset rather than a liability. Earth science examples might have favored the students under one or the other versions of the Regents Earth Science Syllabus.

Split-half reliability coefficients for POST are reported to average .82. (Psychological Corporation, 1965, p.7). Validity is defined in terms of predicting Comprehensive Final (Biology) Exam scores:

> The data suggests that the POST administered at the beginning of either the BSCS or conventional biology courses will predict end-of-year performance on the Comprehensive Final Examination about as well as will standard measures of academic ability. (Psychological Corporation, 1965, p.8)

Despite the opinion of the authors of POST, it was considered by this researcher that several items on POST were excessively loaded on biology. For this reason, the items marked with an asterisk in Appendix G were not included in the scoring of student responses. The POST scores reported in this study are the classroom means of the raw scores obtained by students on the POST items remaining after biology loaded items were eliminated from consideration.

The Teacher Educational Opinion Scale

It was the assumption of the researcher that the educational opinions of teachers included beliefs both about educational procedures in general, and about procedures specific to their own discipline. Since a search of the literature did not reveal a single instrument which attempted to measure both general educational opinions and specific opinions relative to science teaching, it was decided to combine two instruments, each of which had been constructed to measure one of these sets of opinions. Kerlinger and Pedhazur's (1967) Educational Scale VII was designed to measure general educational opinions. Schirner's (1967) Educational Credo Preference Checklist was designed to measure opinions relative to science education. Both instruments consisted of progressive and traditional items. The Teacher Educational Opinion Sclae was constructed by randomly assigning all items from both instruments to positions in the new instrument. Appendix H identifies the source and type of each item in the Scale.

Schirner supported the validity of his instrument by analysis of the responses to his instrument by groups whose educational opinions were "known" from their statements in discussions of educational problems. There is no report of reliability estimates for the Educational Credo Proference Checklist.

Kerlinger (Kerlinger and Pedhazur, 1967, p.63) used factor analysis to investigate the validity of his instrument. He reports as follows:

> [The two factor solution] was done to see if the A [Progressive] and B [Traditional] items would load on separate factors. Of the fifteen A items, fourteen loaded substantially (.40) on one factor. Of the fifteen B items, eleven loaded .40 or greater and one loaded .35... This evidence seems to indicate a basic two-factor structure as predicted.

The reliability of Education Scale VII is reported as "usually .80 or better" (Kerlinger and Pedhazur, 1967, p. 63).

In the administration of the combined instrument, a five point rating scale was employed with the following points designated: 1) Agree Strongly, 2) Agree, 3) Neutral, 4) Disagree, 5) Disagree Strongly. Weights were assigned to responses for all items so that "Agree Strongly" received a weight of five, "Agree" a weight of four, etc.. Summated ratings were obtained by combining a subject's weighted responses and dividing by the number of items to obtain the mean weighted response. Nine subscales were obtained in the scoring process. These can be schematically shown as follows:

	From Kerlinger Instrument	From Schirner Instrument	Total
Progressive items	KP	SP	TP
Traditional items	KT	ST	TT
Ratio of Progressive to Traditional items	$K\frac{P}{T}$	$S\frac{P}{T}$	$T\frac{P}{T}$

The total progressive to traditional score ratio was employed for major comparisons made in this study.

The Earth Science Content Test

The researcher had originally hoped that both versions (Regular and Revised) of the 1971 Regents Earth Science Examination could be administered to the students of all teachers participating in the study. Test security and other practical considerations made this impossible. Joint efforts between the researcher and Mr. Douglas Reynolds of the State Education Department produced the "Earth Science Content Test" which was administered to all students in the study in the spring of 1971 and in the spring of 1972.

This test consists of two sets of items: those selected to measure concepts taught in the traditional version of the syllabus (called "old content" items), and those selected to measure concepts treated in the revised version of the syllabus (called "new content" items).

Items for the "old" content test came from a variety of sources: used by Schirner, the State Education Department's pool of items for the traditional syllabus and researcher devised items. Items for the "new" content test came primarily from a pool of items created by earth science teachers who wrote them for a course in which they analyzed the revised Regents Earth Science Syllabus. The several topics of the revised syllabus were proportionally represented by questions selected for the test with each item tied to content objectives specified by the syllabus.

The total test consisted of thirty items related to each of the syllabi. As with the Checklist, three forms of the Content Test were constructed so that each student responded to only twenty items - - ten from each syllabus. Items were randomly assigned to forms and to sequence within form, within the constraint of distribution by topic. Appendix J is keyed to indicate for which version of the syllabus each item was designed. Students were scored on the basis of the proportion of items answered correctly within each category (new, old). Items that were not attempted were not considered in obtaining this proportion. Classroom scores were obtained by calculating the mean score for the items on each subtest for all students who took the test.

<u>The Regents Earth Science Examination</u>

The Regents Earth Science Examination is prepared yearly by the State Education Department. Items are written by teams of Regents earth science teachers, then reviewed and revised by other teachers, as well as by staff members of the State Education Department. One or more years before use, items are pre-tested and a level of difficulty determined. Hence, prior to administration of the exam, a predicted level of difficulty for the whole test is available.

In the years 1965 through 1971, in addition to the regular regents exam, a special exam was prepared for students whose teachers used the reviced version of the syllabus. In 1972, all students took the exam devised for the revised version of the syllabus. (Now called the regular syllabus).

Studies by Ladd (1972) and by Passero and Schmaltz (1972) have shown that Regents Earth Science exam questions prior to and subsequent to 1965 differ in several respects. Ladd found that prior to 1966, the average "inquiry question ratio" hovered around 30%. On the regular exam, subsequent to 1965, the ratio rose gradually from 50% in 1966, to 70% in 1971. During this same period, the Special Regents Examination maintained a ratio between 60% and 70%.* Passero and Schmaltz report comparable trends with respect to "concept-oriented" [as opposed to memory-type] questions and with re-

* It should be noted that during these years, item writers for the regular syllabus, while continuing to write items for material covered by the regular syllabus, were seeking to change the emphasis from recall to conceptually oriented questions, in preparation for adoption of the more conceptually oriented revised syllabus.

spect to questions requiring "scientific reasoning". These researchers also found that questions emphasizing laboratory situations rose from 0% on the regular syllabus prior to 1969, to 8.3% on the regular syllabus in 1970, and from 4.2% in 1968 to 45.5% on the special syllabus exam in 1970.

Obtaining classroom Regents examination scores required the assistance of the State Education Department. The Bureau of Science Education was able to obtain Regents exam scores from about twenty-five classrooms of teachers involved in the study, in the spring of 1971, and the spring of 1972. Classroom scores for these classes were obtained by calculating the mean raw score for all students taking the exam.

Although the size of the sample from each group of classrooms was not sufficient to permit any firm conclusions about Regents earth science classrooms in general, collection of Regents exams from a sub-sample of participating classrooms did provide data for comparison with the results of the Earth Science Content Test.

CHAPTER IV

Results and Conclusions

For the sake of greater clarity, in the following discussion of results and conclusions, hypotheses will be stated in their research form, rather than in their null form. Thus, the statement, "the hypothesis was not supported" is equivalent to stating that the null hypothesis was not rejected at the chosen α level. The α level chosen for significance testing in this study will be $p \leq .05$. Tests of hypotheses whose F ratios or t-values are marked with an asterisk (*) were found significant at $\alpha = .05$. Those marked with "ns" were found to be non significant at $\alpha = .05$. For multivariate hypotheses, "p" values will be listed.

In the discussion which follows, it should be recalled that Group A consists of classrooms whose teachers elected to continue using the traditional syllabus in 1970-71 when the revised syllabus first became available on a state-wide, optional basis. Group B consists of classrooms whose teachers elected to begin teaching the new syllabus in the first year of its state-wide availability. Group C consisted of classrooms whose teachers had participated in the development of the new syllabus, and were teaching it again in the fall of 1970.

Tests of Multivariate Hypotheses

In order to determine whether the three groups differed significantly from one another on the several dependent variables considered simultaneously, and whether the groups changed through time with respect to these same variables, a multivariate analysis of variance was performed, using a three (groups) by two (years) factorial design.

Multivariate tests concerned with differences between groups:

Hypothesis M-1:

> Classrooms whose teachers adopted the new syllabus only when its adoption became mandatory will differ significantly from classrooms whose teachers voluntarily adopted the new syllabus prior to 1971, in respect to the major dependent variables measured in the study: teaching behaviors employed, teacher educational opinion, improvement of student ability to employ processes of science, and student achievement on tests of earth science knowledge.

Table 5 indicates that analysis of the data supports this multivariate hypothesis. The univariate tests indicate significant differences between Group A and Groups B and C with respect to each of the dependent variables: instructional behaviors, teacher educational opinion, student achievement on measures of "old content" and "new content", and on POST scores.

TABLE 5

MULTIVARIATE AND UNIVARIATE ANALYSIS OF COVARIANCE OF MEANS CONTRASTING GROUP A WITH GROUPS B AND C COMBINED

A. Multivariate F ratio: 23.9963*

Degrees of Freedom: 5, 164

p value .0001

B. Univariate F ratios:

Variable	Hypothesis Mean Square	F-ratio	p value
Checklist overall	3.2359	95.3162*	.0001
Content, old	.1093	24.6201*	.0001
Content, new	.0362	11.8064*	.0008
POST, spring	19.6700	5.8694*	.0165
Opinion Scale	.2757	5.0238*	.0264

Covariates whose effect was eliminated prior to contrast:

POST, fall scores; Opinion Scale, fall scores

Degrees of Freedom: 1, 168

Hypothesis M-2:

> Classrooms whose teachers participated in the development of the new syllabus will differ significantly from classrooms whose teachers voluntarily adopted the new syllabus when it was first offered for state-wide adoption, in respect to the major dependent variables measured in the study.

Table 6 indicates that this hypothesis was not supported by analysis of the data. Group B did not differ significantly from Group C with respect to the dependent variables measured.

TABLE 6

MULTIVARIATE ANALYSIS OF COVARIANCE OF MEANS CONTRASTING GROUP B WITH GROUP C

Multivariate F ratio:	1.2252 ns
Degrees of Freedom:	5, 164
p value:	.2996

Multivariate tests concerned with changes made by the groups through time

Each of the three groups of classrooms studied will change significantly from 1970-71 to 1971-72 in respect to the major dependent variables measured in the study.

TABLE 7

MULTIVARIATE AND UNIVARIATE ANALYSIS OF COVARIANCE OF MEANS CONTRASTING SPRING 1971 WITH SPRING 1972

A. Multivariate F ratio:	3.2280*
Degrees of Freedom:	5, 164
p Value	.0084

B. Univariate F ratios:

Variable	Hypothesis Mean Square	F ratio	p value
Checklist overall	.1839	5.4167*	.0212
Content, old	.0115	2.5978 ns	.1089
Content, new	.0025	.8325 ns	.3629
POST, spring	19.0913	5.3984*	.0214
Opinion Scale	.1296	2.3605 ns	.1264

Covariates whose effect was eliminated prior to contrast: POST, fall scores; Opinion Scale, fall scores

Degrees of Freedom: 1, 168

Table 7 indicates that there was a significant difference from one year to the next, on the variables taken collectively. The univariate analysis indicates that significant longitudinal effects were detected in teacher behavior and in student performance on POST. The latter finding reflects the higher POST scores attained by all three groups in the second year of the study.

Hypothesis M-4:

> Classrooms whose teachers adopted the new syllabus only when its adoption became mandatory will show significantly greater change between 1970-71 and 1971-72 than will the other two groups of classrooms in respect to the major dependent variables measured in the study.

This hypothesis was tested by means of an analysis of the interaction between the contrast of Group A with Groups B and C, and the contrast between years. Table 8 shows that the hypothesis found support in the analysis of the data.

TABLE 8

MULTIVARIATE AND UNIVARIATE ANALYSIS OF COVARIANCE OF MEANS
INTERACTION OF THE CONTRAST BETWEEN GROUP A AND GROUPS B&C
WITH THE CONTRAST BETWEEN SPRING 1971 and SPRING 1972

A. Multivariate F ratio	6.6035*
Degrees of Freedom:	5, 164
p value	.0001

B. Univariate F ratios:

Variable	Hypothesis Mean Square	F ratio	p value
Checklist, overall	.5724	16.6594*	.0001
Content, old	.0728	16.3946*	.0001
Content, new	.0014	.4511 ns	.5028
POST, spring	5.2203	1.5577 ns	.2138
Opinion Scale	.1269	2.3124 ns	.1303

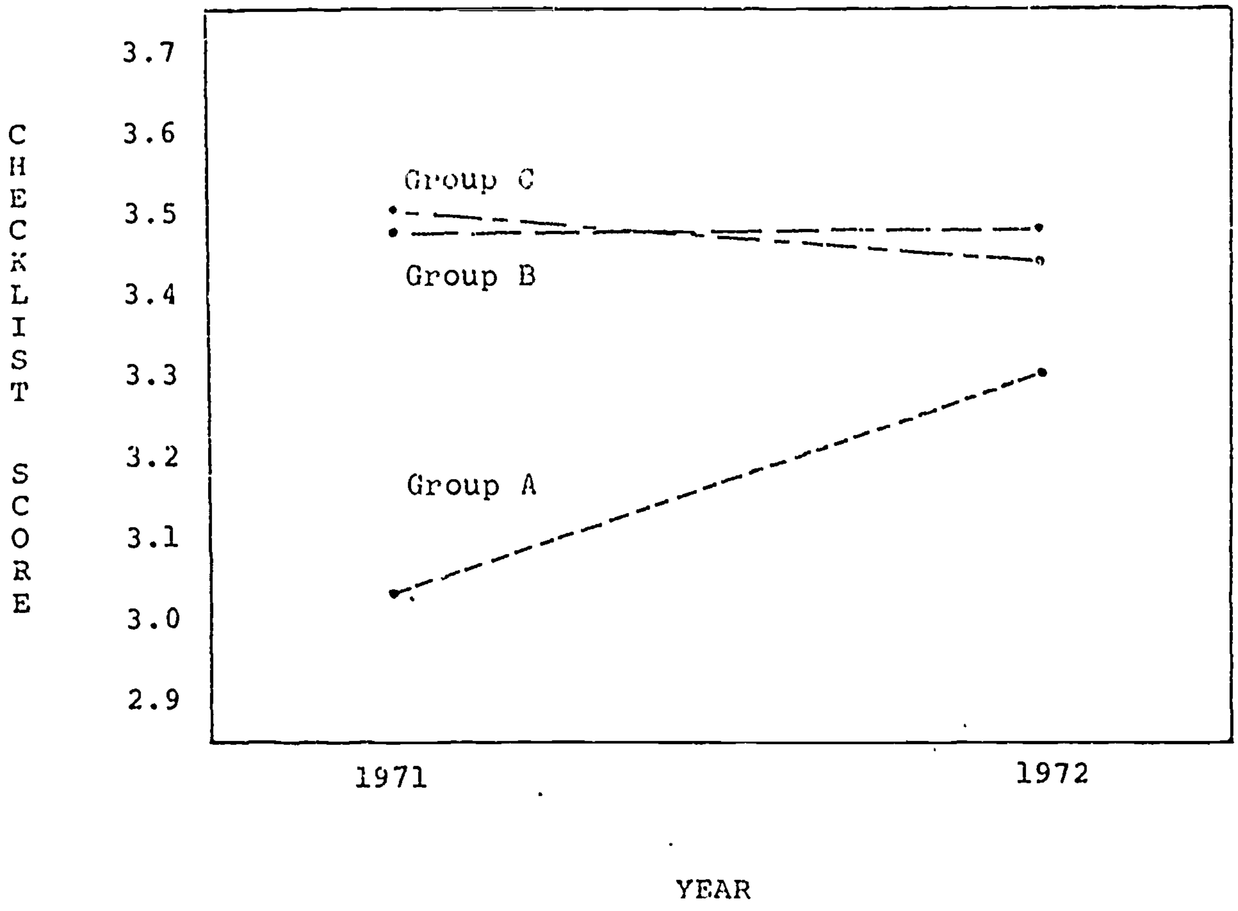
Covariates whose effect was eliminated prior to test:

POST, fall scores; Opinion Scale, fall scores

Degrees of Freedom: 1, 168

FIGURE 3

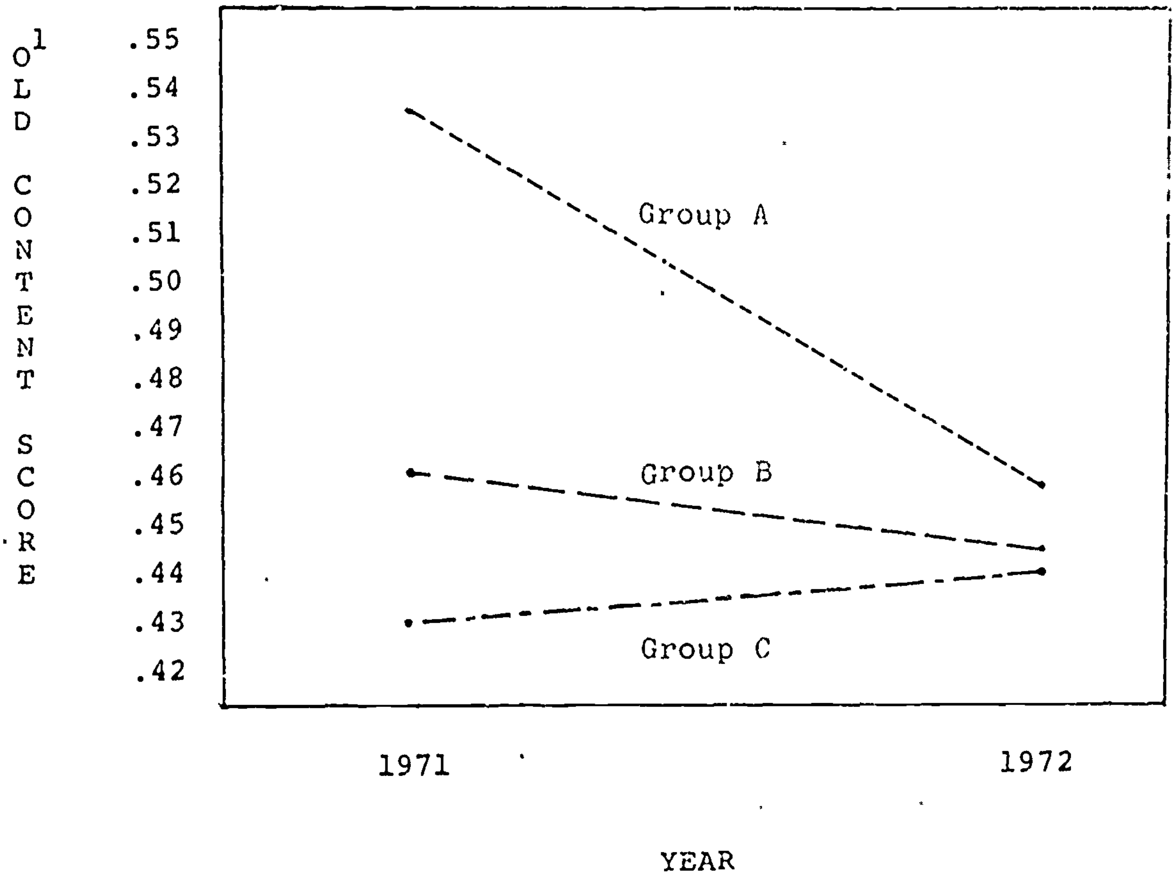
GROUP MEANS ON OVERALL CHECKLIST SCORE, BY YEARS



Univariate analysis suggests that this interaction occurs chiefly in teacher behavior and in student performance on the test of "old content". An inspection of means, shown graphically in Figure 3, shows that interaction with respect to teaching behavior can be traced to the significant change in teaching behaviors made by Group A between the spring of 1971 and the spring of 1972. The interaction with respect to student performance on a test of "old content", shown graphically in Figure 4, can be traced largely to the drop in scores of Group A students on this sub-test, from one year to the next.

FIGURE 4

GROUP MEANS ON "OLD CONTENT" SCORES, BY YEARS



[1] Scores Reported Are Per Cent Correct Responses

Tests of Specific Univariate Hypotheses

Tests concerned with teaching behaviors

The following set of hypotheses is concerned with teaching behaviors primarily as measured by the Earth Science Classroom Activity Checklist. Findings from the Tape Analysis Instrument will be used chiefly to expand or clarify significant Checklist findings.

Hypothesis A-1:

> Teachers having prior experience with the new course materials will employ classroom and laboratory strategies more in accord with the objectives of the new course than will teachers not having this prior experience, but trying the new course for the first time.

An analysis of variance is reported in Table 9, using as dependent variable teacher behaviors measured by the spring 1971 overall Checklist score. Groups B and C were contrasted for this analysis. No significant difference was found between groups. This would indicate that Group C's prior experience with the new syllabus gave these teachers no advantage in terms of teaching behaviors employed.

TABLE 9

PLANNED INDEPENDENT CONTRAST - GROUP B VS GROUP C ON OVERALL ACTIVITY CHECKLIST SCORE, SPRING 1971

Category	Means A	Means B	Means C	SS Compare	MSW	F Ratio
Overall		3.49	3.51	.0316	.0389	.35 ns
(Number)		36	34			

Degrees of Freedom: 1, 70

This finding is particularly surprising when one considers that Group C teachers not only had prior experience with the new materials; they had helped develop them. Tests of hypotheses A-2 and A-4 (below) indicate that the Checklist does discriminate between some groups of teachers, so it is not valid to argue that the instrument was insensitive to differences in teaching behavior. An alternate interpretation would be that the new syllabus was in fact "teacher proof", in the sense that simply adopting it led teachers to immediately begin using the behaviors advocated by the curriculum's developers. Such conjecture would, of course, be stepping well beyond the findings reported for hypothesis A-1. This interpretation should be borne in mind, however, as subsequent hypotheses are tested.

Hypothesis A-2:

> Teachers with prior experience and those trying the syllabus for the first time in 1970-71 will both employ strategies more in accord with the objectives of the new syllabus than will teachers using the traditional syllabus.

Table 10 reports the finding that there was a significant difference in teacher behaviors between Group A and Groups B & C, as reported by students on the overall scale of the Checklist in the spring of 1971.

Teaching behaviors of Group A teachers in 1971 differed significantly from those of Groups B and C on every subscale of the Checklist, except that of text related items. There were significant differences with respect to classroom activities, tests, lab related activities, and time allotment.

Group A differed significantly from Groups B & C in 1971 on mean classroom responses on fifty-eight of the eighty-seven Checklist items. (See Table A, Appendix E) Group B had higher mean scores than Group A on fifty-seven of the fifty-eight items. Group C had higher mean scores on fifty of the fifty-eight items. High scores in all cases represented more frequent use of the behaviors desired by developers of the new science curricula.

The magnitude of these significant differences ranged from .2 to 1.5 points on the scale interval of 1 to 5. The mean difference was approximately .68 points, which represents 17% of the range of the scale.

TABLE 10

PLANNED INDEPENDENT CONTRASTS - GROUP A VS GROUPS B & C ON CATEGORIES OF THE ACTIVITY CHECKLIST, SPRING 1971

Category	Means A	Means B	Means C	SS Compare	MSW	F Ratio
Overall	3.05	3.49	3.51	4.84	.0389	124.3*
Text Related	3.46	3.51	3.55	.10	.07	1.43 ns
Classroom Related	3.06	3.25	3.31	1.14	.04	32.12*
Test Related	2.92	3.52	3.63	10.02	.12	85.24*
Lab Related	3.13	3.53	3.55	3.93	.04	90.55*
Time Allotment	2.63	3.18	3.32	9.16	.18	50.11*
True-False	2.85	3.79	3.71	19.4	.15	130.0*
(Number)	36	36	34			

Degrees of Freedom: 1, 106

Item analysis of the Checklist suggests that the course taught by teachers using the new syllabus is more interdisciplinary (items 27, 56, and 113), that it is more open-ended (items 5, 15, 21, 53, 67, 74, and 115), more concerned with discovery (items 8, 22, 65, 68, 71, 126, and 127), and engages in more long term investigations (item 26)*. All of these are consistent with the stated objectives of the designers of the new science curricula, particularly of the Earth Science Curriculum Project, and of the revised New York State Regents Earth Science Syllabus.

* Items will be found in the Checklist, forms A,B,and C, Appendix E .

The fall 1970 Tape Analysis indicated that there were several significant differences between Group A and Groups B & C. (See Table B, Appendix F ; Appendix F also describes the individual scores on the Tape Analysis Instrument) Differences were found on the General Index Score (subscore 1), laboratory related activity (subscore 2) and several laboratory related subscores (subscores 3,4,5,6, and 7). These differences indicated that Group A spent a smaller fraction of their instructional time engaged in the kinds of activity advocated by the developers of the new science curricula. Another group of significantly different scores (subscores 14,15, and 16) indicate that Group A teachers engaged in significantly more lecture discussion activity than the other two groups. The developers of the new science curricula discourage heavy reliance on this mode of instructional behavior.

Summarizing the findings with respect to hypothesis A-2, it would appear that those who taught the old syllabus in 1970-71 did not employ the "newer" teaching strategies as frequently as those who taught the new syllabus in this same year. This finding is consistent with the findings of Kochendorfer (1967) and Barnes (1967) relative to BSCS biology teachers. When the teaching procedures employed by teachers using one of the new science curricula are compared with the procedures employed by teachers using a traditional science curriculum, it is found that teachers using the new curriculum employ significantly more of the procedures advocated by the developers of the new science curricula. Since the "traditional curriculum" was more precisely defined in the present study than in Kochendorfer and Barnes' studies, a stronger case is made to attribute the difference to curriculum differences. Before making this inference, however, it should be asked whether the differences found might be due not to the syllabus used, but to selection factors. Teachers with more traditional teaching behavior patterns may have elected to continue teaching the old syllabus during this year, while those with more progressive patterns may have elected to teach the new syllabus. This important issue is dealt with under hypothesis A-4.

Hypothesis A-3:

> Teachers in their second year of experience with the new syllabus will employ strategies more in accord with the objectives of the new syllabus than they did in their first year of experience with them.

It is clear from Table 11 that the teachers in Group B made no significant change in teaching behavior between the spring of 1971 and the spring of 1972, as measured by the overall score of the Checklist. Thus, for these teachers, additional experience with the new syllabus did not bring teaching behavior into greater accord with the objectives of the new syllabus. This finding, coupled with the lack of difference between the teaching behaviors of Groups B and C in 1971, suggests that if the new syllabus occasions behavior change, the change occurs rather abruptly, and that behaviors do not become increasingly more progressive.

TABLE 11

T-TEST OF DIFFERENCE OF MEANS ON ACTIVITY CHECKLIST FOR GROUP B, SPRING 1971 TO SPRING 1972

Mean Difference	t-Value (Related Groups)	Degrees of Freedom
-.0053	-.2425 ns	29

The stability of teaching behaviors employed by Group B during the period 1971-72 suggests that this group might be considered as a "post hoc" control group against which the teaching behaviors of Group A might be compared during the same time interval. The two groups were alike during 1971-72 in that both were using the new syllabus in that year. They differed in that Group B had previously used the new syllabus, while Group A had previously used the old syllabus.

Hypothesis A-4:

> Teachers in their first year of experience with the new syllabus will employ strategies more in accord with the objectives of the new syllabus than they did in the previous year, when they used the traditional syllabus.

Table 12 shows that this hypothesis is supported by contrasting the overall Checklist scores of Group A in the spring of 1971 with the scores of these same teachers one year later, after they had begun using the new syllabus.

TABLE 12

T-TEST OF DIFFERENCES OF MEANS ON ACTIVITY CHECKLIST FOR GROUP A, SPRING 1971 TO SPRING 1972

Variable	Mean Difference	t-Value (Related Group)	Degrees of Freedom
Checklist overall	.2173	5.5605*	27
Text Related	.0546	1.1854 ns	27
Classroom Activities	.0519	1.1804 ns	27
Test Related	.3706	4.2353*	27
Laboratory Related	.2273	4.7979*	27
Time Allotment	.1424	2.3906*	27
True-False Items	.4491	5.1649*	27

Checklist sub-scores in the categories of test related, laboratory related, time allotment, and true-false showed significant increase with time. The Tape Analysis, which was largely concerned with amounts of time spent in various forms of classroom and laboratory activity, showed significance in the predicted direction on the General Index score, when fall measures were compared with fall measures. (See Table C, Appendix F) There was only a slight positive, non-significant trend when spring measures were compared with spring measures.*

Tape analysis sub-scores which showed significant change from the fall of 1971 to the fall of 1972 (see Table C, Appendix F) included measures of time spent in laboratory activities (subscores 2 and 4) and in higher level discussion (subscores 8 and 14). These behaviors showed increased frequency of occurence, in harmony with the objectives of the new curriculum developers. Use of lecture discussion (subscore 7) decreased, again in harmony with the objectives of the new curriculum developers.

Group A's 1972 teaching behaviors measured on thirty-nine of the Checklist items differed significantly from this group's 1971 behaviors. (See Table D, Appendix E) On thirty-six of the thirty-nine items, the change was in the predicted direction.

It is interesting to note that the changed behavior items are essentially a subset of the items which originally distinguished the behaviors of Group A from those of the other two groups. This might suggest that Group A changed precisely those behaviors which they needed to change in order to employ patterns similar to those used by other teachers using the new materials. However, since there was little contact between teachers of the various groups, it seems unlikely that Group A teachers used other teachers for models of change. It seems more likely that these teachers picked up specific cues for behavior change from the curriculum materials themselves.

Examination of the specific items which showed significant difference from 1970-71 to 1971-72 suggests that the course as taught by Group A teachers in the second year of the study differed in several important respects from the course they taught in the first year of the study. Responses on items 27 and 56 indicate a movement toward teaching a more interdis-

*Possible implications of the non-significance of the spring-spring differences will be discussed in Chapter V.

ciplinary course. Responses on item 115 suggest that the course in the second year is more open-ended. Responses on items 65 and 68 maybe interpreted to mean that the course was more discovery oriented in the second year. Response to item 76 seems to indicate that more time was spent in laboratory work during the second year. (This interpretation is supported by the findings obtained from the Tape Analysis sub-score dealing with the percent of time spent in small group laboratory activity.) Laboratory, which now more frequently precedes classroom discussion of the topic (item 65), also now uses a broader variety of lab materials (items 16, 81, 133). Students more frequently record data as part of their laboratory experience (items 18, 122). They spend more time in post-laboratory, comparing data and analyzing conclusions they have drawn (items 19, 20, 75, 125, and 126). Finally, tests now include more items based on laboratory experience (item 62).

Analysis of data provided by both the Checklist and the Tape Analysis Instrument support the overall hypothesis that these earth science teachers who were required to adopt the new Regents Earth Science Syllabus in the fall of 1971 did indeed change their teaching strategies to conform more closely to the model proposed by the designers of the new science curricula. It should be noted, however, that despite the changes made by Group A, they still differed significantly from the teachers in the other two groups on the 1972 overall Checklist score and on all sub-scores except text-related. (See Table 13)

There were significant differences on twenty-one of the items of the Checklist when Group A behaviors were compared with those of Groups B and C. (See Table E in Appendix E) Groups B and C were found to employ more of the desired behaviors as measured by nineteen of the twenty-one items. It appears that Groups B and C still have laboratory more frequently (item 25), and that they spend less time talking (item 23) than do the teachers in Group A. The experienced groups put more stress on laboratory (item 28), and tend to be less rigid in adhering to a scheduled laboratory period (item 130).

Group A tends to use laboratory manuals more frequently (item 123). They also tend to provide fewer items of laboratory equipment than the other two groups (item 81). Tests for Group A students do not seem to have lab related items as often as do tests for students in the other two groups, despite advances made by Group A (item 62). The only area in which Group A teachers seem to surpass the other groups is in respect to desirable utilization of the text (item 55). It may be that the teachers in Groups B and C simply do not use the text as a major reference in their course.

TABLE 13

PLANNED INDEPENDENT CONTRASTS ON ACTIVITY CHECKLIST CATEGORIES FOR GROUP A VS GROUPS B & C, SPRING 1972

Category	Means A	Means B	Means C	SS Compare	MSW	F Ratio
Overall	3.30	3.49	3.47	.607	.031	19.52*
Text Related	3.56	3.47	3.52	.079	.060	1.31 ns
Classroom Related	3.13	3.26	3.26	.326	.024	13.74*
Test Related	3.31	3.58	3.65	1.748	.130	13.43*
Lab Related	3.41	3.54	3.52	.292	.042	6.97*
Time Allotment	2.86	3.22	3.23	2.50	.132	18.90*
True-False	3.30	3.73	3.62	2.698	.148	18.15*

Degrees of Freedom: 1, 84

Despite the fact that certain differences in teaching behaviors still exist between those teachers who adopted the new syllabus under mandate and those teachers who had voluntarily adopted the new syllabus in prior years, the fact remains that the teachers of Group A <u>did</u> change their behaviors in the desired direction upon adoption of the new syllabus. The inference that the differences found in teaching behaviors is due to adoption of the curriculum, and not due to selection factors influencing curriculum adoption finds firm support in the changed teaching behavior of the teachers in Group A. Thus, findings drom the longitudinal aspect of this study confirm findings of the group comparison aspect of this study, as well as of Kochendorfer and Barnes' studies.

Hypothesis A-5:

> In their first year of experience with the new materials, teachers electing to use the materials in 1970-71 will employ strategies more in accord with the new syllabus than will teachers adopting the new materials in 1971-72.

Underlying this hypothesis was the assumption that those who voluntarily adopted the new syllabus (in the fall of 1971) would be more amenable to change of teaching behavior than those who adopted the new materials only after their use had been mandated.

Table 14 indicates that, although the mean on the overall Checklist score attained by Group B in the first year of its experience with the new materials was higher than the score of Group A in its first year of experience with the new syllabus, the difference between means did not achieve the .05 level of significance. Hence it appears that those teachers who adopted the new syllabus only when its use was mandated, were able to employ in their first year of experience with the new materials essentially the same strategies that were used in the first year of experience with the new materials by the group which voluntarily began to use them in 1970.

TABLE 14

T-TEST OF DIFFERENCE OF MEANS ON ACTIVITY CHECKLIST OVERALL SCORE FOR GROUP A VS GROUP B, SPRING, 1971

Mean Difference	t-Value (Unrelated groups)	Degrees of Freedom
.18	1.2845 ns	64

Tests concerned with teacher educational opinion

The next set of hypotheses have to do with the teacher's educational opinions, as measured by the Educational Opinion Scale. The ratio of progressive to traditional opinion scores was used in making the major comparisons below.

Hypothesis B-1:

> Teachers having experience with the new materials prior to 1970-71 will have more progressive educational opinions than teachers in the other gwo groups.

Table 15 shows that Group C's educational opinions differ significantly from those of the other two groups throughout the duration of the study.

TABLE 15

PLANNED INDEPENDENT CONTRASTS ON OPINION SCALE FOR GROUP C VS GROUPS A & B

Time	Means			SS		F
	A	B	C	Compare	MSW	Ratio
Fall 1970	1.57	1.65	1.84	1.46	.11	12.80*
Spring 1971	1.51	1.67	1.92	2.30	.13	17.72*
Fall 1971	1.65	1.68	1.95	1.57	.15	10.13*
Spring 1972	1.52	1.63	1.82	1.09	.14	9.97*

At each administration of the instrument, Group C differed significantly from Groups A and B. It is possible that some sort of selection factor produced this difference. Teachers who volunteered to participate in development of the new syllabus may have held more progressive educational opinions than the general population of Regents earth science teachers. An alternate explanation suggests that these teachers developed such opinions in the process of curriculum development.

Hypothesis B-2

> Teachers electing to begin use of the new materials in 1970-71 will have more progressive educational opinions than those electing to continue teaching the traditional materials that year.

Table 16 shows that Group A did not differ significantly from Group B on the opinion scale score at any time during the course of the study. This is somewhat surprising, since it had been hypothesized that educational opinion would have been a selection factor in constituting the membership of these two groups.

TABLE 16

PLANNED INDEPENDENT CONTRASTS ON OPINION SCALE FOR GROUP B VS GROUP A

Time	Mean A	Mean B	SS Compare	MSW	F Ratio
Fall 1970	1.57	1.65	.07	.11	.58 ns
Spring 1971	1.51	1.67	.40	.13	3.06 ns
Fall 1971	1.65	1.68	.02	.15	.10 ns
Spring 1972	1.52	1.63	.18	.14	1.31 ns

The lack of difference suggests that early or late adoption of the syllabus may have been due less to teacher characteristics than to factors such as administrative co-operation or availability of suitable facilities and equipment.

Hypothesis B-3

> Educational opinion change over the two year period will be in a progressive direciton for all groups. This change will be greatest for teachers beginning to use the new materials for the first time in 1971-72.

As is clear from Table 17, this hypothesis was not supported by analysis of the data. None of the groups significantly changed its educational opinion between the fall of

1970 and the spring of 1972, although there were minor, but statistically significant fluctuations within the period of the study, notably among Group A teachers. This group showed a trend toward progressivism in the fall of 1971 when they adopted the new syllabus, but returned to their previous opinions in the spring of 1972. Perhaps a burst of enthusiasm when adopting the new syllabus led to Group A's short-lived adoption of more progressive opinions.

TABLE 17

T-TEST OF DIFFERENCES ON OPINION SCALE, BY GROUPS THROUGH SEVERAL TIME INTERVALS

	Difference	t-value	Degrees of Freedom
Group A			
*Fall 1970-Spring 1972	.0070	.1591 ns	26
Fall 1970-Spring 1971	-.0331	-.8746 ns	29
Spring 1971-Fall 1971	.1076	2.2649*	21
Fall 1971-Spring 1972	-.1045	-1.7886*	25
Group B			
*Fall 1970-Spring 1972	-.0352	-.7354 ns	27
Fall 1970-Spring 1971	.0414	.9292 ns	34
Spring 1971-Fall 1971	-.0169	-.3665 ns	27
Fall 1971-Spring 1972	-.0693	-1.4933 ns	26
Group C			
*Fall 1970-Spring 1972	-.0300	-.7011 ns	25
Fall 1970-Spring 1971	.0625	1.1245 ns	31
Spring 1971-Fall 1971	.0722	1.0108 ns	25
Fall 1971-Spring 1972	-.1568	-2.4698*	24

* Fall 1970-Spring 1972 scores compared for Hypothesis B-3

The significant move away from progressivism by Group C in the spring of 1972 (as compared to fall 1971 opinions) might be explained as a "spring let-down" associated with fatigue and the other factors which a year's experience with a hundred and fifty active high school students can provide. The same kind of trend is visible in the fall 1971-spring 1972 difference of means for Groups A and B as well. It should be pointed out however, that the mean score of Group C on the Opinion Scale remains significantly higher than the scores of the other two groups in the spring of 1972 (Group A = 1.521, Group B = 1.64, Group C = 1.822).

In general, analysis of data on teacher educational opinion obtained in this study suggests that although these opinions differ significantly among groups of teachers, the opinions held by a particular group are stable, over relatively long periods of time.

Tests concerned with student ability to employ the processes of science

The next set of hypotheses deals with student ability to employ the processes of science, as measured by the Processes of Science Test (POST).

Hypothesis C-1:

> When spring POST scores are adjusted for fall POST scores, students using the new syllabus will obtain higher scores than will students in classrooms using the traditional syllabus.

Table 18 shows that there was no significant difference in 1970-71 between groups when spring scores (adjusted for fall scores) on this test were analyzed by analysis of covariance. This finding is consistent with that made by Welch (1972b) relative to PSNS students, but is inconsistent with the findings of Kochendorfer (1967) relative to BSCS students. It appears that much more needs to be done in regards to measuring process of science objectives.

TABLE 18

ANALYSIS OF COVARIANCE OF MEANS ON PROCESSES OF SCIENCE TEST FOR ALL GROUPS, 1970-71

Group	Treatment Mean	Adjusted[1] Mean	Mean Square Adjusted M	Mean Square Within	F Ratio	D.F.
A	17.18	17.71				
B	18.33	18.20	7.58	4.99	1.52 ns	2, 102
C	17.67	17.26				

[1]Spring POST scores adjusted for fall POST scores

Hypothesis C-2:

When spring POST scores are adjusted for fall POST scores, students whose teachers adopted the new syllabus in 1970-71 will obtain higher scores than will students whose teachers adopted the new syllabus in 1971-72.

Table 19 shows that this hypothesis was not supported by the analysis of data. There was no significant difference between the spring POST means of Group B in 1971 and the spring POST means of Group A in 1972 when they were covaried with the fall means of the respective groups. The conditions of choice under which the syllabus was adopted seems to have no effect on student growth in the abilities measured by POST.

TABLE 19

ANALYSIS OF COVARIANCE OF MEANS ON PROCESSES OF SCIENCE TEST FOR GROUP A 1971-72 VS GROUP B 1970-71

roup	Treatment Mean	Adjusted[1] Mean	Mean Square Adjusted M	Mean Square Within	F Ratio	D.F.
A	17.39	17.67	2.89	3.51	.823 ns	1, 59
B	18.33	18.11				

[1]Spring POST scores adjusted for fall POST scores

Hypothesis C-3

> When spring POST scores are adjusted for fall POST scores students whose teachers adopted the new syllabus in 1971-72 will obtain higher scores than will the students of the same teachers in the previous year.

Table 20 shows that this hypothesis is not supported by analysis of the data. When the spring POST scores are co-varied with the fall scores, and Group A's 1971 performance is compared with its 1972 performance, no significant difference is detected. The teacher's changing to the new syllabus did not seem to improve student abilities measured by the Processes of Science Test.

TABLE 20

ANALYSIS OF COVARIANCE OF MEANS ON PROCESSES OF SCIENCE TEST FOR GROUP A 1970-71 VS GROUP A 1971-72

Year	Treatment Mean	Adjusted Mean	Mean Square Adjusted M	Mean Square Within	F Ratio	D.F.
1970-71	17.39	17.34	.26	3.89	.066 ns	1, 60
1971-72	17.18	17.21				

[1]Spring POST scores adjusted for fall POST scores

Hypothesis C-4:

> When spring POST scores are adjusted for fall POST scores, students whose teachers had more progressive educational opinions will obtain higher scores than will students whose teachers had less progressive educational opinions.

Table 21 indicates that this hypothesis was not supported by analysis of the data. When classes were assigned to three groups of approximately equal size on the basis of the progressive educational opinions of their teachers (using Schirner's progressive sub-scale) there was no significant difference between groups on spring POST scores after adjustment for fall POST scores. It is interesting to note that students of teachers with both high progressive scores (mean = 4.4838) and low (mean = 3.7638) obtained greater POST gains than did students of teachers with moderate progressive scores (mean = 4.1533).

TABLE 21

ANALYSIS OF COVARIANCE OF MEANS ON PROCESSES OF SCIENCE TEST ALL CLASSROOMS GROUPED BY TEACHER PROGRESSIVE OPINION SCORES SPRING 1972

Group Name	N	Opinion Scores (Grouping Mean)	Treatment Mean	Adjusted[1] Mean
Progressive	28	4.48	18.06	18.14
Moderate	25	4.15	17.29	17.47
Non-progressive	29	3.76	18.74	18.51
Mean Square Adjusted Mean		6.30		
		F-ratio: 1.60 ns	D.F. 2, 77	
Mean Square Within		3.95		

[1]Spring POST scores adjusted for fall POST scores

None of the hypotheses concerning gains on the Processes of Science Test scores was supported. It can be concluded that the curriculum used, the conditions of adoption of the new syllabus, experience of the teacher with the new syllabus and teacher educational opinion have no significant effect on student growth on the abilities measured by POST.

Spring 1971 POST scores correlated significantly with cognitive achievement as measured by the spring 1971 earth science tests of "old content"and "new content". (This correlation used mean classroom scores from all classrooms in the study.) The correlation of POST with "old content" was .51; correlation of POST with "new content" was .63. These correlations suggest that the abilities measured by POST may not be quite as specific as "the ability to employ the processes of science".*

Tests concerned with knowledge of earth science

The following tests were concerned with knowledge of "old content" and of "new content" as measured by the "Earth Science Content Test".

Hypothesis D-1:

> All students will achieve best on the test instrument devised for use with the syllabus version used by their teacher.

Table 22 shows that this hypothesis was supported for Groups B and C, but not for A. In 1971, students of teachers using the new syllabus did significantly better on the new content sub-test than they did on the old content sub-test. Although there was a tendency for students of teachers using the old syllabus to do better on the old content sub-score than on the new content sub-score, this trend was not significant.

Findings of the nature reported here are not surprising. Curricula tend to focus most effectively on content objectives, so it is to be expected that students will achieve best on tests of the particular concepts stressed in the curriculum to which they are exposed. Differences in achievement are only important if knowing one set of concepts is more valuable than knowing another set. It was the judgment of the Earth Science Syllabus Revision Committee that the concepts found in the old syllabus inadequately represented current knowledge in the field of earth science. For this reason they introduced new content

* A similar question was raised by Wallace (1963, p. 28),

> The correlations between the Impact Test [POST] and the two achievement tests are of particular interest, since there is a question as to whether the Impact Test [POST] does in fact measure a unique set of skills. These data suggest that it does not. If a unique set of skills was being measured, the partial r's should be nearer to zero. The correlations and partial correlations between the Cooperative Biology Test and the two BSCS tests were also high.

into the new syllabus. It appears from analysis of the data reported here that the new syllabus presents the new concepts more adequately than the old concepts.

TABLE 22

T-TEST OF DIFFERENCES BETWEEN MEANS ON EARTH SCIENCE TEST SUBSCORES, FOR EACH GROUP, SPRING 1971

Group	"Old Content" Mean	"New Content" Mean	t value (Related Groups)	Degrees of Freedom
A	.5398	.5185	-1.0255 ns	35
B	.4575	.5640	6.6736*	35
C	.4305	.5577	7.0719*	33

Hypothesis D-2:

On the "new content" sub-test, students whose teachers use the revised syllabus will outperform students whose teachers use the traditional syllabus.

Table 23 shows that analysis of the data supports this hypothesis. Group B and C students achieved significantly better on the "new content" test than did Group A students. Exposure to the new syllabus apparently gave an advantage to students on the "new content" exam.

TABLE 23

PLANNED INDEPENDENT CONTRASTS ON EARTH SCIENCE TEST FOR GROUP A VS GROUPS B & C, SPRING 1971

Subscore	Means A	B	C	Mean Square Hypothesis	MSW	F Ratio	D.F.
"Old Content"	.540	.458	.431	.213	.0072	29.24*	1,102
"New Content"	.519	.564	.558	.043	.0045	9.44*	1,102

This finding is similar to the findings of most other science curriculum researchers. It contradicts the findings of Champlin and Hassard (1966) and Sargent (1966) in respect to ESCP earth science.

Hypothesis D-3

> Students whose teachers use the traditional syllabus will outperform students whose teachers use the revised syllabus on the "old content" sub-test.

Table 23 shows that this hypothesis was supported by analysis of the data. Students of Group A significantly outperformed students of the groups not using the traditional syllabus on the content test devised to test knowledge related to the traditional syllabus. Taking the results of the last two analyses together supports the premise that neither syllabus subsumes the content objectives of the other. Neither adequately prepares students for achievement tests appropriate to the other syllabus.

The finding that students using the traditional syllabus outperform students using one of the new curricula on tests of traditonal concepts, agrees with the findings of Schirner (1967) relative to students under ESCP and non-ESCP curricula.

Hypothesis D-4

> On the "new content" sub-test, students whose teachers have one or more years experience with the new materials will outperform students whose teachers began use of the new materials only when such use was mandated.

Table 24 shows that this hypothesis was not supported by analysis of the data. This would suggest that their teacher's previous experience with the new syllabus did not give students an advantage over students whose teachers did not have prior experience with the new syllabus. Contradictory evidence, however, is supplied by analysis of Regents Examination mean classroom scores in 1972, when all groups were using the new syllabus. Table 25 shows the results of contrasts between Group A and Groups B & C. In these small samples (N =

7-8 per group), the Regents scores obtained by Group A classes were significantly lower than for the other two groups. It would appear that students of these teachers had more difficulty with the exam than students of teachers having had prior experience with the new syllabus. Since these samples are so small, it seems prudent to withold judgment on the question of whether mandated statewide adoption of the revised Regents Earth Science Syllabus led to lower than average scores for those newly adopting it.

TABLE 24

PLANNED INDEPENDENT CONTRASTS ON EARTH SCIENCE TEST FOR GROUP A VS GROUPS B & C, SPRING 1972

Subscore	Means A	B	C	Mean Square Hypothesis	MSW	F Ratio	D.F.
"Old Content"	.453	.438	.442	.0032	.0057	.56 ns	83
"New Content"	.529	.554	.542	.0064	.0051	1.25 ns	83

TABLE 25

PLANNED INDEPENDENT CONTRAST ON 1972 REGENTS EARTH SCIENCE EXAMINATION FOR GROUP A VS GROUPS B & C

Means A	B	C	Mean Square Hypothesis	MSW	F Ratio	Degrees of Freedom
73.402	81.703	78.077	21.943	3.540	6.1973*	22

Hypothesis D-5

On the "new content" sub-test, students of teachers using the new syllabus for the first time when its use was optional will outperform students of teachers who used the new syllabus only when its use was mandated.

Table 26 shows that analysis of the data supports this hypothesis. A test contrasting the scores of Group B in 1971 with those of Group A in 1972 reaches significance.

TABLE 26

T-TEST OF DIFFERENCES ON "NEW CONTENT" SUBSCORE OF EARTH SCIENCE TEST, GROUP A, SPRING 1972 VS GROUP B, SPRING 1971

Group	Year	Mean	t-Value	Degrees of Freedom
A	1972	.5292	1.8926*	63
B	1971	.5640		

Earlier it was found that in their first year of experience with the new materials, teachers in Group A did not differ significantly from the teachers in Group B with respect to teaching behaviors employed or educational opinions held. Now it is found that students in the two groups <u>do</u> differ significantly in their performance on tests of knowledge of the new content. It might be surmised that student cognitive ability was greater in the Group B students, but if the fall POST test is any indicator of this ability, the two groups did not differ significantly in cognitive ability (see Table 27).

TABLE 27

T-TEST OF DIFFERENCES ON FALL POST SCORES BETWEEN GROUP A, 1970 AND GROUP B, 1971

Mean group A	Mean Group B	t-value
16.82	17.11	1.277

The differences found between these two groups on the new content subtest might possibly be due to non-verbal differences in the instructional procedures used by their teachers.

In general, it can be said concerning student achievement on earth science tests devised for use with the two syllabi, that students do best on the test devised for the syllabus which their teacher is using. It does not appear that students under the new syllabus can learn both the "old" and the "new" content at the same time. Other studies (Ladd, 1972; Passero and Schmaltz, 1972) have shown, however, that the questions on the new Regents exams reflect more accurately than the old exams the values of the new science curriculum developers. If those values have merit, then the students under the new syllabus are gaining more than they are losing.

Summary of Procedure and Findings

This study was designed to investigate the effects which adoption of the revised version of the New York State Regents Earth Science Syllabus might have on teachers' strategies of instruction, teacher educational opinion, student ability to employ the processes of science, and student achievement on tests of earth science knowledge. Samples of approximately thirty teachers and their classrooms were drawn from each of three groups of Regents earth science teachers:

A. Population A, which consisted of teachers who taught the older version of the syllabus during the first year of the study, and who adopted the new syllabus when its use was mandated, at the beginning of the second year of the two year study.

B. Population B, which consisted of teachers using the new syllabus for the first time during the first year of the study, when adoption of the new syllabus was optional, and who continued to use the new syllabus during the second year of the study.

C. Population C, which consisted of teachers who had used the new syllabus prior to the first year of the study, when its use was restricted to those teachers engaged in its development.

Employment of teaching strategies was measured twice during the study by means of the Earth Science Classroom Activity Checklist. This instrument was completed by students in the classrooms of the study in May of each year of the study.

A second measure of teaching strategies was obtained by means of the Tape Analysis Instrument. This instrument was used to analyze the teaching strategies of a subsample of teachers in each of the three groups. (N in each taping sample = 8) A sequence of five recorded classroom sessions was analyzed for each of the teachers in the subsamples each fall and eacn spring during the study.

Measures of teacher educational opinions were obtained four times during the course of the study, by means of the researcher devised "Teacher Educational Opinion Scale". Student ability to employ the processes of science were assessed by administering the Processes of Science Test (POST) in the fall and spring of each year of the study. Student achievement on knowledge of content relevant to the old syllabus and to the new syllabus was measured by a researcher-devised "Earth Science Content Test", which had equal numbers of items related to each of the syllabi.

The principal findings of the study were:

1. The teaching procedures employed by teachers using the new syllabus are significantly more in accord with the procedures advocated by the developers of the new syllabus and of other new science curricula, than are the procedures employed by teachers using the old syllabus.
2. Teachers who were mandated to begin using the new syllabus employed teaching behaviors which were significantly more in accord with the advocated procedures <u>after</u> this adoption than <u>before</u> the adoption.
3. None of the groups of teachers significantly changed its educational opinions during the course of the study. The teachers who had participated in development of the new syllabus had educational opinions which were significantly more progressive than those of the other two groups.
4. When spring POST scores were adjusted for fall scores, classroom means on this test did not differ significantly among the three groups during either year of the study.
5. Students performed significantly better on those items

of the earth science knowledge test which had been devised for the syllabus used by their teacher. In the second year of the study, achievement on items devised for the new syllabus did not differ significantly among the three groups.

CHAPTER V

Implications and Applications

This final chapter will deal with implications of the present study, and recommendations for further research which are suggested by the results of this study. Certain weaknesses and limitations of the study will be discussed in the context of their relation to recommended research.

Implications and recommendations flowing from this study seemed to have particular relevance to two groups of educators:

A. Science curriculum developers and researchers, in general.

B. The New York State Education Department, in particular.

Implications and Recommendations for Science Curriculum Developers and Science Education Researchers

This study found that the Earth Science Classroom Activity Checklist reliably measured differences between classrooms in respect to the classroom teaching strategies on which it reported. Correlations with the Tape Analysis Instrument tended to support the validity fo the Checklist.

The Checklist exhibits several advantages over classroom observation instruments such as the Tape Analysis Instrument. The Checklist was much more sensitive to small but significant items of teaching behavior, such as how often laboratory learnings were tested, or whether lab work required construction of graphs and tables, or whether long term investigations were part of the earth science course. Furthermore, the Checklist seems to be more sensitive to overall trends than is the Tape Analysis Instruemnt. This can be illustrated by comparing data from the two instruments for Group A in the 1971-72 academic year. The fall Tape Analysis for this group showed a significant increase in desired teaching behaviors when compared to the previous fall's behaviors (see Table 29).

TABLE 28

T-TEST OF DIFFERENCES ON GENERAL INDEX SCORES OF TAPE ANALYSIS INSTRUMENT, GROUP A, 1970-71 TO 1971-72

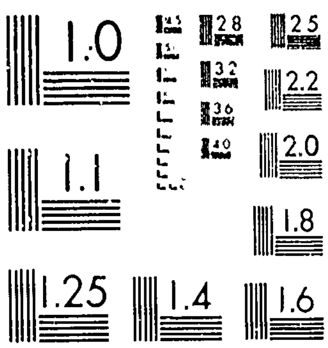
Season	Differences	t value
fall to fall	.876	2.18*
spring to spring	.084	.99 ns

The spring Tape Analysis results, however, did not differ significantly from those of the previous spring. (See Table 28) The 1972 Checklist administered at the same time as the spring Tape Analysis <u>did</u> show a significant increase in advocated teaching behaviors when compared to the results of the 1971 Checklist. (See analysis of Hypothesis A-4, above, in Chapter IV.) The Tape Analysis Instrument records the behaviors of the moment. In the fall it may be inferred that as the teachers began to use the new syllabus, they engaged in more of the behaviors advocated by its developers. However, in the spring, this group of teachers may have felt rushed by the amount of ground left to "cover" in the new syllabus, and therefore substituted lecture for laboratory. Another possibility is that they may have begun very early to "review for the Regents". (Instances of both kinds of activity were in evidence on the tapes.) In any event, the students, reporting via the Checklist, were apparently able to transcend the events of the moment, and to reflect on their year as a whole. Thus they report behaviors significantly different from those reported for these teachers at the end of the previous year.

The Checklist seems to be better fitted than the observation instrument for the review of longer periods of classroom proceedings. It is better able to assess the occurence of infrequent, but significant items of behavior. Finally, it is certainly simpler and more economical to administer than the observational instruments. Instruments such as the Earth Science Classroom Activity Checklist should be useful tools

2 OF 2

ED 089 953



for further research on teaching strategies used by science teachers. Reports by Sidney Smith (1973), Spradlin (1973), and Bingman (1973) at the 1973 Annual Meeting of the National Association for Research in Science Teaching indicate that science classroom activity checklists are beginning to be used more widely. The results of this study would tend to support the extended use of such instruments.

The results of this study have shown that the teaching strategies used by science teachers can be modified by adoption of a curriculum which is written in such a way as to promote this modification. This knowledge should be heartening to the many science educators who worked long and hard to make the new curricula instruments of change. Much remains to be learned, however, about curriculum adoption and consequent change in teaching behavior. Now that it is clear that the curriculum package brings about change in teaching behavior, it becomes important to find out which elements of the package are most effective in bring about change. Among the elements which may contribute to behavior change are: the thematic structuring of concepts, integration of laboratory investigations with the concept outline, the nature of laboratory instructions for teacher and student, the format of syllabus (or textual) material, provision for teacher training, and the nature and weighting of the final examination. The effect on teacher behavior exerted by each curricular component needs to be investigated.

The relation between employment of one of the new science curricula and student ability to employ the processes of science is of vital interest to the curriculum effectiveness researcher. The present study's inability to detect any significant curriculum effect on this variable could be viewed as an indication that the new science curricula are failing to attain their objective of enhancing these abilities in the student. On the other hand, it is possible that the instrument selected (POST) to measure this variable was inadequate for the task. More research needs to be done on the effectiveness of instruments devised to measure these abilities. In this regard, Tannenbaum's (1971) "Test of Science Processes" seems worthy of further exploration. So also does the "Science Process Inventory" developed by Welch (1972b).

There may be interesting implications in the significantly more progressive educational opinions held by the group of teachers who had been actively engaged in developing the new earth science syllabus. If the difference is due to selection factors, then project directors for curriculum development efforts should be aware that teachers who volunteer to participate in such projects may tend to have more progressive educational opinions than the general population of science teachers. It seems likely that statewide or national implementation of a curriculum might be made easier if there were more "non-progressive" representatives on the curriculum development team.

If, on the other hand, the higher progressive scores of the group which participated in developing the syllabus was the result of that participation, then even more interesting implications suggest themselves. If educational opinion, which this study found to be a rather stable teacher characteristic, can be changed by participating in the curriculum development process, then it seems likely that other teacher characteristics and abilities might also be enhanced by such participation. An obvious example would be the ability to more effectively participate in continuing curriculum modification efforts. There is some support for this conjecture in the activity of many of the teachers in Group C subsequent to their involvement in the Regents Earth Science Syllabus revision process. Through efforts loosely coordinated through the Bureau of Science Education, fifteen or twenty Group C teachers are currently modifying the revised syllabus for use in an individualized mode of instruction. Personal observations of this researcher indicate that many other teachers in this group are engaged in individualization of curriculum efforts in their own classrooms.

What is being suggested here, is that the effects of a teacher's participation in the curriculum development process on his subsequent professional activities is worthy of further research. It seems likely that such participation is a very effective form of in-service teacher training.

Developers of new science curricula are interested in the reasons why some teachers adopt their product, and others do not adopt it. An assumption underlying this study was that the new curricula were adopted by "progressive" teachers, and were rejected by "traditional" teachers. The findings of the study did not favor this assumption. Those teachers who adopted the new curriculum when its adoption was optional held educational opinions which did not differ significantly from those held by teachers who decided to continue using traditional curriculum materials. This would suggest that educational opinion does not in itself dispose a teacher to adopt or reject a new science curriculum.

Another indication that the teachers who continued to use the traditional materials after the appearance of the new curriculum did not differ greatly from those who adopted the new curriculum at once is to be found in the first year teaching behaviors employed by each group. In their first year of experience with the new materials, these two groups did not differ significantly with respect to the teaching behaviors employed. Apparently both groups of teachers were equally flexible in adopting the teaching strategies advocated for the new curriculum.

If teacher educational opinion and willingness to change teaching strategies did not constitute the basis for adopting or not adopting the new curriculum, then it seems that the basis for this decision may be traceable to factors less closely related to the teacher. In retrospect, it now seems likely that the decision to adopt the new science curriculum may have been more closely related to such factors as administrative support, availability of facilities, funding for equipment, supplies, and new textbooks than it was to teacher characteristics. Further research needs to be conducted on the factors related to adopting a new science curriculum.

Science education researchers who have reviewed the research that has been done on the effectiveness of the new science curricula (Balzer, 1970; Welch, 1969) have urged that curriculum evaluation should concern itself with a broad range of variables. The present study supports the feasibility of investigating several aspects of a curriculum implementation problem within a single study. Such an approach provided some new knowledge, as well as leads for further research. On the other hand, the three year's experience this researcher has had with the present project tends to confirm the admonition which Wayne Welch (1969, p.441) offered in concluding his review of science curriculum evaluation efforts in the sixties:

> Only at centers where there has been a concentrated effort to investigate many facets of a course or teaching method by a group of researchers does one find any discernible evidence of advancement.. . . This concentrated group research needs to be encouraged and supported. Isolation in the past has led to fragmentation. Limitations in theory, instrument development, experimental design, data processing, statistical knowledge, and subject-matter competency are difficult for a single investigator to overcome. Several people concerned with common problems and bringing together their own skills an experience appear to offer the best hope for continued improvement of curriculum evaluation in science.

Since curriculum development is a process which affects many lives and affects them in a variety of ways, it is important that development and implementation of new science curricula be accompanied by research which seeks to identify not only the effects of the curricula, but the interaction of the curriculum with various characteristics of the teacher, students, classroom and school setting. Future curriculum evaluation efforts should study as many of these variables as possible.

Implications and Recommendations for Members of the New York State Education Department

An important modification of teaching behavior was found to result from adoption of the revised version of the New York State Regents Earth Science Syllabus. This would seem to justify a careful review of the syllabus package itself, and of the revision process which produced it, to determine if there are implications for development of other syllabi. Such review might lead to questions which would require additional research, such as:

1. Do teaching behaviors employed by teachers of the other secondary science syllabi change as a result of adopting a new syllabus? A generalized version of the Earth Science Classroom Activity Checklist (The Science Classroom Activity Checklist) is available for use in any science classroom.
2. Do teaching behaviors employed by Regents earth science teachers change after several years of experience with the revised syllabus? Do their educational opinions change?
3. Do teachers who use the revised Regents Earth Science Syllabus, but who do not administer the Regents Exam to their students use different teaching procedures than teachers who do administer the exam?
4. Do Regents earth science teachers use different teaching strategies in the spring than they do in the fall?

These constitute but a small sample of the kinds of questions that can be asked about a curriculum subsequent to its adoption, through <u>summative evaluation</u> procedures. Answers to such questions could be very helpful in providing guidelines for future curriculum development. Of perhaps even greater importance, however, is research which <u>accompanies</u> curriculum development, i.e. <u>formative evaluation</u>.

New York State has long been a leader in the curriculum development field, as indicated by its long history of preparing Regents syllabi. The present study has shown that useful research can be conducted on a curriculum which the State Education Department has developed. Is it not time for the Department to consider undertaking its <u>own</u> curriculum evaluation program? Should it not transform its curriculum development program into a RESEARCH and DEVELOPMENT program? In addition to the obvious benefit to subsequent curriculum development activity, introducing research planning into the curriculum development process itself has an important secondary effect. Research which accompanies development tends to keep all the curriculum objectives foremost in the minds of the developers. There is an unfortunate tendency in curriculum development to set forth a broad range of educational objectives (cognitive, affective, etc.) at the outset of the process, only to focus primarily on a narrow range of cognitive skills during the production phase of the process. When research planning accompanies curriculum development, the broad range of curriculum objectives is kept before the developers at all times, since they know that if their product is to prove effective, it must provide learning learning experiences which are related to all of the objectives of the program, not merely to a few cognitive goals.

An excellent model for formative evaluation of curriculum is presented by Sawin in his <u>Evaluation & the Work of the Teacher</u> (1969, p.210). Use of such a model could greatly improve the effectiveness of the syllabus revision process, and perhaps lead to greater modification of student behaviors than was discovered by the present summative evaluation of the earth science syllabus.

Expansion of the Department's curriculum development program to include a research component would undoubtedly require additional funding. The expense, however, should be easily justified by the benefits to students and teachers in the Regents' classrooms of New York State. The quest for funds should be made easier by the accountability aspects of curriculum research. As Sawin remarks (1969, p. 219),

> In the industrial world, a much larger proportion of total expenditure is spent on product evaluation and research than most educators would presently dream of spending for curriculum evaluation and research.

REFERENCES

Balzer, LeVon, 1969. Nonverbal and verbal behaviors of biology teachers. The American Biology Teacher. April, 1969: 226-9.

Balzer, LeVon. 1970. Review, appraisal and recommendations concerning research on classroom behavior in science. Paper presented at the 43rd annual meeting of the National Association for Research in Science Teaching, Minneapolis, Minnesota. ERIC Document 059 874.

Barnes, Lehman W., Jr. 1967. Laboratory instruction in high school biology classes using different curriculum materials. In Research and curriculum development in science education. 1. The new programs in high school biology, edited by Addison E. Lee. Austin, Texas: University of Texas. ERIC Document 024 605.

Bingman, Richard M. 1973. Relationships between teacher practices and student learning of inquiry processes. Paper presented at the 46th annual meeting of the National Association for Research in Science Teaching, Detroit, Michigan.

Blankenship, Jacob W. 1967. An analysis of certain characteristics of biology teachers in relation to their reactions to the BSCS biology program. In Research and curriculum development in science education, 1. The new programs in high school biology, edited by Addison E. Lee. Austin, Texas: University of Texas. ERIC Document 024 605.

Bureau of Secondary Curriculum Development. 1961. Earth Science, a handbook of activities to accompany the course of study in earth science. Albany, New York: State Education Department.

Bureau of Secondary Curriculum Development. 1962. Earth Science, an outline of topics and related understandings for a course of study. Albany, New York: State Education Department.

Bureau of Secondary Curriculum Development. 1970. Earth Science syllabus and supplement. Albany, New York: State Education Department.

Champlin, Robert F. 1970. A review of the research related to ESCP. Journal of Geological Education. 28: 31-9.

Champlin, Robert F., and Hassard, John Russell. 1966. In A review of the research related to ESCP, by Robert F. Champlin. Journal of Geological Education. 28: 31-9.

Cogan, Morris L. 1958. The behavior of teachers and the productive behavior of their pupils: I. "Perception analysis." Journal of Experimental Education. 27: 89-105.

Cooley, William W., and Klopfer, Leopold E. 1963. Evaluation of specific educational innovations. Journal of Research in Science Teaching. 1: 73-80.

Earth Science Curriculum Project. 1967. Investigating the earth, teachers guide, vol. 1. Boston: Houghton Mifflin Co.

Evans, Thomas P. 1969. A category system for teacher behaviors. The American Biology Teacher. April, 1969: 221-225.

Fischler, Abraham S., and Zimmer, George. 1967-68. The development of an observational instrument for science teaching. Journal of Research in Science Teaching. 5: 127-37.

Flanders, Ned A. 1967. Teacher influence in the classroom. In Interaction analysis: theory, research, and application. edited by Edmund J. Amidon and John B. Hough. Reading, Massachusetts: Addison-Wesley Publishing Co. pp. 103-16.

Gennaro, Eugene D. 1964. In An analysis of research on instructional procedures in secondary school science. Part I: Outcomes of instruction, by Gregor A. Ramsey and Robert W. Howe. The Science Teacher. March, 1969: 62-70.

Hassard, John R. 1970. The development of the science teacher behavior code and its utilization with ninth grade earth science teachers. Paper presented at the 43rd annual meeting of the National Association for Research in Science Teaching, Minneapolis, Minnesota.

Hurd, Paul DeHart, and Rowe, Mary Budd. 1964. Science in the secondary school. Review of Educational Research. 34: 286-297.

Hurd, Paul DeHart. 1969. New directions in teaching secondary school science. Chicago: Rand McNally & Co.

Kerlinger, Fred N. 1965. Foundations of behavioral research. New York: Holt, Rinehart and Winston, Inc.

Kerlinger, Fred N. and Pedhazur, Elazar J. 1967. Attitudes and perceptions of desirable traits and behaviors of teachers. New York: New York University.

Kochendorfer, Leonard H. 1967. Classroom practices of high school biology teachers using different curriculum materials. Research and curriculum development in science education, 1. The new programs in high school biology. edited by Addison E. Lee. Austin Texas: University of Texas. ERIC Document 024 605. pp. 79-84.

Korth, Willard W., Czelen, Jean, and Moser, Gene W. 1971. A study of the relationships between measures of teacher-pupil verbal interaction and student assessment of classroom practices. Washington, D.C.: U.S. Department of Health, Education and Welfare. ERIC Document 055 798.

Ladd, George T. 1972. An analysis of the inquiry level of New York State Earth Science Regents examinations, (1960-1971). Science Education. 56(1): 97-101.

Lee, Addison E. 1967. Research and development in science education. 1. The new programs in high school biology. Austin, Texas: University of Texas. ERIC Document 024 605.

Leeds, Carroll, H., and Cook, Walter. 1947. The construction and differential value of a scale for determining teacher-pupil attitudes. Journal of Experimental Education. 16: 149-59.

Medley, Donald M., and Mitzel, Harold E. 1963. Measuring classroom behavior by systematic observation. In Handbook of Research on Teaching, edited by N.L. Gage. Chicago: Rand McNally & Co. pp. 247-348.

Moser, Gene W., and Feldgoise, Roberta. 1968. In A study of the relationships between measures of teacher-pupil verbal interaction and student assessment of classroom practices, by Willard W. Korth, Jean Czelen and Gene W. Moser. Washington, D.C.: U.S. Department of Health Education and Welfare. ERIC Document 055 798.

Parakh, Jal. S. 1968. A study of teacher-pupil interaction in BSCS Yellow Version biology classes. The American Biology Teacher. Dec. 1968: 841-848.

Passero, Richard N., and Schmaltz, Lloyd J. 1972. The New York Regents earth science examinations: have they reflected trends in the philosophy in earth science education? School Science and Mathematics. June, 1972: 541-52.

Psychological Corporation. 1962. Processes of science test. New York: Psychological Corporation.

Ramsey, Gregor A. and Howe, Robert W. 1969. An analysis of research on instructional procedures in secondary school science. Part I: Outcomes of Instruction. The Science Teacher. March, 1969: 62-70.

Reed, Horace B. 1962. Implications for science education of a teacher competence research. Science Education. 46: 473-86.

Remmers, H.H. 1963. Rating method in research on teaching. In Handbook of Research on Teaching, edited by N.L. Gage. Chicago, Rand McNally & Co. pp. 329-78.

Ryans, David G. 1960. Characteristics of teachers, their description, comparison and appraisal. Washington, D.C.: American Council on Education.

Sargent, Earl Alvin. 1966. In A review of the research related to ESCP, by Robert F. Champlin. Journal of Geological Education. 28: 31-9.

Sawin, Enoch I. 1969. Evaluation and the work of the teacher. Belmont, California: Wadsworth Publishing Company, Inc.

Schirner, Silas. 1967. A comparison of student outcomes in various earth science courses taught by seventeen Iowa teachers. Unpublished Ph. D. dissertation, University of Iowa.

Scott, William A. 1955. Reliability of content analysis: the case of nominal scale coding. Public Opinion Quarterly. 19: 321-5.

Smith, John P. 1970. The development of a classroom observation instrument relevant to the Earth Science Curriculum Project. Paper presented at the 43rd annual meeting of the National Association for Research in Science Teaching, Minneapolis, Minnesota.

Smith, Sidney P. 1973. An analysis of teacher self-assessment and correlated student perception of the instructional behavior of middle school science teachers. Paper presented at the 46th annual meeting of the National Association for Research in Science Teaching. Detroit, Michigan.

Spradlin, Susan D. 1973. A study of classroom behavior change following teacher involvement in a summer teacher retraining program. Paper presented at the 46th annual meeting of the National Association for Research in Science Teaching. Detroit, Michigan.

Stanko, Dianne E. 1967. The nature of biology teachers' manuals and an analysis of their use by high school biology teachers. In Research and curriculum development in science education, 1. The new programs in high school biology, edited by Addison E. Lee. Austin, Texas: University of Texas. ERIC Document 024 605.

Tannenbaum, Robert S. 1971. The development of the test of science processes. Journal of Research in Science Teaching. 8: 123-36.

Troxel, Verne A. 1968. In An analysis of research on instructional procedures in secondary school science. Part I: Outcomes of instruction, by Gregor A. Ramsey and Robert W. HOwe. The Science Teacher. March, 1969: 62-70.

Vickery, Robert Lyn. 1968. An examination of possible changes in certain aspects of teacher behavior resulting from the adoption of individualized, laboratory centered instructional materials. Unpublished Ph. D. dissertation, Florida State University.

Wallace, Wimburn. 1963. The BSCS 1961-1962 evaluation program--a statistical report. Biological Sciences Curriculum Study Newsletter. No. 19: 22-4.

Welch, Wayne W. 1969. 4: Curriculum evaluation. Review of Educational Research. 39: 429-43.

Welch, Wayne W. 1971. Review of the research and development program of Harvard Project Physics. ERIC Document 059 687.

Welch, Wayne W. 1972a. Review of research 1968-1969 in secondary level science. Journal of Research in Science Teaching. 9: 97-122.

Welch, Wayne W. 1972b. Evaluation of the PSNS course. I: Design and implemention. Journal of Research in Science Teaching. 9: 139-45.

Welch, Wayne W. 1972c. Evaluation of the PSNS course. II: Results. Journal of Research in Science Teaching. 9: 147-56.

Yager, Robert F. and Wick, John W. 1966. In An analysis of research on instructional procedures in secondary school science. Part I: Outcomes of instruciton, by Gregor A. Ramsey and Robert W. Howe. The Science Teacher. March, 1969: 62-70.

INSTRUCTIONAL OBJECTIVES

If the objectives of any course of study are not clearly defined, it will be difficult to evaluate what has been learned. Without such clearly defined objectives, there can be no sound basis for selecting appropriate course content or instructional methods and materials. Clearly defined objectives should provide the student with a means to evaluate his own progress at any time and to help him organize his efforts into relevant activities.

In this syllabus, the focus is upon the identification and formulation of appropriate objectives which have been [illegible]. These are classified into two groups: those related to the process of inquiry (PIO's), and those related to subject matter or course content (CCO's). Both groups of objectives have been specifically related to the understandings in each topic.

Process-of-Inquiry Objectives (PIO)

At the completion of the course, the student should be able to:

1. demonstrate the following skills in mathematics:
   a. determine relative error in percent,
   b. use scientific notation correctly,
   c. solve for unknowns in simple algebraic equations (e.g., $D = \frac{M}{V}$)
   d. use proportions in establishing scale,
   e. measure dimensions using metric system and convert from one metric unit to another metric unit;
2. a) read the scales on standard measuring apparatus, such as rulers, protractors, balances, graduated cylinders, barometers, or compasses, to an accuracy of 1/2 of the smallest scale calibration of the apparatus;
   b) demonstrate a degree of precision with standard measuring apparatus by collecting 3 trial measurements that vary no more than ±1/2 of the smallest scale calibrations of the apparatus;
   c) demonstrate an ability to determine map measurements, such as directions, locations, distances, and other quantities designated on special maps, which are appropriate to the limitations of the map;
3. a) devise a classification system that can be used to interpret natural phenomena;
   b) create models that can be used to interpret natural phenomena;
4. list possible sources of error in an investigation when given a description of the data, procedure, and instrumentation;
5. a) collect and organize data;
   b) construct graphs using scales which are appropriate for the data;
   c) extrapolate from and interpolate within a set of data;
   d) interpret models which have been created to represent natural phenomena.

Course-Content Objectives (CCO)

At the completion of the course, the student should be able to identify examples from observations of his environment which illustrate that:

1. Change is universal and results from energy flow across an interface.
2. Mass-energy is conserved as change occurs.
3. The sun is the major source of energy which drives earth systems.
4. Natural systems tend to move toward a state of dynamic equilibrium.
5. Many earth processes reflect cyclical changes.
6. Changes or events reflect interactions between physical, chemical, and biological aspects of an environment, and are described within the frames of reference of space and time.
7. The properties of the environment and the materials of which it is composed indicate how they were formed and how they may change.
8. The study of present environments may be used to predict the future and to explain the past.
9. Data derived from a microenvironment may be used as a guide to the interpretation of a macroenvironment.
10. Observations occur when one or more of the senses are focused on an aspect of the environment.
11. Powers of observation are limited by the senses, and can be extended by the use of instruments.
12. There is a difference between information based on sensory perception and inferences made from these observations

*Mager, R.F. *Preparing Instructional Objectives.* Palo Alto, California. Fearon, 1962, pp. 3-4.

ANNOTATED FORMAT EXAMPLE

Syllabus Pages

The topic question is an indication of the inquiry theme of the entire topic.

Topic title from outline

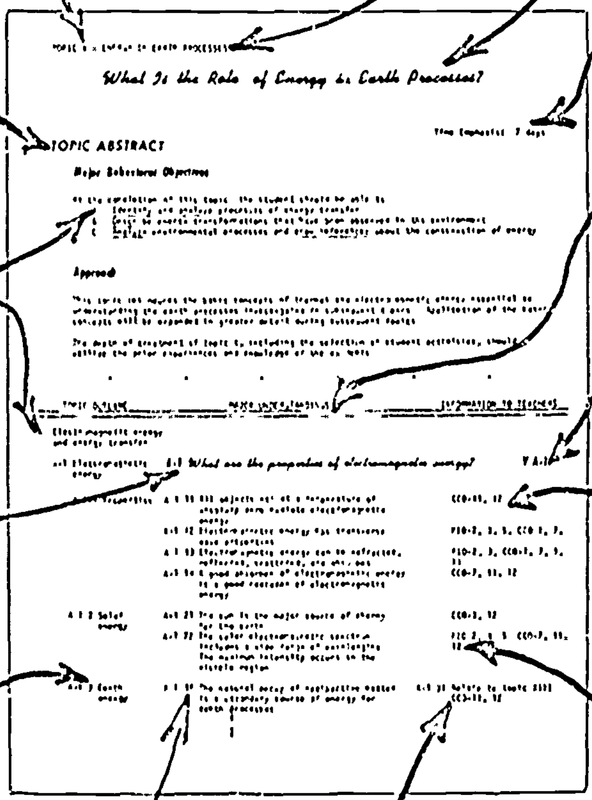
Topic number

Digest of -
1. *Major Behavioral Objectives for students.*
2. *Suggested Approach for the teacher with emphasis on what precedes or follows.*

The letter designation indicates the Major Behavioral Objective which is related to a specific section of the topic.

Whole number integers designate section questions. The understandings will develop from the investigation of the question, enabling the student to accomplish the appropriate Major Behavioral Objective.

A number in tenths (A-1.3) designates a subtopic required to develop an answer to the section question.



This time estimate suggests the extent of depth of treatment. It is exclusive of time required for testing.

This column represents statements of student understandings which should be derived primarily from investigations.

V-A-1 refers to the specific section of the supplement.

This designates the Course-Content Objectives. The CCO(s) represent broad themes which permeate the syllabus, and should be stressed accordingly at this point.

This designates the Process-of-Inquiry Objectives. The PIO(s) should be employed in helping the student achieve the understanding.

A number in hundredths (A-1.31) designates the specific major understandings.

This information refers only to the single understanding if it is coded in hundredths (A-1.31). It refers to the entire section of the topic if it is coded in tenths only.

ANNOTATED FORMAT EXAMPLE

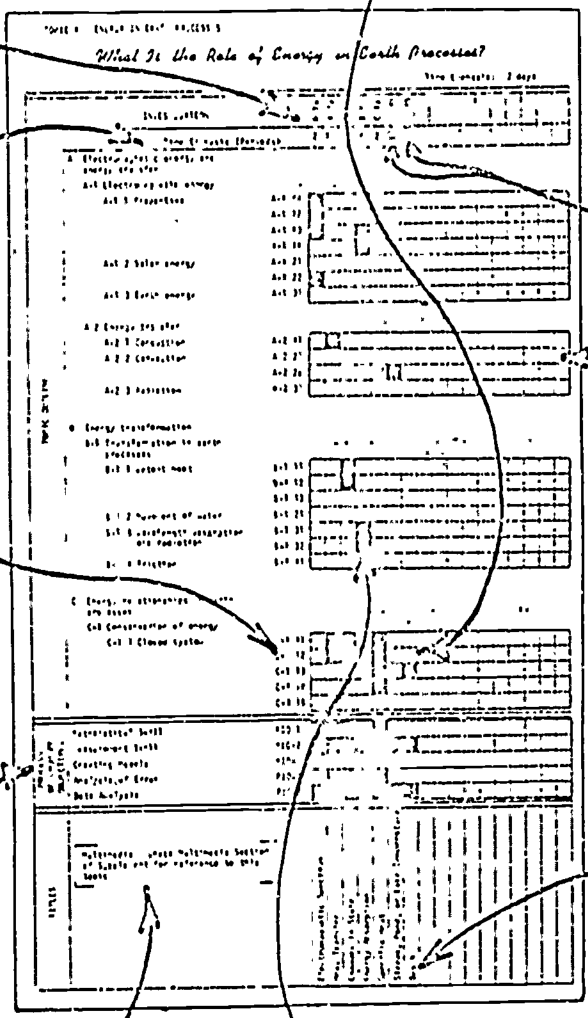
Investigations-Understandings Matrix

The blocks in a horizontal column designate which investigations will support and explain a single understanding. For C-1.12, (The amount of energy lost....) any or all of the investigations (A-2a, B-1a, C-1a) might be used.

Investigation number (topic omitted) found at top of both teacher and student laboratory guide sheet.

Estimated time in 45-minute class periods.

Long Term Investigations and Field Experiences



The understandings are coded directly to the syllabus, Major Understandings column. (i.e., C-1.12, The amount of energy lost by a source equals....)

Space left for teachers to place resources of their school into matrix (i.e., films, filmstrips, slides, videotapes, off-prints, library books, etc.)

Those Process Objectives used in an investigation.

Name of investigation

All multimedia are located in front of supplement by topic.

The blocks in a vertical column designate which understandings are included in a single investigation. Investigation B-1a: Energy Absorption, includes understandings: A-1.13, A-1.14, B-1.31, B-1.12.

Contents

September 1970

Dear Earth Science Teacher;

As you know, high school science courses have undergone a tremendous transformation since 1956. There now exists a large variety of nationally devised curricula ranging from PSSC to ESCP. Here in New York State, all of the Regents science curricula have also been revised in the last few years. This curriculum revision has been expensive in both money and man hours. It is quite natural to ask whether the expense has been worthwhile: What have been the effects of the widespread adoption of these new science curricula?

For some of the curricula, some of the answers are in. For example, PSSC students do better on PSSC exams than do students who have taken a "traditional" physics course. This type of effect has to be expected. Other, perhaps more important effects, however, have not yet been determined. Questions such as the following remain:

1. What effect does the new curriculum have on teaching and learning procedures in the classroom?

2. What effect does the new curriculum have on the students' ability to apply the processes of science to new problems and situations?

3. How does the teacher's outlook affect the way in which the new curriculum is taught?

Hopefully, questions of this type will be answered by carefully planned research. The Bureau of Science Education of the State Education Department encourages the kind of curriculum research which seeks answers to the questions above. It has, therefore, welcomed the research by me working through the State University of New York at Buffalo. I intend to study the effects of adopting the Revised Regents Earth Science Syllabus in New York State during the next two years. If you expect to teach either of the Regents Earth Science syllabi during the year 1970-71 and expect to teach Regents Earth Science again in 1971-72, I urge you to participate in this study. THIS RESEARCH WILL STUDY THE EFFECTIVENESS OF THE NEW CURRICULUM, NOT INDIVIDUAL TEACHERS. ALL INFORMATION GATHERED IN THE STUDY WILL BE HELD IN STRICT CONFIDENCE.

Those selected to participate will be asked to do the following:

I. Early Fall, 1970:

A. Complete a form requesting information in their teaching assignment, background, etc. 20 minutes.

B. Administer to one section of Regents Earth Science students an instrument devised to measure their ability to apply the processes of science. (Data will be collected from only one section of your earth science students each of the two years.) One class period.

C. Complete a teacher educational outlook inventory. (This can easily be filled in while the students are working on the processes of science test.)

D. (If recording equipment is available), record a sequence of six periods of class and lab activities. (Tape will be supplied by the study.)

A category system such as the Flanders' Interaction Analysis System, will be used to identify the teaching and learning procedures used by the teacher and students.

II. April, 1971:

A. Administer to the students an "Earth Science Classroom and Laboratory Activity Checklist." In this Checklist, the students will report on their long-term perception of the teaching and learning procedures used in their classroom and laboratory. One class period.

B. Administer the processes of science test as a post-test. One class period.

C. (If recording equipment is available), record a second sequence of six classroom and laboratory sessions. (Set up time for recorder).

III. May, 1971:

Administer an earth science exam which will contain items appropriate to both the regular and revised curricula. (This will permit comparisons to be made between results of this study and those of earlier, content-oriented, studies).

IV. Fall, 1971:

Administer the processes of science test to the students.

V. April, 1972:

A. Administer the "Earth Science Classroom and Laboratory Activity Checklist." One class period.

B. Administer the processes of science test. One class period.

C. Complete the teacher educational outlook inventory. (During processes of science test.)

D. If equipment is available, record a third sequence of six classroom and laboratory sessions.

In summary, the expected expenditure of time will be:

	Students	Teacher
First Year of the Study	Four class periods	An additional three or four hours, at most, to: Complete initial information form and (set up recording equipment) mail materials to project director.
Second Year of the Study	Three class periods	An additional three or four hours to: (set up recording equipment) mail materials to project director and complete the final report form.

All materials will be provided by the project. All scoring of tests and inventories will be handled by the project. School districts will be asked to provide return postage (about $2 per year), and if possible, use of a tape recorder for two weeks the first year, one week the second year.

Science teaching in New York State, and elsewhere, should profit greatly from the time invested in this project by the earth science teachers and students who participate. The generosity which seems characteristic of earth science teachers holds the key to the success of the project. For the study to be meaningful, a large number of volunteers are needed. From these, a sample will be selected to participate in the actual study. Upon the completion of the study, each participant will receive a complete report of the results.

You are urged to volunteer for the project by filling in the accompanying form and returning it in the enclosed envelope no later than October 1 . You will be notified by Oct. 12 if you have been selected to participate.

Thank you very much for having considered this proposal.

Sincerely,

James R. Orgren

JAMES R. ORGREN

THE UNIVERSITY OF THE STATE OF NEW YORK
THE STATE EDUCATION DEPARTMENT
ALBANY, NEW YORK 12224

BERNARD F. HAAKE
ASSISTANT COMMISSIONER FOR
INSTRUCTIONAL SERVICES
(GENERAL EDUCATION)

DIVISION OF GENERAL EDUCATION
TED T. GRENDA, DIRECTOR

BUREAU OF SCIENCE EDUCATION
HUGH TEMPLETON, CHIEF

ASSOCIATES
WILLIAM A. CALHOUN
JOHN V. FAVITTA
ROGER W. MING
EDWARD T. LALOR

518 474-7746

October 1970

Dear Principal;

All too seldom do researchers in the schools of education of our universities investigate problems of mutual and immediate interest to school districts and state departments of education. The researcher, whose request for cooperation you find enclosed, has chosen such a problem.

The New York State Regents program is known across the country. The development of statewide Regents curricula and examinations has required, and continues to require, the time and talents of hundreds of trained educators. The Department has over the years acquired a wealth of data on the performance of students in the state on the Regents examinations. Unfortunately, however, it has practically no hard data concerning the effect which introduction of a new curriculum has on classroom procedures and behaviors. Since the new science curricula, state and national, strongly encourage a more investigative and open-ended classroom behavior, it is particularly important to know whether or not adoption of one of these curricula actually stimulates more of these kinds of behavior. The proposed study will attempt to measure changes of classroom behavior which one of the new curricula may bring about. Future curriculum revisions could be directly affected by the outcome of this study.

As you know, the Revised Earth Science Syllabus is being introduced statewide over the next two years. As the researcher points out, adoption of this inquiry-oriented science course presents a unique opportunity to study the effects a new curriculum has on a large number of classrooms. Demands on participating schools are small when compared with the possible outcomes. The school will be asked to supply return mailing costs, at about two dollars per year. It may also be asked to provide use of a tape recorder for about 12 class periods during each year of the study, if a tape recorder is available. Demands on participating teachers are spelled out in detail in the letter sent to your earth science teacher(s). A copy of this letter is attached for your information and files.

I urge you to encourage your earth science teacher(s) to participate in this important study and if he so elects, to support him in carrying out his responsibilities.

Hugh Templeton

HUGH TEMPLETON

A STUDY OF THE EFFECTS OF THE ADOPTION OF THE SPECIAL EARTH SCIENCE REGENTS SYLLABUS 1970 - 72

Please return form to:

Mr. James Orgren
Department of Geosciences
State University College
1300 Elmwood Avenue
Buffalo, New York 14222

Dear Mr. Orgren:

_______________ Date

____ I shall be unable to participate in the study.

____ I have the permission of my school administration to participate in this project.

Name: ______________________________ (PLEASE PRINT)

School Address		Home Address	
Name of School	____________	Street Address	____________
Street Address	____________	City & Zip	____________
City & Zip	____________	Home Phone	____________
School phone & Ext.	____________		

My teaching assignments are as follows (I've checked or filled in the appropriate lines, or encircled the appropriate response).

1. In 1970-71, I shall be teaching;
   a. Conventional Regents Earth Science ____
   b. Special Regents Earth Science ____
   c. Both ____

2. I (have; have not) taught the Special Earth Science Course before.

3. I (do; do not) expect to teach Regents Earth Science in 1971-72.

4. My Regents science assignment schedule for a typical day in 1970-71 is:

Period	Subject	Regents?	Enrollment (Approx)	Grade Level(s)
____	____	____	____	____
____	____	____	____	____
____	____	____	____	____
____	____	____	____	____
____	____	____	____	____
____	____	____	____	____
____	____	____	____	____
____	____	____	____	____

(Signature)______________________________

November 3, 1970

Dear

My sincere thanks to you for volunteering to share in our study of the effects of adopting the revised version of the New York State Regents Earth Science Syllabus over the next two years. This letter is confirmation of your selection to participate in the study. I am sorry for the delay in this notification. It took more time than anticipated to assemble the samples for the study. However, we now have a good state-wide representation; this should permit an unbiased analysis of the effects of adopting the new syllabus.

Our special thanks to those of you who volunteered for the taping aspects of this study. We randomly selected thirty teachers from among the taping volunteers for this part of the study. Those who were selected should have received their package of tapes by now. If you volunteered for taping and have not received tapes, you can assume that you will not be required to do any recording of classroom sessions.

Enclosed in this packet are materials for the first phase of the study. The Processes of Science Test is to be administered to the students; you are asked to respond to two forms: the Information Form and the Educational Attitude Scale.

The Regents Earth Science section selected for this study is your

____.

If for some reason you select a different group to participate in the study would you please jot your reasons on the "Information Form". It is crucial that the same group of students be used for all aspects of this year's study.

The Processes of Science Test (POST) is obviously not a measure of the students knowledge of earth science. It attempts to measure the students' ability to employ the processes of science. Before administering the test be sure adequate #2 pencils are available for all students. (Use of ink or ball point pen will invalidate the students' answer form. The IBM data processer is blind to anything but pencil). Your guidance staff may have a supply of pencils which you can borrow. The test is to be administered to the entire group at one time; <u>the time limit is 35 minutes</u>. It is not expected that all students will complete the test in this time. If all groups are allowed the same time, however, everyone will be on an equal footing.

Before administering the POST test to the students, would you please explain to them that the State Department of Education is interested in the effect of the earth science curriculum on students. Mr. Orgren, of the State College at Buffalo is conducting a study of these effects. The first portion of this study will consist of taking a test entitled the Processes of Science Test.

Please read the following instructions to the students before you begin the test:

1. You must use a pencil (preferably #2) for this test.

2. Please fill in the name of the school, your name, age, grade and sex across the top of the answer form. (Allow time for everyone to to this).

3. Please make no marks in the test booklet. All answers are to go on the answer form.

4. Please notice that the response space answers for question number 2 are to the right of the answers for question number 1. Be sure that the number on the answer sheet matches the number of the question in the test booklet.

5. Blacken completely the space provided for the response you select on the answer sheet.

6. You will have 35 minutes for this test. It is not expected that all of you will finish. If you do finish early, please read quietly until the signal is given for the end of the test period. Turn in your answer sheets first, then turn in your test booklets.

During the test please be sure all students are using pencils, and that they have understood the directions. Afterwards, please stack the answer forms so that all of the clipped edges are in the same corner.

In completing the Educational Attitude Scale, please use one of the IBM answer forms. If you fill it in while the students are taking the POST instrument, please be sure to separate your answer form from those of your students. On the top of the form, only your name is necessary.

You may fill in the Teacher and Class Information Form, directly on the form itself. All such information, will of course remain in strict confidence.

Please administer the POST, and fill in the other instruments within a week of receipt of the package. If the carton is re-usable, carefully re-pack all materials in it. If not, please use a carton at least as strong. Carefully reseal the package and tape the edge. Affix the return address card. Mail the package at the EDUCATIONAL MATERIALS RATE (this should cost the school less than 50¢).

Again, may I thank you for your participation in this study.

Sincerely,

James Orgren

P.S. Please fill in and return the enclosed post card immediately on receipt of the package. We want to know the speed of delivery and the condition of packages mailed at the educational materials rate.

P.P.S. In order for you to make plans, we will notify you two weeks in advance of the spring mailing.

AUDIO TAPING INSTRUCTIONS

1. Please tape a sequence of six session with the class selected for the study. Complete a log for each session.

2. Include laboratory periods. (see special directions below).

3. Include all class activities, unless a film, field trip, exam, etc. is to take up the entire period. In this event, note film title, nature of field trip... and the date in log; tape an additional session at the end of the sequence.

4. Record at slowest available rate.

5. Placement of the recorder
   a) for large group settings (lecture-discussion, AV presentation, teacher deomonstrations); place the recorder and microphone in the front of the room, to the right of the location where most talking occurs (teacher desk or demonstration table); face the microphone diagonally across the room, toward the opposite rear corner. Turn the volume to the highest setting unless extreme sound distortion is noted from nearby voices. (a trial might help).

   b) for small group settings (lab work, small group discussion); place microphone close enough to one of the small groups that it will pick up their conversation; turn the volume to high so that teacher comments to entire group will be recorded. It is recognized that students will probably "interact" with the microphone to some extent, particularly in the small group setting. This can best be minimized by the teacher ignoring the recorder once it is set up and recording.

6. Preparation of the class for the sequence of tape recordings.

   Mr. Orgren of the State College at Buffalo has asked us to help him in his study of earth science classrooms in New York State. Part of his study will consist of analyzing the discussion and activities that occur in various classrooms. Since he cannot visit classrooms all over the state, he has asked us to tape record a series of six periods for his study. We will begin recording today.

7. Note that the tapes are labelled: 1, 2, and 3. Each tape should be recorded on two sides. Please use tape number 1 for the first two days of the sequence, tape 2 for the third and fourth day, and tape 3 for the last two days. Please make note of the tape number on each days log.

Please use one side for each day!

Room 118, Science Building
State College at Buffalo
1300 Elmwood Avenue
Buffalo, N.Y. 14222
3 May 1971

Dear

May is upon us; the vernal equinox has come and gone, though many sections of New York State have yet to feel the warm breath of spring. Despite the uncooperative weather, the close of another school year is now in sight. The time is now for completing the 1970-71 portion of the "Earth Science Classroom Study". This packet contains the materials you will need for this phase of the study. (Those of you who are taping your classroom sessions have received, or will soon receive your spring tapes.)

INSTRUCTIONS:

1. Please return immediately the postcard indicating receipt of the package.

2. Be sure that sufficient #2 pencils are available for each test.

3. It is essential that all tests be administered to the same group which took them in the fall.

4. Please administer the form titled "Classroom Activity Checklist" first, no later than a week after receiving the packet.

   This instrument has two sections: the "Classroom Activity Checklist" and the "Earth Science Test". It is, however, to be administered as a unit, without a break. Students should be able to complete the total of 49 items within a single class period.

   This instrument has three different forms: A, B, C. These forms have already been intermixed in the packet. Therefore, if you will simply distribute them in the order in which you find them, randomization will be preserved.

   Each student should receive one IBM answer sheet on which he will record his answers for both the Checklist and the Earth Science Test. He should mark the top of the answer sheet with A, B, or C (depending on the form he is using) and his grade and sex.

   Please be sure that all students understand the instructions on pages 1 and 2. In particular, be sure that students having Form A begin with answer 1 on the answer sheet, students having Form B begin with answer 53 on the answer sheet, and students having Form C begin with answer 105 on the answer sheet.

5. Please administer the "Processes of Science Test" three or four days after the students have completed the Checklist and Earth Science Test. Each student should mark the top of the answer sheet with "POST", grade, and sex. Please instruct the students to mark 1 on the answer sheet if they select answer A; 2 for B; 3 for C, and 4 for D.
   The items on this test were designed to measure the students' ability to employ the processes of science.
   Students should complete the test within 35 minutes.

6. While the students are working on the Processes of Science Test, would you please complete the "Educational Opinion Scale" on one of the IBM answer forms. Please mark it "Opinion Scale". (It's possible that end-of-the-year outlooks may differ from those held earlier in the year.)

7. NO LATER THAN MAY 30, please return all materials (now completed) to the mailing package.

   (Checklist of items to be returned:)

   ___ 1 set of IBM forms for the Checklist

   ___ 1 set of IBM forms for the Processes of Science Test

   ___ 1 IBM answer sheet for the Educational Opinion Scale.

   ___ 1 set of Classroom Activity Checklist booklets

   ___ 1 set of Processes of Science Test booklets

   ___ 1 identification card: school, teacher and section

8. Tape the return address card to the outside of the mailing envelope.

9. Please seal the mailing package securely. In addition to staples, please use masking or mailing tape to wrap the package the long way. A large number of last fall's packages required re-wrapping at the post office, and a few answer sheets were badly wrinkled.

10. If you would like to know how your students did on the Earth Science Test, please indicate this on your identification card; I will get these results to you as soon as possible.

Let me take this occasion to thank you sincerely for your cooperation in the "Earth Science Classroom Study". There is every indication that the data you are providing will lead to substantial conclusions concerning the effects of the new syllabus on earth science classrooms. Keep up the good work.

We'll be contacting you in the fall about the final phases of the study.

I hope you have a great summer.

Sincerely,

James Orgren
State University College at Buffalo

P.S. Please write your return address on the outside of the packet and mark it "FROM"

EARTH SCIENCE CLASSROOM ACTIVITY CHECKLIST CLASSROOM MEANS
SPRING 1972 GROUP A

UNIT	TEXT RELATED	CLASSROOM TEST RELATED	LAB RELATED	TIME ALLOT	TRUE-FALSE	OVERALL MEAN
102	3.3889	3.1042	3.5000	3.0500	3.0000	3.5556	3.1801
104	3.9268	2.9554	3.3310	3.3857	3.2041	3.2439	3.3086
105	3.7560	3.0431	3.1100	3.2705	2.6275	3.0455	3.1646
106	3.1337	2.9063	2.3958	3.0125	2.6364	2.9789	2.9280
107	3.4878	3.1964	2.9524	3.5090	2.7000	3.2857	3.3141
109	3.5385	3.2143	3.5625	3.6038	3.8947	3.4516	3.5266
110	3.3333	3.3158	3.8055	3.7083	2.7857	3.7606	3.5500
111	3.2.44	3.2520	3.3478	3.3007	3.0741	3.4176	3.3233
112	3.8775	3.0527	3.0200	3.3604	3.0000	3.2800	3.2749
113	3.5379	2.8065	2.8448	3.1451	2.2239	2.4138	2.9214
114	3.7297	3.0792	2.3534	3.6024	2.6364	3.3158	3.3473
116	3.3214	3.146'	3.1786	3.4225	2.9375	3.6909	3.3457
118	3.6567	3.1804	4.0300	3.7267	3.7759	4.1200	3.7048
120	3.4054	3.0294	3.5000	3.2857	2.5000	3.1333	3.1770
121	3.3595	3.317.	3.5652	3.6580	2.7358	3.5217	3.5112
122	3.4705	2.8113	3.3500	3.1920	2.7083	2.7333	3.0892
123	3.5714	3.234.	3.3333	3.5375	3.4286	2.8333	3.3523
125	3.6286	3.2104	3.4444	3.5955	2.7907	3.0556	3.3757
126	3.5567	3.2115	3.5222	3.5831	2.5370	3.3130	3.4335
127	3.5525	3.0687	3.5532	3.4356	2.7018	3.7234	3.3527
401	3.4694	3.2125	3.1875	3.7625	2.9636	3.4000	3.4385
402	3.8158	3.0990	2.7365	3.0751	2.8000	2.8333	2.9836
403	3.5417	3.1875	3.6667	3.5375	3.1071	4.0533	3.5230
404	3.5517	3.4228	3.5455	3.4852	3.1270	3.3396	3.4352
405	3.5365	3.2054	2.3571	2.8393	2.7400	2.7143	2.8949
409	3.7818	3.1322	3.3492	3.5701	2.4474	3.4615	3.3794
410	3.3111	3.1282	2.8372	3.3690	2.6863	2.9770	3.1754
411	3.3585	3.1164	3.7037	3.3848	2.3594	3.5714	3.2895
MEAN	3.5587	3.1300	3.3103	3.4075	2.8618	3.2984	3.3312

N = 28

EARTH SCIENCE CLASSROOM ACTIVITY CHECKLIST CLASSROOM MEANS
SPRING 1972 GROUP B

UNIT	TEXT RELATED	CLASSROOM	TEST RELATED	LAB RELATED	TIME ALLOT	TRUE-FALSE	OVERALL MEAN
201	3.5377	3.1829	3.2337	3.3869	2.8056	3.3089	3.2887
203	3.7000	3.3750	3.8333	3.4600	2.6571	3.4407	3.4194
204	3.7419	2.5814	3.4375	3.5374	3.2778	3.7937	3.5571
205	3.4348	3.1967	3.5435	3.5817	3.5741	3.9565	3.5495
206	3.5000	3.2824	3.4375	3.5775	3.2368	3.9841	3.5356
207	3.6047	3.2679	3.3810	3.2679	2.3542	3.2381	3.2233
208	3.3162	3.4286	3.7500	3.8323	2.9310	4.2323	3.7344
211	3.5161	3.1860	3.5333	3.5000	3.2703	4.2500	3.5345
212	3.0357	3.0000	3.3393	3.4173	3.2121	3.8785	3.3524
213	3.6383	3.3643	3.3125	3.5000	3.4182	3.4167	3.4532
214	3.6136	3.1026	3.4773	3.5358	3.2692	3.8636	3.4312
215	3.4800	3.2205	3.5375	3.3135	2.7273	3.3478	3.2923
216	3.1935	3.2532	3.5965	3.5950	3.5278	4.0667	3.5953
218	3.8435	3.2773	3.3412	3.6889	3.3000	2.9701	3.5112
220	2.9149	3.1301	2.7708	3.3750	3.3750	3.9583	3.3391
222	3.5385	2.8116	3.9231	3.3988	2.7419	3.6923	3.3236
223	3.6000	3.3395	4.1000	3.3939	3.5652	3.5718	3.5261
224	3.2250	3.4000	3.3211	3.7769	3.4468	3.9231	3.6708
225	3.4848	3.5000	2.3710	3.5991	2.8378	3.1017	3.3969
229	3.6389	3.1545	3.8913	3.4575	3.2453	2.8901	3.3524
231	3.0541	3.1053	3.5555	3.4812	3.6512	3.9444	3.4655
501	3.5294	3.1752	3.4314	3.5751	3.2951	3.7692	3.4133
502	3.6591	3.1475	3.3555	3.4883	3.2830	3.6364	3.4716
503	3.1346	3.1690	4.1200	3.5218	3.4262	3.5542	3.5267
504	3.1556	3.5656	3.5444	3.9672	3.6604	4.0870	3.8182
505	3.7548	3.2189	3.5632	3.4694	3.3048	3.4471	3.4326
506	3.3208	3.0486	2.3523	3.5722	3.1290	3.7407	3.4051
507	3.4348	3.4382	3.5333	3.6399	3.3519	3.7660	3.5349
508	3.5556	3.3671	3.3513	3.6895	3.0625	3.9818	3.6209
509	3.6818	3.5345	3.4545	3.5712	3.4000	4.6364	3.7445
510	3.1020	3.3306	3.6250	3.4745	3.4182	3.8261	3.4757
MEAN	3.4575	3.2647	3.5815	3.5435	3.2179	3.7314	3.4892

N = 31

EARTH SCIENCE CLASSROOM ACTIVITY CHECKLIST CLASSROOM MEANS
SPRING 1972 GROUP C

UNIT	TEXT RELATED	CLASSROOM TEST RELATED	LAB RELATED	TIME ALLOT	TRUE-FALSE	OVERALL MEAN
301	3.6667	3.1771	3.5714	3.5125	3.4048	3.6667	3.4779
302	4.0000	3.3647	3.5625	3.5915	2.7143	3.1695	3.4539
303	3.2542	3.0283	3.3246	3.2468	3.5036	3.3260	3.2777
304	3.5589	3.2321	3.7727	3.5747	3.3333	3.8095	3.6145
305	3.1053	2.8993	3.3750	3.1474	2.5882	3.3784	3.0999
306	3.6087	3.2049	4.0444	3.3497	2.4727	3.3556	3.3163
308	3.6528	3.3317	3.9872	3.7846	3.2660	3.7179	3.6567
309	3.2857	3.3636	3.3125	3.5913	3.1500	3.5846	3.5352
312	4.0714	3.5467	3.7143	3.7647	3.7500	3.3571	3.7537
313	3.5345	3.4532	3.5923	3.5562	3.6333	3.5019	3.5344
314	3.9211	3.2718	3.5000	3.4253	2.4615	3.1053	3.3236
316	3.1724	3.0946	3.7500	3.3602	2.9394	3.5926	3.3218
317	3.5179	3.1895	3.3535	3.4541	3.6119	3.5487	3.4291
319	3.1220	3.1792	3.6250	3.2576	2.8043	3.5823	3.2574
320	3.6522	3.2623	3.3444	3.1937	3.5472	3.4828	3.3515
321	3.5094	3.1957	3.8462	3.3497	3.0820	3.4231	3.3554
324	3.6279	3.0714	3.4285	3.2571	3.9375	3.5714	3.3580
326	3.5333	3.4390	4.1567	4.0100	3.0958	4.1864	3.8453
327	3.1136	3.3256	3.5503	3.4393	2.8772	3.2917	3.3473
328	3.5000	3.1449	2.8554	3.3837	3.1803	3.3301	3.2380
601	3.3333	3.2657	3.6481	3.5826	3.5484	4.2075	3.5341
602	3.9333	3.3629	3.0000	3.5705	3.2308	3.5652	3.4895
603	3.3548	3.2093	3.6129	3.7877	2.9722	3.7302	3.5564
605	3.2857	3.3973	4.1538	3.8023	3.5152	4.2000	3.7449
606	3.4717	3.3116	3.3922	3.4783	3.6000	3.7843	3.4327
607	3.3684	3.4063	3.7547	3.3749	3.6750	4.2778	3.8304
608	3.6596	3.1691	3.6458	3.4802	3.1667	3.5532	3.4294
611	3.2333	3.2562	3.4500	3.5113	3.4348	3.4483	3.4259
MEAN	3.5206	3.2573	3.5463	3.5194	3.2320	3.6196	3.4707

N = 28

TAPE ANALYSIS GENERAL INDEX SCORES

	CLASSROOM	FALL 1970	SPRING 1971	FALL 1971	SPRING 1972
GROUP A	401	0.603		2.124	0.220
	402	1.904	1.075	2.279	0.897
	403	0.299	0.428	1.199	0.619
	404	0.451	0.513	3.698	0.996
	405	0.299	0.184	0.201	0.222
	406	0.782	0.459		
	408	0.333	0.257		
	409	0.675	0.258	1.801	0.248
	410	0.771	0.411	0.603	0.287
	411	0.283	0.131	0.382	0.318
	MEAN	0.640	0.412	1.536	0.478
	N	10	9	8	8
GROUP B	501	1.124	1.070		0.352
	502	1.368	0.750		2.680
	503	2.065	2.291		0.757
	504	2.422	2.177		4.815
	505	1.568	0.663		0.475
	506	1.115	1.923		7.976
	508	0.247	0.839		0.402
	509	1.567	0.791		2.161
	510	0.697	0.259		0.546
	MEAN	1.353	1.196		2.240
	N	9	9		9
GROUP C	601	4.534	4.410		1.757
	602	1.040	0.754		1.849
	603	0.994	0.513		0.506
	604	0.637	1.247		
	605	1.952	5.162		1.750
	606	2.556	1.765		0.739
	607	2.001	1.193		2.496
	608				
	611	2.121	0.980		0.688
	MEAN	1.979	2.003		1.398
	N	8	8		7

EDUCATIONAL OPINION SCALE: PROGRESSIVE / TRADITIONAL SCORE
GROUP A

Fall 1970		Spring 1971		Fall 1971		Spring 1972	
Unit	Score	Unit	Score	Unit	Score	Unit	Score
101	1.2809	101	1.2262	101	1.9578	301	1.4557
102	1.6301	102	1.8333	102	1.7344	302	1.5286
103	1.4691	105	1.4474	104	1.7537	303	1.8906
104	1.8281	106	1.2273	106	1.1935	304	1.7903
105	1.5694	108	1.1688	107	1.3655	305	1.8333
106	1.1143	109	2.2115	109	2.1192	306	2.0566
107	1.3857	110	1.5606	110	1.7302	308	2.5490
108	1.4853	111	1.7742	111	1.5441	309	2.0179
109	2.1538	112	1.4744	112	1.7587	312	1.7302
110	1.4478	114	1.2073	113	1.3060	313	1.6462
111	1.9153	115	1.5429	114	1.1951	314	1.2000
112	1.3373	116	1.8254	116	1.7647	316	1.4706
113	1.2689	118	1.4933	118	1.7391	317	1.6935
114	1.2308	120	1.6087	120	1.6857	319	2.8222
115	1.9062	121	1.3924	121	1.4620	320	2.0000
116	2.0492	122	1.2564	123	1.6351	321	1.5993
117	2.2632	123	1.6184	125	1.3333	324	1.9667
118	1.2558	124	1.3846	126	1.5577	326	2.1111
119	1.7241	125	1.3291	127	1.7500	327	1.8889
120	1.3889	126	1.3944	129	1.7657	328	1.4235
121	1.2584	127	1.6190	401	1.9474	601	1.3580
122	1.4384	401	1.4928	402	1.9841	602	1.8281
123	1.5063	402	1.7027	404	1.7031	606	1.9167
124	1.7742	403	1.5652	405	1.7042	605	1.7042
125	1.3214	404	1.5821	409	1.5467	607	1.9692
126	1.5909	405	1.6620	410	1.8496	608	2.1132
127	1.5342	406	1.3418	411	1.3724	611	1.6232
401	2.0926	408	1.3506	MEAN	1.6466	MEAN	1.8217
402	1.6000	410	1.5224	N = 27		N = 27	
403	1.5556	411	1.5976				
404	1.2857	MEAN	1.5138				
405	1.8000	N = 30					
406	1.3117						
408	1.5075						
409	1.5882						
410	1.4648						
411	1.6000						
MEAN	1.5658						
N = 37							

EDUCATIONAL OPINION SCALE: PROGRESSIVE / TRADITIONAL SCORE
GROUP B

Fall 1970

Unit	Score
201	1.3611
202	2.2115
203	1.5077
204	3.0263
205	1.3235
206	1.4507
207	1.1266
208	1.7812
210	1.5205
211	1.0716
212	1.2738
213	1.7353
214	1.6418
216	1.6618
217	1.2532
218	1.3086
220	1.2195
221	1.6885
222	1.3206
223	1.8358
224	2.0345
225	1.3049
227	1.6714
229	1.5972
230	2.0604
231	1.5709
501	1.5362
502	1.4103
503	1.3381
504	2.4200
505	1.8956
506	1.7903
507	1.9016
508	1.9245
509	1.1951
510	1.5672
MEAN	1.6260
N =	36

Spring 1971

Unit	Score
201	1.2410
202	2.8409
204	2.3830
205	1.4391
206	1.5147
207	1.0747
208	1.8281
210	1.6176
211	1.2941
212	1.7162
213	1.5493
214	1.3684
216	2.0566
217	1.1398
218	1.4500
220	1.2619
221	1.0738
222	1.3333
223	1.8689
224	1.7868
225	1.2139
227	1.6111
229	1.5067
230	2.3148
231	1.6087
501	1.6866
502	1.4430
503	1.7562
504	2.5102
505	1.7059
506	1.8814
507	2.2500
508	2.2449
509	1.2152
510	1.6912
MEAN	1.6708
N =	35

Fall 1971

Unit	Score
201	1.5507
203	1.6250
204	1.6115
205	1.6190
206	1.4697
207	1.0588
208	1.7538
209	1.1928
211	1.2614
214	1.4139
215	2.8043
216	1.9636
218	1.3380
220	1.2892
222	1.2750
223	1.8807
224	2.1930
225	1.3366
226	1.6537
229	1.6061
230	1.8966
231	1.5600
501	1.7778
502	1.3293
503	1.8297
504	2.1897
505	1.6279
506	2.0164
507	2.0000
508	2.7674
509	1.1579
510	1.6818
MEAN	1.6791
N =	32

Spring 1972

Unit	Score
201	1.3158
203	1.5455
204	1.8545
205	1.4265
206	1.3494
207	1.0941
208	1.6104
212	1.5068
213	2.0167
214	1.5785
215	3.1989
216	1.9138
218	1.3375
220	1.2683
222	1.2593
223	1.9500
224	1.9180
225	1.3165
229	1.5070
231	1.3721
501	1.6818
502	1.3846
503	1.4384
504	2.4423
506	1.6814
507	1.8871
508	1.8333
509	1.1310
510	1.5588
MEAN	1.6337
N =	29

EDUCATIONAL OPINION SCALE: PROGRESSIVE / TRADITIONAL SCORE
GROUP C

Fall 1970

Unit	Score
301	1.5352
302	1.6818
303	1.7746
304	1.5375
305	2.0179
306	2.3727
308	2.4118
309	2.1071
310	1.6308
311	1.8983
312	1.6875
313	1.8197
314	1.3582
316	1.4776
317	1.5507
318	2.1724
319	2.4172
320	1.8065
321	1.5797
323	2.3542
324	1.9153
325	1.3947
326	2.3830
327	2.1579
328	2.0536
601	1.2317
602	1.6418
603	1.6081
604	2.1111
605	1.7424
606	1.8095
607	1.9219
611	1.8615
MEAN	1.8492
N =	33

Spring 1971

Unit	Score
301	1.9048
302	1.5050
303	2.2632
304	1.6316
305	1.7213
306	2.0192
308	2.7391
309	1.9138
310	2.2308
311	1.7377
312	1.5070
314	1.1875
316	1.5347
317	1.5821
318	1.6197
319	2.8140
320	2.2979
321	1.7797
323	1.8305
324	2.2321
325	1.5429
326	2.3469
327	1.8525
328	1.7692
601	1.4250
602	1.7353
603	1.7059
604	2.4200
605	1.9077
606	2.4800
607	2.0152
608	2.0600
611	1.9508
MEAN	1.9171
N =	33

Fall 1971

Unit	Score
301	1.6087
302	1.4225
303	2.1167
304	1.8636
305	1.7797
306	2.4583
308	2.4038
309	1.9895
312	1.8000
313	1.4870
314	1.3803
316	1.5070
317	1.6750
319	2.7778
320	2.2308
321	1.7627
324	2.1053
326	2.0645
327	2.4898
328	1.7887
601	1.3214
602	1.7846
603	1.7353
605	1.9077
607	2.1228
608	3.5453
611	1.6377
MEAN	1.9543
N =	27

Spring 1972

Unit	Score
102	1.8852
104	1.3462
105	1.3750
106	1.2029
107	1.4028
109	2.5000
110	1.9153
111	1.8600
112	1.6316
113	1.3659
114	1.2024
116	1.8030
118	1.5600
120	1.4722
121	1.4125
123	1.5385
125	1.3210
126	1.3291
127	1.6780
129	.6383
401	1.7031
402	1.7361
403	1.4429
404	1.4085
405	1.6667
409	1.4342
410	1.2533
411	1.5152
MEAN	1.5214
N =	28

PROCESSES OF SCIENCE TEST RELEVANT ITEMS
GROUP A

UNIT	FALL 1970	SPRING 1971	FALL 1971	SPRING 1972
101	19.38	20.30		
102	17.11	18.73	19.90	20.89
103	19.00	19.84	0.00	
104	17.22	16.61	15.62	17.19
105	14.40	15.44	13.52	16.55
106	15.78	16.55	16.16	14.57
107	18.63	21.97	18.62	20.10
108	19.56	20.04		
109	14.18	11.40	14.00	13.62
110	18.80	21.10		18.50
111	15.53	13.14	15.57	10.91
112	16.37	16.08	13.88	14.50
113	18.45	19.08	18.96	19.37
114	17.91	17.06	15.84	17.25
115	16.17	16.11		
116	11.58	12.69	16.19	11.79
117	16.59			
118	18.28	20.65	18.96	20.16
119	11.70	10.33		
120	16.31	12.60	17.90	12.71
121	16.40	18.22	15.81	20.09
122	17.76	19.37	12.61	14.50
123	9.06	11.14	17.45	17.18
124	18.81	20.23		
125	17.74	20.13	16.12	20.00
126	20.27	20.97	15.87	18.22
127	16.67	16.35	14.74	14.42
401	17.05	18.21	17.27	20.30
402	19.15	19.78	18.16	16.83
403	16.91	15.71	18.85	21.00
404	17.31	17.29	17.96	19.31
405	15.38	16.76	17.39	18.43
406	15.89	16.95		
408	14.63	11.50		
409	16.30	17.34	19.09	20.03
410	17.57	18.00	18.82	18.95
411	19.77	20.83	18.93	20.58
MEAN	16.75	17.18	16.22	17.43
N	37	36	28	28

PROCESSES OF SCIENCE TEST RELEVANT ITEMS
GROUP B

UNIT	FALL 1970	SPRING 1971	FALL 1971	SPRING 1972
201	17.53	19.87	17.73	17.74
202	18.14	18.19		
203	15.59	18.41	18.57	21.47
204	18.00	19.74	18.00	19.00
205	15.81	16.68	16.28	18.44
206	20.20	22.14	15.18	17.87
207	19.05	20.50	16.50	21.40
208	18.69	20.52	13.41	18.65
209	14.64		13.11	
210	12.06	11.22		
211	17.55	19.50	16.29	15.75
212	15.96	16.12	15.11	14.86
213	16.72	15.35	14.58	18.54
214	13.32	13.74	15.50	19.05
215	18.19		14.87	14.48
216	19.39	21.32	16.00	18.33
217	17.62	18.76		
218	15.09	19.70	15.63	16.41
219	14.71			
220	15.92	16.91	18.24	17.85
221	16.62	17.42		
222	17.12	19.87	17.64	19.42
223	18.71	21.33	17.75	19.18
224	17.85	19.07	16.83	19.40
225	16.47	17.53	15.38	18.13
227	13.67		17.27	
229	19.45	20.35	17.38	17.55
230	18.81	16.32	14.55	
231	17.61	18.14	16.65	16.67
501	18.45	17.79	14.12	17.36
502	19.68	20.48	14.80	11.78
503	16.95	16.42	16.53	19.26
504	18.75	19.05	18.13	19.26
505	16.67	18.96	18.19	
506	18.30	19.57	17.50	19.69
507	14.50	14.04	15.83	15.90
508	18.00	18.56	18.15	18.36
509	17.53	18.27	18.58	20.56
510	18.23	19.83	16.96	16.10
MEAN	17.12	18.33	16.39	18.02
N	39	35	34	30

PROCESSES OF SCIENCE TEST RELEVANT ITEMS
GROUP C

UNIT	FALL 1970	SPRING 1971	FALL 1971	SPRING 1972
301	20.55	20.68	18.91	20.88
302	18.50	20.87	15.80	19.21
303	12.89	14.83	15.30	20.08
304	16.19	13.19	15.86	19.71
305	16.17	16.74	18.24	19.08
306	19.08	21.09	16.73	19.50
308	17.96	17.92	17.05	18.86
309	17.65	19.38	17.55	18.94
310	21.80	20.74		
311	20.00	22.65	15.56	
312	17.58	19.64	18.14	19.14
313	17.58	19.71	17.50	19.77
314	16.17	16.73	16.57	19.81
316	16.05	17.47	18.33	18.56
317	19.21	18.96	16.60	19.81
318	16.41	18.30	15.32	0.00
319	16.47	16.18	17.59	20.75
320	16.46	14.17	13.14	14.21
321	18.82	18.74	15.50	15.68
322	15.11			
323	19.25	19.93		
324	15.40	15.29	16.24	16.35
325	17.47	10.13		
326	15.75	19.67	15.59	18.00
327	14.68	15.04	16.70	14.65
328	18.52	21.08	18.41	21.37
601	17.31	19.75	18.84	18.28
602	16.76	17.21	17.77	18.43
603	21.67	21.60		21.27
604	16.25	15.69		
605	19.24	19.33	21.23	20.00
606	21.04	22.18	20.00	21.07
607	16.41	17.35	16.65	17.52
608	16.52	17.82	16.04	17.39
611	17.25	18.38	14.06	16.47
MEAN	17.55	18.19	16.93	18.09
N	35	34	29	29

71 CONTENT, GROUP A

UNIT	71 OLD	71 NEW
101	.5952	.6143
102	.4800	.5000
103	.5564	.5729
104	.5102	.4312
105	.4681	.4981
106	.4560	.4270
107	.6421	.6632
108	.6437	.7167
109	.3927	.3727
110	.6618	.6917
111	.4966	.5503
112	.4540	.4561
113	.6449	.6870
114	.6324	.6471
115	.4884	.4596
116	.3232	.3333
118	.6586	.6721
119	.4004	.3547
120	.5328	.5354
121	.4595	.4286
122	.5244	.5259
123	.4317	.4348
124	.6095	.6720
125	.5080	.5182
126	.5197	.5457
127	.4712	.4286
401	.5889	.5851
402	.5111	.5222
403	.5277	.5619
404	.5918	.5947
405	.5370	.5630
406	.5658	.6000
408	.4489	.4409
409	.6158	.6945
410	.5407	.5442
411	.5620	.5925
MEAN	.5292	.5399

N = 36

72 CONTENT, GROUP A

UNIT	72 OLD	72 NEW
102	.4916	.4358
104	.4569	.3990
105	.4625	.4470
106	.4367	.4195
107	.5465	.5657
109	.3625	.3250
110	.5071	.4602
111	.4374	.4083
112	.4364	.3633
113	.6135	.5098
114	.5529	.5291
116	.4588	.4236
118	.5486	.4713
120	.4324	.3735
121	.5054	.4870
122	.3214	.2000
123	.3924	.3846
125	.4958	.4511
126	.4561	.4035
127	.4743	.4000
401	.5316	.4703
402	.4471	.4096
403	.5343	.4750
404	.5284	.4565
405	.5721	.5298
409	.6279	.5346
410	.5330	.5591
411	.6093	.5337
MEAN	.4919	.4535

N = 28

1972 REGENTS SCORES

106	67.63
109	66.13
110	77.17
112	68.85
114	73.97
116	74.53
121	73.35
404	85.59
MEAN	73.40
N	8

71 CONTENT, GROUP B

UNIT	71 OLD	71 NEW
201	.5547	.5673
202	.5022	.4561
203	.4657	.3963
204	.4720	.4024
205	.4659	.4160
206	.5632	.4818
207	.4264	.3023
208	.5481	.4673
210	.3753	.3402
211	.5556	.5292
212	.4865	.4813
213	.4449	.3761
214	.4716	.4576
216	.5766	.5045
217	.6072	.5743
218	.5000	.4316
220	.5363	.5300
221	.5109	.4847
222	.6031	.5812
223	.5819	.4966
224	.5364	.4478
225	.5627	.5833
227	.4634	.4255
229	.5932	.6022
230	.4677	.3791
231	.4143	.3188
501	.5026	.4526
502	.5823	.4819
503	.4990	.4578
504	.5250	.4545
505	.5538	.5161
506	.5476	.5327
507	.4393	.3467
508	.4697	.3862
509	.5126	.4015
510	.4773	.4074
MEAN	.5110	.4575

N = 36

72 CONTENT, GROUP B

UNIT	72 OLD	72 NEW
201	.5032	.5151
203	.6000	.5458
204	.4890	.3433
205	.4637	.3567
206	.4625	.3312
207	.4795	.3667
208	.5392	.4413
211	.4875	.4125
212	.5135	.4794
213	.4662	.4242
214	.5795	.5227
215	.3404	.2341
216	.5533	.4800
218	.4586	.3509
220	.4237	.3729
222	.5231	.4515
223	.5131	.5306
224	.5260	.4444
225	.4824	.5064
229	.5526	.5198
231	.4397	.4094
501	.4912	.5313
502	.4088	.3442
503	.5774	.5204
504	.5289	.4775
505	.4408	.4067
506	.5149	.5019
507	.4570	.3347
508	.5495	.4963
509	.5583	.4904
510	.4521	.3712
MEAN	.4960	.4382

N = 31

1972 REGENTS SCORES

205	79.42
207	81.71
211	85.82
214	82.23
220	79.63
222	81.79
506	76.29
509	86.72
MEAN	81.70
N	8

71 CONTENT, GROUP C

UNIT	71 OLD	71 NEW
301	.5974	.5371
302	.6143	.5524
303	.3171	.2722
304	.4572	.3958
305	.5100	.4550
306	.5789	.5487
308	.4716	.3824
309	.4279	.3430
310	.6000	.5231
311	.5405	.5000
312	.4700	.3500
313	.4312	.3806
314	.4956	.5235
316	.5026	.4415
317	.4848	.4113
318	.4809	.3606
319	.5141	.4562
320	.4310	.3619
321	.5011	.4636
323	.5235	.4409
324	.3596	.3125
325	.4933	.4247
326	.4856	.4275
327	.4108	.3610
328	.4923	.4000
601	.5879	.5126
602	.4531	.4076
603	.5116	.4593
604	.5185	.4932
605	.5895	.5120
606	.5451	.4533
607	.4457	.3672
611	.4837	.3970
MEAN	.4947	.4311

N = 33

72 CONTENT, GROUP C

UNIT	72 OLD	72 NEW
301	.4958	.4222
302	.5094	.4625
303	.5034	.4271
304	.5031	.4682
305	.4726	.4413
306	.5022	.4044
308	.5275	.4615
309	.5000	.3938
312	.5108	.4317
313	.5356	.4208
314	.6054	.5011
316	.4708	.4222
317	.5220	.4857
319	.4835	.4573
320	.3192	.2558
321	.5097	.4749
324	.3584	.3590
326	.5017	.5203
327	.5053	.4873
328	.5173	.4615
601	.5151	.4521
602	.4683	.4174
603	.5144	.4323
605	.6212	.5878
606	.5651	.4903
607	.4157	.3750
608	.4382	.3875
611	.3799	.3527
MEAN	.4921	.4425

N = 28

1972 REGENTS SCORES

306	83.36
309	83.35
313	77.81
316	76.38
323	87.73
327	73.24
602	64.67
MEAN	78.08
N	7

EARTH SCIENCE CLASSROOM ACTIVITY CHECKLIST

FORM A

The purpose of this checklist is to determine how well students can describe what activities occur in their Earth Science classrooms. Each statement on the following pages describes some classroom or laboratory activity. The activities are not judged as either good or bad. Therefore THIS CHECKLIST IS NOT A TEST AND IS NOT DESIGNED TO GRADE EITHER YOU OR YOUR TEACHER. Please read each statement and carefully select the answer that best described the activities in your class.

SAMPLE QUESTION:

Checklist	Answer Sheet:
My teacher takes class attendance	1 2 3 4 5

1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

If this item were on the checklist, you would blacken the space under the number of the answer which best describes how often attendance is taken in your earth science classroom.

DIRECTIONS:

A. All statements should be answered on the answer sheet by blackening the space under the chosen response with a #2 pencil. (Your responses cannot be used if you use a pen.)

B. Please make no marks on the checklist.

C. Please do NOT write your name on the checklist or on the answer sheet.

D. At the top of the answer sheet please record your grade level and sex.

E. Please mark the top of your answer sheet with the letter "A" (because this is form A of the checklist).

When you have carefully read the above instructions, please turn the page.

ADDITIONAL INSTRUCTIONS:

F. Please note that on the answer sheet, the responses for question #2 lie to the right of the responses for question #1, etc.

G. Please find answer number 1 on your answer sheet. You will record your first answer in this place, since Form A begins with item #1.

Questions related to the text (or readings)

1. When reading the text, we are expected to learn the details that are stated there.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*2. Our teacher encourages us to ask questions of the text.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

Questions related to Classroom Activities

3. In earth Science Class, we watch films or film strips.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*4. My teacher asks questions that cause us to think about the evidence that is behind statements that are made in the textbook.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

5. If there is a discussion among students, the teacher tells us who is right.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*6. If I don't agree with what my teacher says, I feel free to tell him so.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*7. We read the original writings of scientists.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

Questions relating to tests

*8. Our tests include questions which give us new data and ask us to draw conclusions from these data.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

9. Our tests include questions that ask us to write out definitions of terms.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

* ITEMS MARKED WITH ASTERISK WERE WEIGHTED SO THAT "VERY OFTEN" = 5
UNMARKED ITEMS WERE WEIGHTED SO THAT "VERY OFTEN" = 1

Questions relating to laboratory activities

10. In laboratory, we work individually.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*11. Members of our class are able to help in the preparation of upcoming laboratory exercises.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*12. We spend some time before laboratory in determining the purpose of the experiment.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

13. We know the answer to a laboratory problem that we are investigating before we begin the experiment.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

14. We ask the teacher if we are doing the right thing in our experiment.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*15. The teacher answers our questions about the laboratory work by asking us questions.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

16. In the laboratory we are concerned with rock and mineral identification or the study of topographic maps.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*17. We go beyond the regular laboratory exercise and try out things on our own.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*18. We make tables and draw graphs of data that we collect in our investigations.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*19. After a laboratory session we compare the data that we have collected with the data of other individuals or groups.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*20. We spend some time in interpreting the graphs and tables of data that we collect in laboratory.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*21. We do an additional experiment because the data previously collected suggest a new question to us.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*22. I get the best understanding of the nature of scientific investigation from (1) DISCUSSING LABORATORY EXPERIMENTS (2) DOING LABORATORY EXPERIMENTS (3) CLASSROOM DISCUSSION OF EARTH SCIENCE TOPICS (4) CLASSROOM DEMONSTRATIONS BY THE TEACHER OR OTHER STUDENTS (5) LISTENING TO THE TEACHER LECTURE.

Questions related to the amount of time spent in various classrooms and laboratory activities:

23. During regular class, listening to the teacher talk about earth science topics takes up
1. MORE THAN THREE-FOURTHS OF THE TIME 2. BETWEEN ONE-HALF AND THREE-FOURTHS OF THE TIME 3. BETWEEN ONE-FOURTH AND ONE-HALF OF THE TIME 4. LESS THAN ONE-FOURTH OF THE TIME 5. HARDLY ANY OF THE TIME

*24. In the laboratory, we gather and analyze data
1. MORE THAN THREE-FOURTHS OF THE TIME 2. BETWEEN ONE-HALF AND THREE-FOURTHS OF THE TIME 3. BETWEEN ONE-FOURTH AND ONE-HALF OF THE TIME 4. LESS THAN ONE-FOURTH OF THE TIME 5. HARDLY ANY OF THE TIME

25. On the average, we have laboratory about
1. ONCE A MONTH OR LESS 2. ONCE EVERY TWO WEEKS 3. ONCE A WEEK 4. TWICE A WEEK 5. MORE THAN TWICE A WEEK

Questions requiring the response TRUE or FALSE

26. Our experiments never require us to collect data for several days or weeks.
1. TRUE 2. FALSE

27. In our earth science course we study each part separately: air, land, sea and sky.
1. TRUE 2. FALSE

*28. The students in our class seem to feel that the laboratory is the most important part of our earth science course.
1. TRUE 2. FALSE

*29. We had night sky observation session(s) this year.
1. TRUE 2. FALSE

ADDITIONAL INSTRUCTIONS:

F. Please note that on the answer sheet, the responses for question 54 lie to the right of the responses for question 53, etc.

G. Please find answer number 53 on your answer sheet. You will record your first answer in this place, since Form B begins with item #53.

Questions related to the text (or readings)

*53. Beyond the text and the teacher's notes, our classroom discussions are based on other sources of earth science information.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

54. We are required to outline sections of the text.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*55. My teacher asks us to explain the meaning of things in the text.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

Questions related to classroom activities

*56. My teacher asks questions that cause us to think about the things that we have learned in other parts of the course.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*57. If I don't agree with what my teacher says, I feel free to tell him so.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

58. We are required to write out definitions to word lists.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*59. When we discuss a scientist's conclusions, we discuss the evidence that is behind them.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*60. In our Earth Science course we study several parts of the earth at the same time to see how they work together.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

Questions relating to tests

*61. Our tests include questions that ask us to figure out answers to new problems.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*62. Our tests include questions based on things we have learned in the laboratory.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

Questions relating to laboratory activities

*63. In laboratory, we work in teams or in small groups.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

64. The teacher or other students do the experiments that are in the laboratory manual while the class watches.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*65. The laboratory comes before we talk about the specific topic in class.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

66. My teacher tells us step-by-step what we are to do in the laboratory.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*67. We use the laboratory to investigate a problem that comes up in class.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

68. We can answer our laboratory work questions by finding the answers in the text.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

69. Our laboratory consist of thorougly learning the names of topographic features or gelogic eras.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*70. We are able to set our own pace when doing a laboratory investigation.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*71. The laboratory includes activities that make it possible for us to discover things for ourselves.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*72. If our first attempts to do an experiment were careless and sloppy, we do it over again.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

73. The neatness of our data books is graded by our teacher.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*74. The data that I collect are different from data that are collected by other students.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*75. We analyze the conclusions that we have drawn in the laboratory.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

Questions related to the amount of time spent in various classroom and laboratory activities:

*76. In our earth science course, we are doing laboratory work
1. MORE THAN THREE-FOURTHS OF THE TIME 2. BETWEEN ONE-HALF AND THREE-FOURTHS OF THE TIME 3. BETWEEN ONE-FOURTH AND ONE-HALF OF THE TIME 4. LESS THAN ONE-FOURTH OF THE TIME 5. HARDLY ANY OF THE TIME

77. The number of field trips we took this year was
1. NONE 2. ONE 3. TWO 4. THREE 5. FOUR OR MORE

<u>Questions requiring the responses TRUE or FALSE</u>

78. If we get the wrong answer for an experiment, we have to do it over again, even if we were careful the first time.
1. TRUE 2. FALSE

*79. There are two or three ideas that come up again and again as we study various topics in Earth Science.
1. TRUE 2. FALSE

80. During labs I get help more often from the teacher than from other students.
1. TRUE 2. FALSE

81. Maps, models and wall charts are the lab equipment we use most often in our laboratory exercises.
1. TRUE 2. FALSE

ADDITIONAL INSTRUCTIONS:

F. Please note that on the answer sheet, the responses for question 106 lie to the right of the responses for question 105, etc.

G. Please find answer number 105 on your answer sheet. You will record your first answer in this place, since Form C begins with item #105.

Questions related to the text (or readings)

*105. When reading the text, we are expected to look for the main problems and for the evidence that supports them.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

Questions related to classroom activities

106. My teacher repeats almost exactly what the textbook says.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*107. My teacher admits his mistakes.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

108. I copy down and memorize what the teacher tells us.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*109. Classroom demonstrations are done by students (rather than by the teacher).
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*110. We discuss the problems faced by scientists in the discovery of a scientific principle.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

111. We can learn about a new topic in earth science without having to refer to things we learned in earlier topics in earth science.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

Questions relating to tests

112. Our tests include questions which ask us to put labels on maps or diagrams.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*113. Our tests include questions that ask us to relate things that we have learned at different times.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

Questions relating to laboratory activities

*114. Our laboratory work is related to topics we study in class.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*115. We are asked to design our own experiment to answer a question that puzzles us.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

116. We are encouraged to read up on an experiment before we do it in order to find the answer ahead of time.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*117. When we have laboratory, we have equipment to set up.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

118. Our teacher explains exactly what results we should expect from an investigation.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

119. Our teacher is busy grading papers or doing some other personal work while we are working in the laboratory.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*120. The laboratory provides opportunities to identify and define problems to be investigated.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

121. We use laboratory time to define earth science terms and to learn these definitions.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*122. We record our data at the time we make our observations.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

123. We copy the purpose, materials, and procedures used in our experiments from the laboratory manual.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*124. We talk about what we have observed in the laboratory within a day or two of the laboratory session.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*125. The class is able to explain unusual data collected in the laboratory.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*126. When analyzing the data from one of our experiments, we are aksed to make predictions about what might happen in related experiments.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

*127. In our laboratory activities, I feel that I am participating in real scientific investigations.
1. VERY OFTEN 2. OFTEN 3. SOMETIMES 4. SELDOM 5. HARDLY EVER

Questions related to the amount of time spent in various classroom and laboratory activities:

*128. During regular class, discussions between the teacher and the students take up
1. MORE THAN THREE-FOURTHS OF THE TIME 2. BETWEEN ONE-HALF AND THREE-FOURTHS OF THE TIME 3. BETWEEN ONE-FOURTH AND ONE-HALF OF THE TIME 4. LESS THAN ONE-FOURTH OF THE TIME 5. HARDLY ANY OF THE TIME

129. In the laboratory, we listen to the teacher
1. MORE THAN THREE-FOURTHS OF THE TIME 2. BETWEEN ONE-HALF AND THREE-FOURTHS OF THE TIME 3. BETWEEN ONE-FOURTH AND ONE-HALF OF THE TIME 4. LESS THAN ONE-FOURTH OF THE TIME 5. HARDLY ANY OF THE TIME

Questions requiring the responses TRUE or FALSE

130. We have laboratory only on a regularly scheduled basis (such as every Friday, etc.)
1. TRUE 2. FALSE

*131. Our teacher gives the impression that the laboratory is the most important part of our earth science course.
1. TRUE 2. FALSE

132. We spend more laboratory time studying old weather maps than collecting data on current weather.
1. TRUE 2. FALSE

*133. We work with a large variety of equipment, from sand, soil and water to things like stopwatches, balances and thermometers.
1. TRUE 2. FALSE

TABLE A

PLANNED INDEPENDENT CONTRASTS ON ITEMS OF THE ACTIVITY CHECKLIST FOR GROUP A VS GROUPS B & C, SPRING 1971

Item	Means A	Means B	Means C	SS Compare	MSW	F Ratio
1	1.97	2.36	3.93	5.39	.427	12.60*
2	3.60	3.45	3.53	2.23	.479	.48 ns
3	2.83	3.15	4.02	3.18	.667	.27 ns
4	3.62	3.71	3.49	.17	.411	.42 ns
5	2.40	2.93	3.42	8.01	.393	20.35*
6	3.52	3.50	3.07	.35	.318	1.09 ns
7	1.54	1.46	3.44	.06	.171	.39 ns
8	2.67	3.35	3.43	14.98	.420	35.67*
9	3.25	3.83	3.54	10.85	.805	13.48*
10	3.82	4.02	4.68	1.03	.404	2.54 ns
11	2.45	2.48	2.11	.21	.383	.55 ns
12	3.22	3.79	3.14	6.92	.563	12.30*
13	3.71	3.97	4.29	1.20	.203	5.94*
14	2.29	2.20	3.49	.08	.307	.28 ns
15	3.52	3.85	4.19	3.28	.325	10.08*
16	2.37	2.89	4.10	4.49	.231	19.37*
17	1.97	2.13	3.97	.54	.232	2.35 ns
18	2.97	4.46	4.68	49.70	.429	105.71*
19	3.13	3.83	3.64	12.47	.454	27.46*
20	3.04	3.94	4.12	18.34	.375	48.90*
21	1.87	2.07	3.25	1.87	.239	7.81*
22	3.03	3.43	3.40	4.91	.240	20.41*
23	1.80	2.43	3.07	12.27	.577	21.26*
24	3.08	3.79	3.52	3.47	.389	34.59*
25	2.77	3.71	3.49	23.61	.747	31.58*
26	3.29	4.39	3.74	29.32	.843	34.75*
27	2.08	2.77	3.03	16.79	.744	22.56*
28	1.58	3.01	4.10	59.73	.858	69.96*
29	1.55	3.02	4.79	45.98	1.604	28.66*
53	3.06	3.40	3.42	2.98	.261	11.43*
54	4.50	4.48	4.68	.16	.382	.43 ns
55	3.64	3.37	3.21	2.90	.536	5.41*
56	2.56	2.96	2.81	3.13	.245	12.76*
57	3.44	3.44	3.55	.07	.382	.20 ns
58	4.11	4.10	4.52	1.00	.738	1.35 ns
59	3.85	4.07	3.97	.66	.312	2.14 ns
60	3.01	3.16	3.27	1.00	.332	3.03 ns
61	2.63	2.75	2.99	1.37	.379	3.63 ns
62	3.07	4.05	4.08	26.03	.394	64.98*
63	4.22	4.74	4.79	7.15	.326	21.91*
64	4.23	4.32	4.37	.32	.294	1.10 ns
65	2.21	2.86	2.93	11.05	.432	25.58*
66	3.10	2.83	3.07	.58	.764	.76 ns
67	1.96	2.39	2.31	3.48	.268	12.97*

TABLE A --Continued

Item	Means A	B	C	SS Compare	MSW	F Ratio
68	2.74	3.58	3.38	13.28	.404	32.86*
69	3.26	3.84	3.79	7.48	.263	28.46*
70	3.16	3.29	3.55	1.63	.455	3.58 ns
71	3.39	4.01	4.07	10.15	.270	37.58*
72	2.84	3.23	3.17	3.08	.353	8.72*
73	4.17	3.83	4.20	0.61	.807	0.76 ns
74	2.62	3.04	3.04	4.14	.220	18.83*
75	3.44	4.20	4.10	12.00	.366	32.81*
76	2.45	3.59	3.68	33.50	.641	52.56*
77	1.53	1.82	2.19	5.35	.957	5.60*
78	3.34	4.16	3.96	12.33	.809	15.22*
79	4.36	4.55	4.29	0.06	.349	0.20 ns
80	3.87	3.93	3.83	0.00	.648	0.00 ns
81	2.23	3.74	3.25	38.06	1.062	35.82*
105	4.07	4.01	2.53	0.24	.319	0.74 ns
106	2.71	3.19	3.55	10.13	.359	28.21*
107	3.80	3.91	2.68	0.68	.281	2.41 ns
108	3.13	3.32	3.70	1.76	.351	5.00*
109	2.41	3.39	3.04	23.34	.750	31.11*
110	2.80	3.09	3.78	1.90	.342	5.56*
111	3.34	3.60	1.52	0.79	.309	2.54 ns
112	2.68	3.51	3.58	15.12	.522	28.95*
113	3.18	3.59	4.02	3.40	.410	8.28*
114	4.47	4.65	4.05	0.93	.168	5.51*
115	1.73	2.05	2.61	2.82	.319	8.84*
116	3.41	3.19	3.73	1.38	.650	2.12 ns
117	3.00	4.10	3.91	33.57	.454	73.95*
118	3.05	3.49	2.26	4.52	.462	9.78*
119	3.86	4.21	3.94	2.74	.595	4.60*
120	3.61	4.06	2.71	5.34	.187	28.56*
121	3.95	3.90	2.11	0.00	.344	0.00 ns
122	4.04	4.60	4.37	8.51	.228	37.27*
123	3.57	3.63	3.89	0.09	.543	0.17 ns
124	3.54	4.28	3.90	10.27	.694	14.79*
125	2.80	3.36	2.24	5.99	.236	25.40*
126	2.93	3.49	3.54	6.50	.296	21.93*
127	2.66	3.06	2.60	3.81	.360	10.58*
128	3.34	3.52	3.87	0.74	.404	1.84 ns
129	3.39	3.36	3.81	0.03	.357	0.08 ns
130	2.58	3.81	4.41	33.80	2.033	16.63*
131	1.93	3.02	3.07	28.53	1.118	25.51*
132	3.76	4.26	3.33	4.23	.670	6.32*
133	3.77	4.81	2.87	25.08	.511	49.04*

TABLE D

T-TEST OF DIFFERENCES ON ITEMS OF THE ACTIVITY CHECKLIST
FOR GROUP A, SPRING 1971 TO SPRING 1972

Item	Difference of Means	t-Value (Related Groups)	Item	Difference of Means	t-Value (Related Groups)
1	.020	.16 ns	67	.173	1.14 ns
2	.207	1.31 ns	68	.539	2.99*
3	.236	1.68 ns	69	.238	1.37 ns
4	.051	.50 ns	70	.213	1.41 ns
5	.023	.14 ns	71	.259	2.83*
6	-.097	-.63 ns	72	.322	2.35*
7	-.140	-1.40 ns	73	-.129	-.69 ns
8	.768	4.85*	74	.046	.38 ns
9	.206	1.37 ns	75	.574	5.18*
10	-.072	-.45 ns	76	.437	3.23*
11	.914	.95 ns	77	.146	.72 ns
12	.361	2.31*	78	.331	1.42 ns
13	-.065	-.66 ns	79	.260	1.83*
14	-.054	-.33 ns	80	.054	.34 ns
15	-.002	-.02 ns	81	.659	2.76*
16	.367	3.02*	105	-.016	-.14 ns
17	.049	.41 ns	106	.315	3.19*
18	1.047	6.03*	107	-.080	-.52 ns
19	.549	3.30*	108	.017	-.14 ns
20	.604	4.89*	109	.635	3.02*
21	.133	1.19 ns	110	.082	.55 ns
22	.113	.95 ns	111	-.169	-1.12 ns
23	-.024	-.19 ns	112	.344	1.65 ns
24	.384	3.32*	113	.241	1.75*
25	.213	1.69 ns	114	-.032	-.26 ns
26	.589	2.26*	115	.319	2.50*
27	.591	2.49*	116	-.390	-2.49*
28	.701	2.82*	117	.835	4.54*
29	.573	2.81*	118	-.010	-.07 ns
53	.151	1.26 ns	119	.191	.92 ns
54	-.239	-1.90*	120	.217	1.77*
55	.078	.64 ns	121	.068	.39 ns
56	.339	3.04*	122	.462	3.47*
57	-.031	-.29 ns	123	-.160	-.86 ns
58	.046	.29 ns	124	.319	1.95*
59	.189	1.92*	125	.337	3.46*
60	.198	1.58 ns	126	.420	3.52*
61	.156	1.13 ns	127	.280	1.71*
62	.514	4.37*	128	.125	.83 ns
63	.334	2.31*	129	-.224	-1.59 ns
64	.133	1.18 ns	130	.073	.32 ns
65	.470	3.75*	131	.452	1.88*
66	-.285	-1.73*	132	.306	1.38 ns
			133	.813	4.27*

TABLE E

PLANNED INDEPENDENT CONTRASTS ON ITEMS OF THE ACTIVITY CHECKLIST FOR GROUP A VS GROUPS B & C, SPRING 1972

Item	Means A	Means B	Means C	SS Compare	MSW	F Ratio
1	2.27	2.37	2.33	2.08	.575	3.62 ns
2	3.77	3.51	3.54	1.32	.591	2.24 ns
3	2.79	3.04	2.51	0.59	.610	0.96 ns
4	3.31	3.71	3.72	0.01	.430	0.03 ns
5	2.25	2.81	2.78	2.97	.340	8.74*
6	2.78	3.62	3.79	0.75	.289	2.59 ns
7	1.15	1.64	1.65	0.65	.170	3.81 ns
8	2.67	3.54	3.48	0.09	.486	0.19 ns
9	2.79	3.86	4.07	4.65	.719	6.47*
10	3.13	4.04	3.74	0.11	.539	0.21 ns
11	2.22	2.63	2.77	0.02	.471	0.05 ns
12	2.85	3.71	3.61	0.13	.620	0.21 ns
13	3.23	3.97	3.71	0.40	.279	1.45 ns
14	2.53	2.16	2.21	0.06	.202	0.28 ns
15	3.49	3.76	3.91	1.09	.358	3.05 ns
16	2.92	2.73	2.67	0.08	.226	0.36 ns
17	2.23	2.23	2.27	0.59	.284	2.07 ns
18	4.04	4.43	4.32	0.89	.271	3.30 ns
19	3.19	3.85	3.66	0.00	.449	0.00 ns
20	3.66	3.95	3.80	0.18	.293	0.60 ns
21	2.38	2.22	2.33	0.67	.212	3.16 ns
22	3.33	3.48	3.51	0.95	.250	3.80 ns
23	2.02	2.36	2.78	9.03	.518	17.44*
24	3.74	3.84	3.83	0.80	.257	3.11 ns
25	3.25	3.83	3.83	12.04	.692	17.39*
26.	3.59	4.30	4.24	2.33	.807	2.89 ns
27	2.93	2.73	2.64	0.01	.806	0.01 ns
28	2.53	3.32	3.37	18.14	1.372	13.82*
29	1.97	2.86	2.28	6.16	1.430	4.31*
53	3.29	3.48	3.49	0.75	.191	3.95 ns
54	4.37	4.53	4.63	0.78	.274	2.83 ns
55	3.70	3.13	3.12	6.39	.589	10.86*
56	2.90	2.95	3.04	0.19	.239	0.81 ns
57	3.43	3.62	3.76	1.30	.350	3.73 ns
58	4.14	4.41	4.39	1.23	.490	2.51 ns
59	4.05	4.07	3.97	0.01	.267	0.05 ns
60	3.20	3.15	3.22	0.00	.266	0.01 ns
61	2.76	2.85	3.03	0.59	.326	1.80 ns
62	3.63	4.11	4.14	4.67	.384	12.19*
63	4.63	4.08	4.69	0.27	.159	1.70 ns
64	4.34	4.21	4.18	0.42	.423	0.99 ns
65	2.64	2.91	2.64	0.33	.563	0.59 ns
66	2.71	2.93	2.90	0.85	.671	1.27 ns
67	2.19	2.43	2.39	0.87	.276	3.16 ns

TABLE E --Continued

Item	Means A	B	C	SS Compare	MSW	F Ratio
68	3.32	3.48	3.33	0.21	.423	0.29 ns
69	3.45	3.92	3.74	2.70	.442	6.09*
79	3.54	3.22	3.69	0.13	.398	0.33 ns
71	3.82	4.03	4.03	0.88	.259	3.38 ns
72	3.26	3.40	3.56	0.93	.399	2.33 ns
73	4.08	3.83	4.24	0.03	.889	0.04 ns
74	2.69	3.06	2.85	1.25	.216	5.77*
75	4.11	4.34	4.09	0.24	.321	0.73 ns
76	2.99	3.71	3.64	8.76	.455	19.25*
77	1.81	1.85	1.96	0.17	.929	0.18 ns
78	3.67	3.96	3.46	0.03	1.051	0.03 ns
79	4.65	4.66	4.43	0.20	.265	0.77 ns
80	3.90	4.03	3.74	0.01	.664	0.01 ns
81	2.83	3.60	3.26	6.83	.883	7.73*
105	4.09	3.83	3.82	1.35	.407	3.31 ns
106	2.99	3.30	3.30	1.80	.381	4.73*
107	3.78	3.63	3.94	0.00	.416	0.00 ns
108	3.13	3.33	3.26	0.49	.438	1.12 ns
109	3.15	3.44	3.24	0.71	.592	1.20 ns
110	2.91	2.99	2.88	0.02	.357	0.05 ns
111	3.18	3.51	3.44	1.71	.256	6.66*
112	3.05	3.45	3.38	2.44	.715	3.42 ns
113	3.43	3.57	3.72	0.90	.303	2.98 ns
114	4.47	4.63	4.69	0.71	.122	5.86*
115	2.04	2.33	2.33	1.59	.435	3.65 ns
116	3.00	3.12	2.87	0.00	.598	0.00 ns
117	3.92	4.23	4.17	1.46	.419	3.49 ns
118	3.05	3.29	3.42	1.78	.426	4.17*
119	4.01	4.09	3.99	0.02	.578	0.03 ns
120	3.91	4.08	4.07	0.50	.229	2.16 ns
121	4.10	3.92	3.71	1.49	.285	5.24*
122	4.48	4.72	4.58	0.59	.137	4.31*
123	3.33	4.27	3.88	5.61	.524	10.70*
124	3.93	4.12	3.99	0.29	.591	0.49 ns
125	3.21	3.24	3.15	0.01	.325	0.02 ns
126	3.40	3.36	3.44	0.00	.230	0.00 ns
127	2.98	3.03	2.98	0.02	.389	0.04 ns
128	3.48	3.54	3.49	0.02	.432	0.04 ns
129	3.21	3.30	3.27	0.10	.305	0.33 ns
130	2.55	3.49	3.75	21.69	1.831	11.84*
131	2.42	2.81	3.05	4.89	1.165	4.20*
132	4.09	4.16	4.12	0.06	.728	0.08 ns
133	4.64	4.83	4.80	0.61	.189	3.22 ns

APPENDIX F

TAPE ANALYSIS INSTRUMENT SCORES

The scores obtained from the Tape Analysis Instrument are ratios in which the number of tallies from a selected category or categories are compared to the number of tallies in some larger set of categories, of which the selected category (categories) is a subset. Categories selected from the numerator of each ratio are given first in the following list of score descriptions. In most cases, the denominator, or base for the ratio, was the total number of tallies, after the exclusion of "small group" and "uncategorized" behavior tallies. Scores with this denominator are followed by "(1)". Scores which used all but "uncategorized" tallies as denominator are followed by "(2)". Scores which used tallies from some smaller set of categories as denominator (indicated in the latter part of the description) are marked "(3)".

Derivation of the General Index Score is described in the section of the study of "Instruments": "Tape Analysis Instrument".

Overall

*1. General Index Score

Scores In Which Activity Dimension Predominates

Laboratory related activities

*2. All laboratory related activity[1]

*3. All pre-laboratory discussion[1]

*4. All small group laboratory activities[2]

*5. Small group laboratory activities: proportion or pre-laboratory and laboratory time devoted to them.[3]

*6. All post-laboratory discussion[1]

Lecture-discussion related activities

7. All lecture discussion[2]

Scores In Which Level And Subject Dimension Predominates

Higher level

*8. All higher level discussion[1]

*9. Higher level lab-related discussion: 1

*10. Higher level lab-related discussion: proportion of it in laboratory related discussion category[3]

*11. Higher level lecture discussion[1]

*12. Higher level lecture discussion: proportion of it in lecture discussion category[3]

*13. Higher level student questions (1)

*14. Higher level teacher questions (1)

Knowledge and translation

15. All knowledge and translation (1)

16. All knowledge and translation which is lab-related (1)

17. All knowledge and translation which occured within lecture discussion category (1)

Subject

*18. All discussion dealing with laboratory procedures (1)

*19. All discussion dealing with observations and data (1)

Scores In Which Speaker And Mode Dimension Predominate

Student speaker

*20. All student verbal behavior (1)

*21. All student initiated student talk (1)

*22. All student questions (1)

*23. Student laboratory procedure questions: proportion of them in pre-laboratory category. (3)

*24. All student responding verbal behaviors (1)

Teacher speaker: general categories

25. All teacher verbal behavior (1)

26. All teacher initiated teacher talk (1)

27. All teacher questions (1)

28. All teacher response (1)

Teacher speaker: in specific categories

29. Teacher verbal behavior in lecture discussion format (3)

30. Teacher verbal behavior in higher level prelab category (3)

31. Teacher verbal behavior in lab observations & data, in post lab. (3)

32. Teacher verval behavior in post lab, higher level laboratory discussion (3)

33. Teacher verbal behavior in lecture discussion, higher level (3

34. Teacher verbal behavior in pre-lab (3)

35. Teacher verbal behavior in post-lab (3)

36. Teacher verbal behavior in laboratory (3)

*Scores marked with an asterisk are those whose relatively high frequency is advocated by the developers of the new science curricula.

147

LECTURE DISCUSSION, POST LABORATORY LECTURE DISCUSSION, POST LABORATORY

LAB RELATED	PROCEDURES & DIRECTIONS (LAB, POSTLAB)	H	
	LAB OBSERVATIONS & DATA: DISCUSSION, TREATMENT	J	
	LAB KNOWLEDGE & TRANSLATION	K	
	LAB: HIGHER LEVEL	L	
LECTURE, DISCUSSION	KNOWLEDGE AND TRANSLATION	M	
	HIGHER LEVEL	N	
	UNCATEGORIZED	P	

TEACHER NUMBER ________ COLOR ______ LETTER ___ ANALYST ____________ ANALYSIS DATE __________ PAGE ______

Speaker and Mode Code:

2. Question by Teacher
3. Question by Student
6. Response to question, by Teacher
7. Response to question, by Student
8. Statement by Teacher
9. Statement by Student
1. Tallies for uncategorized, Teacher talk in Small Group, and Small Group Laboratory

PRE LABORATORY, LABORATORY

LARGE GROUP	LAB PROCEDURE, DIRECTIONS	A	
	OBSERVATIONS, DATA	B	
	KNOWLEDGE, TRANSLATION	C	
	HIGHER LEVEL	D	
SMALL GROUP	DISTINCT TEACHER TALK IN SMALL GROUP	E	
	STUDENT ACTIVITY & DISCUSSION	F	
	UNCATEGORIZED	G	

TEACHER NUMBER ____ COLOR ______ LETTER __ ANALYST ________________ ANALYSIS DATE ______ PAGE ______

Speaker and Mode Code:
2. Question by Teacher
3. [redacted] by Student [redacted]
1. Fillers or Uncategorized, [redacted]
6. Response to question, by Teacher
7. Response to question by Student [redacted]
[redacted] Teacher Talk in Small Group, [redacted]
8. Statement by Teacher
9. Statement by Student [redacted]
[redacted] Small Group Laboratory

TAPE ANALYSIS INSTRUCTIONS

I. Format Decision Aids

1. Check log sheet
2. Set tape footage indicator to 0
3. Listen to short segment of tape without analyzing; if in midst of tape, note footage indicator and phrase employed to identify location on tape, before moving ahead.
4. If tape begins with student noise for several feet, use Lab Format; if subsequent events indicate that Lecture-Discussion, Post-lab should have been used, transfer tallies to appropriate categories on the latter form, and continue analysis.
5. If pre-lab extends beyond sixty tallies or so (five minutes), spot check (after noting footage and phrase) to determine if the lab follows; an extended "pre-lab" with minimal reference to the upcoming lab should be coded under Lecture Discussion.
6. Lab begins when the students actually begin to DO something--usually signified by breaking into small groups.
7. If after lab has begun, the teacher dominates the whole group from time to time, these segments should be recorded under Laboratory--Large Group.
8. When the teacher calls the whole group to attention, to begin extended discussion, analysis and interpretation of data, Post-Lab ahs begun, and should be recorded on the Post-lab, Lecture-Discussion form.
9. Movies

   Classify all pre and post movie discussion

   Treat the movie itself as a blank tape with the following notes:

   Check every 150 ft. or so to see if movie is still running.
   Make note of movie at top of form being used to tally pre and post movie discussion.
10. Tests:

    Paper and pencil tests: treat as movie, above.
    Lab practical test: treat as lab

TAPE ANALYSIS INSTRUCTIONS

II. Specific category directions

1. Uncategorized includes such items as the following:
   silence, noise (except during lab), roll call, announcements, teacher putting things on board

   directions--open books, page or lab number, etc.--
   NOT instructions in use of equipment or lab procedure to be followed.

   unrelated humor, anecdotes, stories--sometimes, however, the point of a story is directly related to a classroom objective; if in doubt, tally it in a content category and transfer if necessary.

   individual study time, which is clearly not a lab

   procedural discussion of exams, e.g. the Regents

2. Be sparing in use of "Higher Level" category. The best clue that a segment of discussion is at the higher level lies in the responses of the students. If they are trying to apply, analyze, synthesize, or evaluate, the discussion is clearly at the "Higher Level".
   Be sensitive to the following situation: a pre-lab or post lab in which the teacher seeks to get students to interpret, analyze apply, or synthesize, or sets the scene for their doing so in the laboratory. If a teacher is trying to get the students involved in this type of activity, the discussion is at the higher level.

   (Specific interpretations of lab findings would be categorized under "interpreting lab data and Observations.)

3. Student questions:

   If audible, classify by content and context
   If inaudible, classify by context; if in doubt, and decision is between knowledge-comprehension and higher level, use former.

   Within a higher level sequence, a student question, response, or comment may be inaudible; Unless the teacher response gives reason to think otherwise, it can be assumed that the student talk was also at the higher level.

   When the discussion returns to knowledge components related to the higher level discussion, record these segments under knowledge and comprehension.

4. Student reports

   Lecture discussion format
   Use 9
   Usually at knowledge-Comprehension level

TAPE ANALYSIS INSTRUCTIONS

II. Specific category directions, continued

5. Distinct teacher talk: words and message are clearly distinguishable.

6. In the lab, "Lab Procedures, Directions" includes instructions, cautions, distribution of equipment, etc. during lab.

7. On the Discussion, Post-lab sheet, "Procedures" includes tha above items if part of the post-lab; otherwise, directions are placed in uncategorized.

8. Lab Observations, data includes:

   Presentation of data
   Discussion of data (except for critical discussion of sources of error and <u>interpretation</u> of data)
   obtaining class means of data

9. Higher level--lab, includes such things as

   Interpretation of data
   Search for sources of error or disagreement

   Includes interpretation and extrapolation behaviors

10. Higher level

   Includes interpretation and extrapolation behaviors

   "How do you know" is often a clue that higher level discussion is occuring.

Review Bloom's <u>Taxonomy of Educational Objectives</u> for the distinctions between:

   Knowledge and Translation (Translation is a sub-category of Comprehension)

   Higher Level (All sub-categories and categories higher than "Translation" in Bloom's Taxonomy)

TABLE B

PLANNED INDEPENDENT CONTRASTS ON TAPE ANALYSIS INSTRUMENT SCORES
FOR GROUP A VS GROUPS B & C, FALL 1970

Item	Means A	B	C	SS Compare	MSW	F Ratio
1				6.62	0.67	9.83*
2	.2898	.7489	.8411	1.61	0.04	29.29*
3	.1396	.3167	.5143	0.48	0.02	20.91*
4	.1607	.4715	.4850	0.63	0.04	17.13*
5	.4419	.7132	.6375	0.34	0.07	5.12*
6	.0366	.2724	.1818	0.23	0.02	10.54*
7	.7100	.2509	.1587	1.61	0.04	39.29*
8	.0304	.0421	.0539	0.00	0.00	2.13 ns
9	.0051	.0263	.0364	0.00	0.00	6.42*
10	.0278	.0378	.0488	0.00	0.00	1.00 ns
11	.0253	.0157	.0174	0.00	0.00	1.09 ns
12	.9691	.8570	.8305	0.10	0.07	1.44 ns
13	.0018	.0020	.0033	0.00	0.00	0.48 ns
14	.0074	.0107	.0145	0.00	0.00	2.81 ns
15	.8547	.5702	.5143	0.61	0.02	38.49*
16	.0564	.1754	.2280	0.13	0.01	16.43*
17	.7982	.3947	.2862	1.32	0.04	36.96*
18	.0529	.2228	.2857	0.26	0.00	51.99*
19	.0617	.1644	.1458	0.05	0.01	8.15*
20	.1928	.1409	.2078	0.00	0.01	0.27 ns
21	.0240	.0055	.0239	0.00	0.00	0.71 ns
22	.0231	.0201	.0310	0.00	0.00	0.08 ns
23	.7164	.8760	.8194	0.11	0.06	1.78 ns
24	.1455	.1151	.1526	0.00	0.00	0.20 ns
25	.8070	.8589	.7920	0.00	0.01	0.27 ns
26	.5378	.6108	.5311	0.01	0.02	0.46 ns
27	.1779	.1656	.1831	0.00	0.00	0.02 ns
28	.0910	.0823	.0775	0.00	0.00	1.43 ns
29	.8082	.7393	.6476	0.08	0.06	1.48 ns
30	.2706	.3895	.4877	0.18	0.15	1.19 ns
31	.2665	.7633	.6081	1.00	0.10	10.40*
32	.0500	.4561	.4094	0.92	0.09	9.72*
33	.5340	.3832	.2256	0.33	0.08	4.34*
34	.6744	.9096	.8543	0.27	0.06	4.64*
35	.3119	.8245	.6785	1.22	0.10	12.69*
36	.2882	.2537	.3187	0.00	0.04	0.00 ns

TABLE C

T-TEST OF DIFFERENCES ON TAPE ANALYSIS INSTRUMENT SCORES FOR GROUP A BETWEEN FALL 1970 AND FALL 1971

Item	Differences	T Value (Related Groups)
1	.876	2.18*
2	.230	2.29*
3	.029	.38 ns
4	.152	3.17*
5	.215	1.63 ns
6	.140	1.27 ns
7	-.230	-2.29*
8	.062	2.29*
9	.035	1.82 ns
10	.053	1.42 ns
11	.027	.95 ns
12	-.167	-1.41 ns
13	.001	1.04 ns
14	.018	2.89*
15	-.137	-1.69 ns
16	.060	1.14 ns
17	-.197	-1.57 ns
18	.061	1.92*
19	.013	.23 ns
20	-.023	-.89 ns
21	.006	1.06 ns
22	-.002	-.40 ns
23	-.083	-.49 ns
24	-.026	-1.20 ns
25	.023	.89 ns
26	-.019	-.40 ns
27	.037	1.64 ns
28	.005	.64 ns
29	-.064	-.55 ns
30	-.071	-.77 ns
31	.069	.37 ns
32	.128	1.23 ns
33	.080	.54 ns
34	.018	.13 ns
35	.176	.85 ns
36	-.072	-.84 ns

APPENDIX G

The Processes of Science Test

This test is available from the Psychological Corporation, 304 East 45th St., New York, N.Y. 10017. It consists of forty multiple choice items. The following items were not scored in the calculation of classroom means for the present study:

2
11
20
21
22
26
30
33
35
40

APPENDIX H

EDUCATIONAL OPINION SCALE

Key:

SP = Schirner Progressive   ST = Schirner Traditional
KP = Kerlinger Progressive   KT = Kerlinger Traditional

(See right hand margin)

We all have beliefs, opinions, and attitudes about educational ideas, problems, and classroom procedures. Given below are fifty four opinions on such matters. This scale is an attempt to let you express your agreement or disagreement with these opinions. Respond to each of the items as follows:

1. Agree Strongly
2. Agree
3. Neutral
4. Disagree
5. Disagree Strongly

For example, if you agree strongly with a statement, you would fill in response #1 for that statement on the answer form (IBM sheet). If you disagree with it, you would blacken response #4 (Use #2 pencil, please). Respond to each statement, but do not spend too much time on any one statement.

PLEASE NOTE THAT THE RESPONSES FOR QUESTION #2 ARE FOUND TO THE RIGHT OF THOSE FOR QUESTION #1.

1. Field investigations, even if only on the school grounds are an essential part of an earth science course. SP
2. Learning experiences organized around life experiences rather than around subjects is desirable in our schools. KP
3. High school students should be told step by step what to do in the laboratory. ST
4. The curriculum should contain an orderly arrangement of subjects that represent the best of our cultural heritage. KT
5. Since life is essentially a struggle, education should emphasize competition and the fair competitive spirit. KT
6. Large group instruction is preferable to small group instruction because of the economy of cost and time for preparation and presentation. ST
7. Learning is essentially a process of increasing one's store of information about the various fields of knowledge. KT
8. Teachers should encourage pupils to study and criticize our own and other economic systems and practices. KP
9. Right from the very first grade, teachers must teach the child at his own level and not at the level of the grade he is in. KP
10. Education and educational institutions must be sources of new social ideas. KP
11. Children need and should have more supervision and discipline than they usually get. KT

12. Students should consider note-taking their most important classroom activity. ST

13. A teacher should have concern for mastery of concepts which develop a central theme in a given course. SP

14. Each subject and activity should be aimed at developing a particular part of the child's makeup: physical, intellectual, social, moral, or spiritual. KT

15. The true view of education is so arranging learning that the child gradually builds up a storehouse of knowledge that he can use in the future. KT

16. What is needed in the modern classroom is a revival of the authority of the teacher. KT

17. Direct or actual experiences for the students are worth the extra time necessary to make provision for them. SP

18. Group discussion of laboratory results should follow each laboratory activity. SP

19. The public school should take an active part in stimulating social change. KP

20. A teacher should use most student ideas that arise spontaneously during discussion. SP

21. Learning is experimental; the child should be taught to test alternatives before accepting any of them. KP

22. A textbook, if used, should be used only as a point of departure for the reading material in a class. SP

23. Generally, students get more from teacher demonstrations than from laboratory activities. ST

24. Correct answers are the most important outcome of laboratory activities. ST

25. Emotional development and social development are as important in the evaluation of pupil progress as academic achievement. SP

26. The organization of instruction and learning must be centered on universal ideas and truths if education is to be more than passing fads and fancies. KT

27. One of the big difficulties with modern schools is that discipline is often sacrificed to the interests of children. KT

28. Schools should teach children dependence on higher moral values. KT

29. A teacher should have concern for the quantity of specific concepts that may be mastered. ST

30. The curriculum consists of subject matter to be learned and skills to be acquired. KT

31. The learning of proper attitudes is often more important than the learning of subject matter. KP

32. It is better to use commercial tests which accompany a textbook than teacher-made tests because commercial tests measure course material better. ST

33. Student participation should be encouraged only during time open for discussion. ST

34. The goals of education should be dictated by children's interests and needs, as well as by the demands of society. KP

35. Children should be taught that all problems should be subjected to critical and objective scrutiny, including religious, moral, economic, and social problems. KP

36. A teacher should give textbook assignments with specific objectives for the individual. SP

37. Assignment of seats to students is necessary for good discipline. ST

38. True discipline springs from interest, motivation, and involvement in live problems. KP

39. To reduce confusion, students should know in advance the desired result of a laboratory activity. ST

40. Standards of work should not be the same for all pupils; they should vary with the pupil. KP

41. Earth science should be taught as an integrated discipline without regard for boundaries between geology, astronomy, meteorology or oceanography. SP

42. Teachers should keep in mind that pupils have to be made to work. KT

43. Often it is desirable to hold laboratory sessions more than once a week. SP

44. Schools of today are neglecting the three R's. KT

45. We should fit the curriculum to the child and not the child to the curriculum. KP

46. The healthy interaction of pupils one with another is just as important in school as the learning of subject matter. KP

47. Teachers need to be guided in what they are to teach. No individual teacher can be permitted to do as he wishes, especially when it comes to teaching children. KT

48. Development of a scientific vocabulary is the primary aim of a good earth science course. ST

49. Small group student discussion of earth science topics helps students understand things better. SP

50. Subjects that sharpen the mind, like mathematics and foreign languages, need greater emphasis in the public school curriculum. KT

51. Pre-tests of a diagnostic nature are worth the time required to administer them. SP

52. Beyond a good rock and mineral collection, earth science teaching requires little in the way of laboratory materials. ST

53. It is more important that the child learn how to approach and solve problems than it is for him to master the subject matter of the curriculum. KP

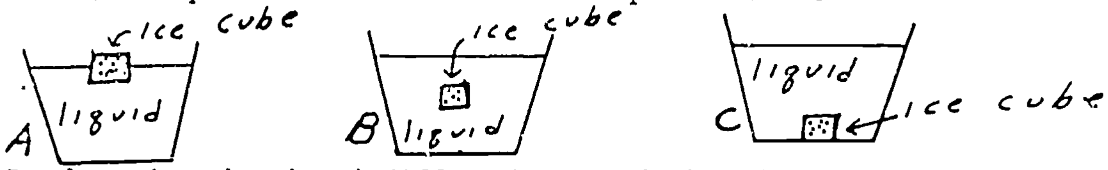
54. Tests should include questions based on things learned in the laboratory. SP

SEE KEY BELOW*

APPENDIX J
EARTH SCIENCE TEST-FORM A

The next twenty questions are designed to test your knowledge of Earth Science. Please answer all items to the best of your ability. Begin now, and put your first answer after number 30 on your answer sheet.

30. The three beakers in the diagram each contain a different liquid. Each also contains an icecube. Which statement is the best inference you can draw from this observation? N
    1. the liquids are of equal density
    2. liquid A is more dense than liquid C
    3. liquid B is more dense than liquids A and C
    4. liquid C is more dense than liquids A and B



31. By observing the sky at different times during the night one is able to conclude that: N
    1. stars appear to have a definite east-west motion trend but retain their positions with respect to each other
    2. stars appear to move in a random manner
    3. stars appear to remain stationary in the sky;they have no apparent motion
    4. the shape of constellations change throughout the night

32. When it is noon, Wednesday, on Guadalcanal (approximently 160° E longitude), what day is it in the United States? O
    1. Tuesday
    2. Wednesday
    3. Thursday
    4. Friday

33. Most of the energy that the earth receives from the sun: N
    1. is retained indefinitely by the earth's oceans
    2. is re-radiated as infrared radiation
    3. is absorbed into the interior
    4. is reflected off clouds

34. What is the longitude of a ship whose chronometer reads 4 P.M. Greenwich time at noon? O
    1. 4° east
    2. 40° west
    3. 60° west
    4. 60° east

35. When the moon casts its umbra on a portion of the earth's surface, which eclipse will occur? O
    1. total solar
    2. total lunar
    3. partial solar
    4. partial lunar

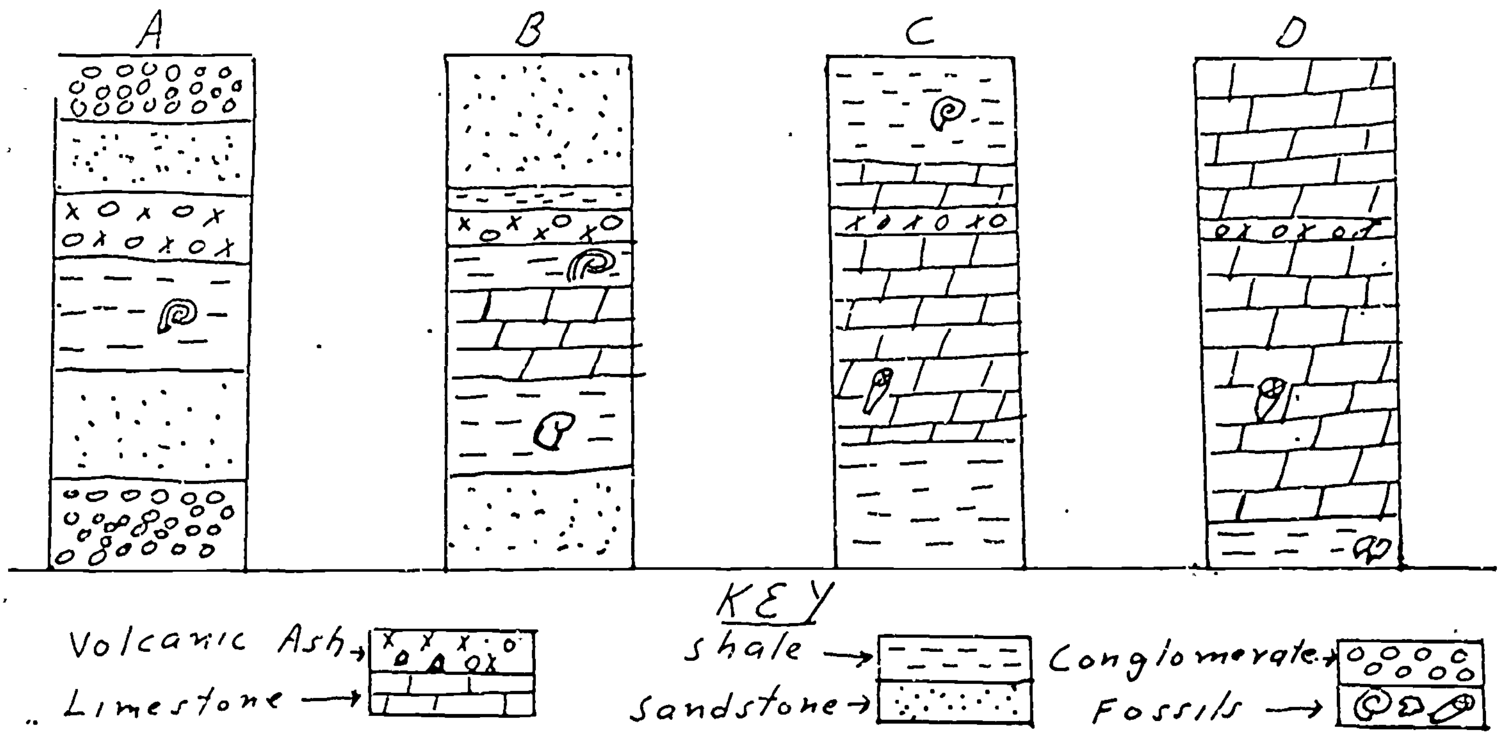
36. A lawn with sandy soil needs watering much more frequently than a lawn with clay soil. This is because sand has a: N
    1. slower infiltration rate
    2. greater porosity
    3. greater permeability
    4. greater capillarity

*KEY: N = NEW CONTENT
O = OLD CONTENT

37. What is the belt of high-pressure calms located about 30° north and south of the equator called? 0
    1. doldrums
    2. horse latitudes
    3. trades
    4. westerlies

38. What do isobars that are far apart indicate about wind velocites? 0
    1. high
    2. low
    3. moderate
    4. nothing

Below are four columns of sedimentary rock (A,B,C,D).

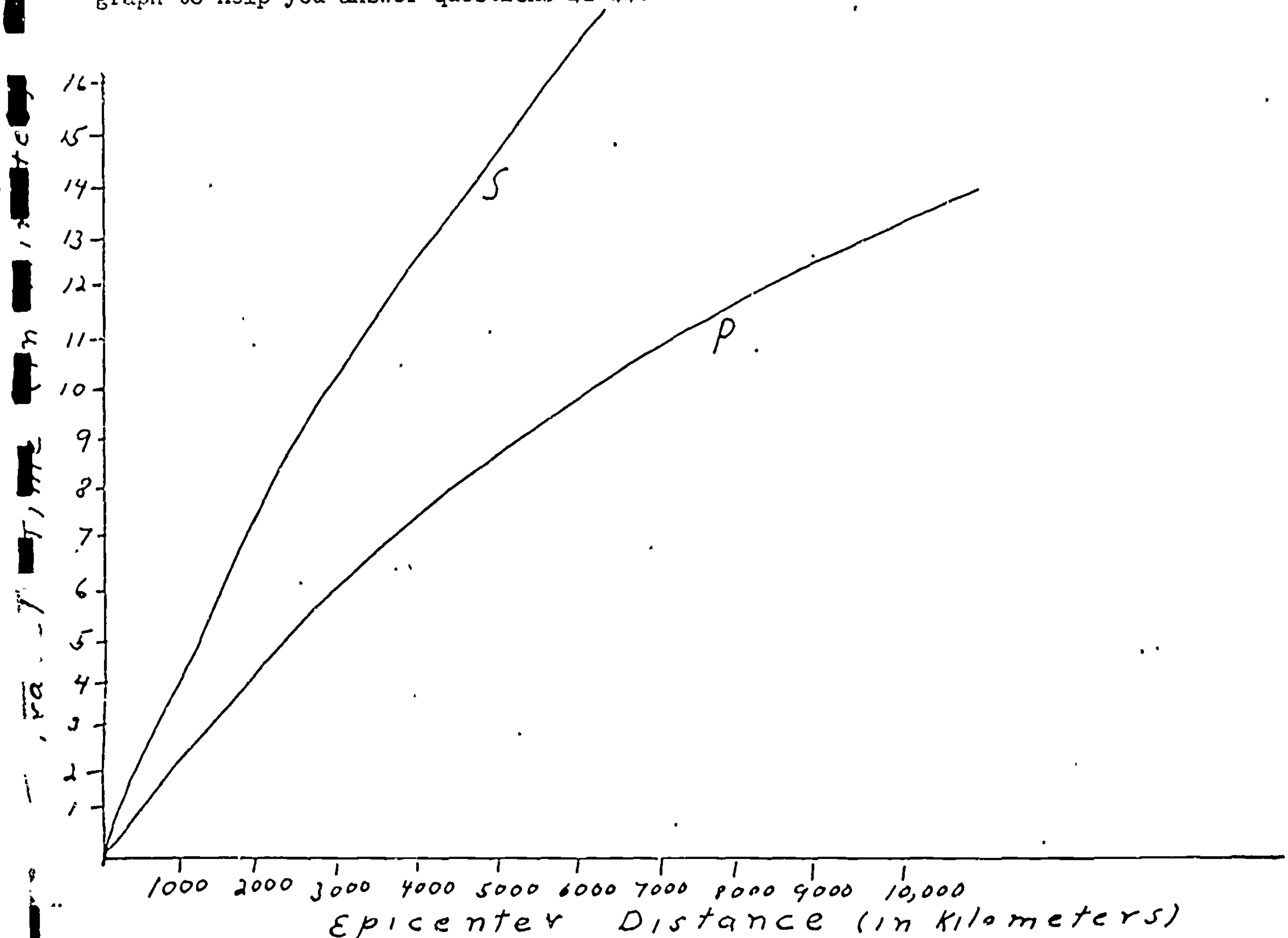


39. Which rock column was closest to the source of volcanic ash? N
    1. column A
    2. column B
    3. column C
    4. column D

40. Which rock column exhibits the greatest stability of depositional environment? N
    1. column A
    2. column B
    3. coulmn C
    4. coulmn D

41. Which rock type provides best time correlation from one column to another? N
    1. limestone
    2. volcanic ash
    3. shale
    4. sandstone

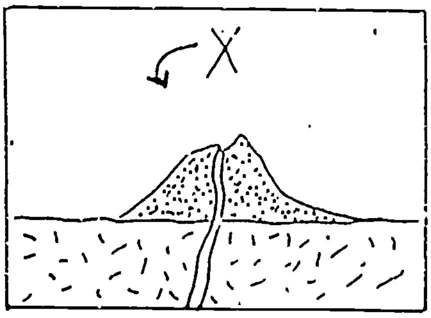
Seismic vibrations radiate out from the focus point of an earthquake. By observing the arrival times of the P and S waves on various seismograms, the following time-distance graph was constructed. Use the following time-distance graph to help you answer questions 42-44.



42. If a station is located 2,000 km away, the P waves would arrive in approximently how many minutes?
    1. 1-3 minutes
    2. 3-5 minutes
    3. 5-7 minutes
    4. 7-9 minutes

43. What would be the approximent difference in arrival time in minutes of the P and S waves on a seismograph if an earthquake occured 4000 km. away? N
    1. 0-2 minutes
    2. 2-4 minutes
    3. 4-6 minutes
    4. 6-8 minutes

44. If you were looking at a seismogram and the arrival time of the P wave was 10:00 A.M. and the S waves didn't arrive until 10:06 A.M., how far away in km. did the earthquake occur? N
    1. 2500-3500
    2. 4000-5000
    3. 5500-6500



45. What is the name of the feature at X ? 0
    1. caldera
    2. cone
    3. crater
    4. laccolithic dome

46. How was the feature at X formed? 0
    1. erosional laccolith
    2. erosional remnant of an igneous intrusion
    3. piling up of magma or cinders
    4. thrust fault

47. The chief mineral found in limestone and marble is: 0
    1. quartz
    2. mica
    3. calcite
    4. feldspar

48. What is the sediment or rock source of marble? 0
    1. granite
    2. limestone
    3. shale
    4. sand

49. What are the rock fragments called that accumulate at the foot of cliffs because of the action of gravity? 0
    1. delta
    2. peneplane
    3. stippe
    4. talus

THANK YOU!

(Please turn in booklets and answer sheets seperately.)

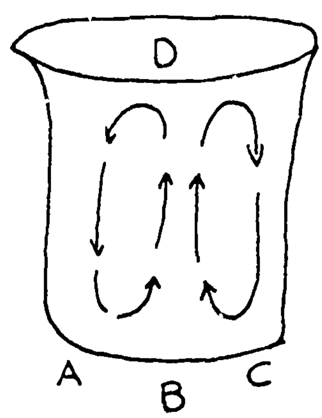
The next twenty questions are designed to test your knowledge of Earth Science. Please answer all items to the best of your ability. Begin now, and put your first answer after number 82 on your answer sheet.

82. A student notes and records a series of temperature readings. Which statement describes best an observation rather than an interpretation? N
    1. the thermometer column rose 4° in five minutes
    2. the thermometer readings indicate the average kinetic energy of the molecules
    3. the thermometer contains colored alcohol
    4. temperature is proportional to heat

83. What is the light called that is reflected from the dark portion of the moon at its new crescent phase? O
    1. earth shine
    2. penumbra
    3. rays
    4. umbra

84. Students observed and recorded the point of sunset over a period of two months. At the start of their observations the sun was setting in the north west. On the last day of their observations the sun set in the south west. Which season started during their observations? (Seasons given are for Northern Hemisphere) N
    1. Summer
    2. Autumn
    3. Winter
    4. Spring

85. Convection cells have developed in the beaker of water shown to the right. Choose the point at which heat is probably being applied. N
    1. A
    2. B
    3. C
    4. D



86. What is the name of a very light- weight spongy volcanic rock? O
    1. basalt
    2. granite
    3. obsidian
    4. pumice

87. Which of the following is one way by which longitude can be determined on board ship? O
    1. by determining the number of degrees the sun is above the horizon looking south
    2. by looking at your watch and comparing this to Greenwich time
    3. by measuring the velocity of the ship
    4. by comparing your time by the sun, to Greenwich time

88. If the earth's axis were inclined more than $23\frac{1}{2}^{\circ}$ what would the winters be like in the Northern Hemisphere? O
    1. more moderate
    2. colder
    3. hotter
    4. stay about the same

89. In the spring of the year a depression in the ground in New York State is observed to have snow on its east, south and west slopes, but no snow on the northern slope. This is chiefly because: N
    1. the prevailing southerly winds would strike that face most directly
    2. the soil on the north slope is probably darker than the other slopes
    3. snow fall is not as great on the north slopes
    4. on the average, the rays of the sun are more direct on the north slopes

90. What are the winds called that blow towards the equator from the horse latitudes? N
    1. jet streams
    2. polar easterlies
    3. prevailing westerlies
    4. trades

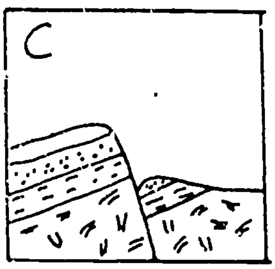
91. Which of the following relationships between precipitation (P) and potential evaporotransperation (PE) indicate a humid climate? N
    1. $\frac{P}{PE} = 1$
    2. $\frac{PE}{P} = 1$
    3. $\frac{P}{PE} = 1.5$
    4. $\frac{PE}{P} = 1.5$

92. The weather instrument that gives a continuous record of the atmospheric pressure is the: O
    1. baragraph
    2. mercurial barometer
    3. thermograph
    4. anemometer

93. Schist is what kind of rock? O
    1. igneous
    2. metamorphic
    3. sedimentary
    4. it isn't a rock, it is a sediment

94. Along which feature are most of the world's best harbours located? O
    1. barrier reefs
    2. emergent shorelines
    3. lagoons
    4. submergent shorelines

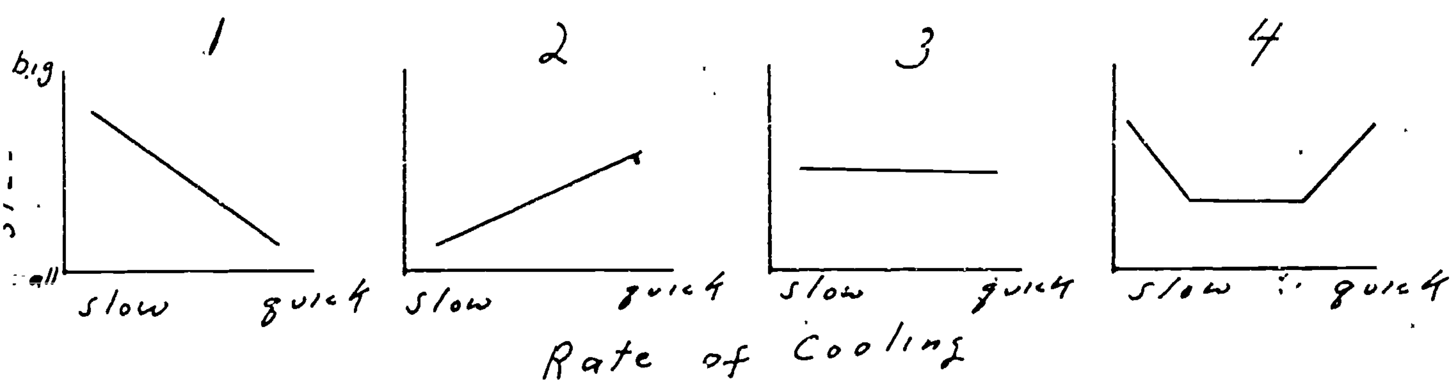
Use the sketch below for the following two questions. O



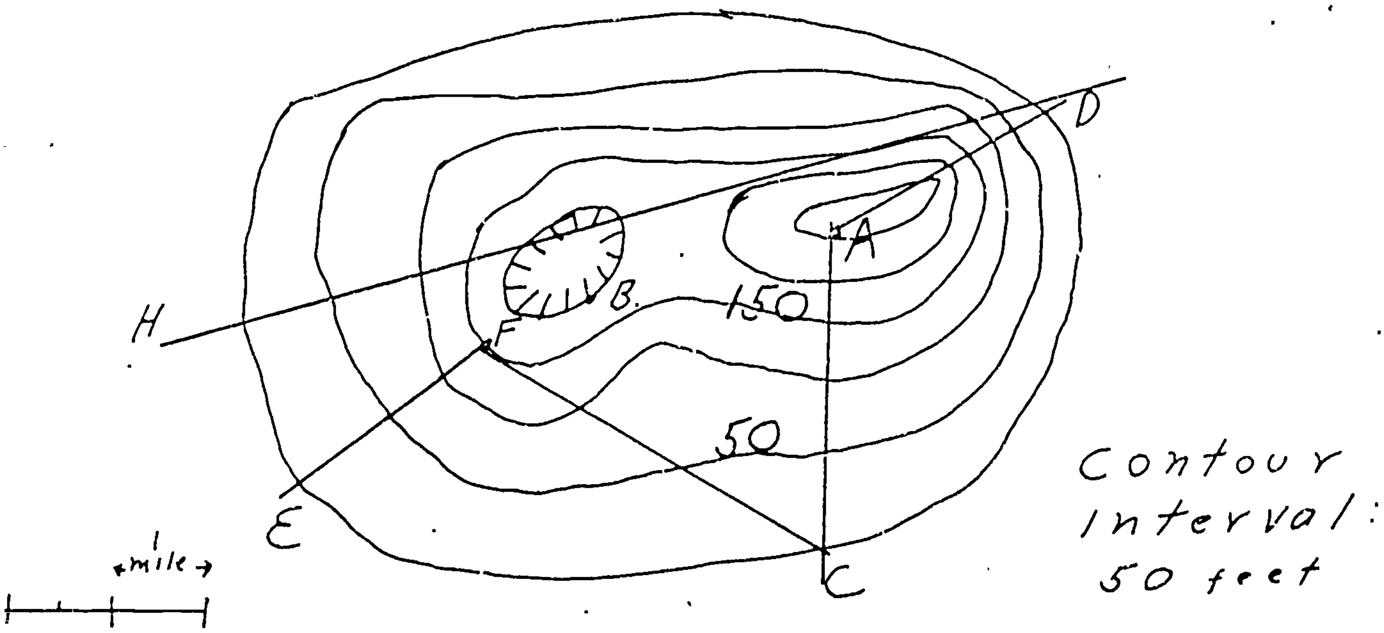
95. Which of the following best explains how a mountain such as the one at C was formed? O
    1. block faulting
    2. folding of beds
    3. thrust faulting
    4. volcanic eruptions

96. Which type of mountain is shown in the diagram? O
    1. block mountain
    2. complex mountain
    3. thrust-fault mountain
    4. folded mountain

97. Which graph below indicates the relationship between crystal size and rate of cooling? N



Use the following diagram to answer the next four questions.

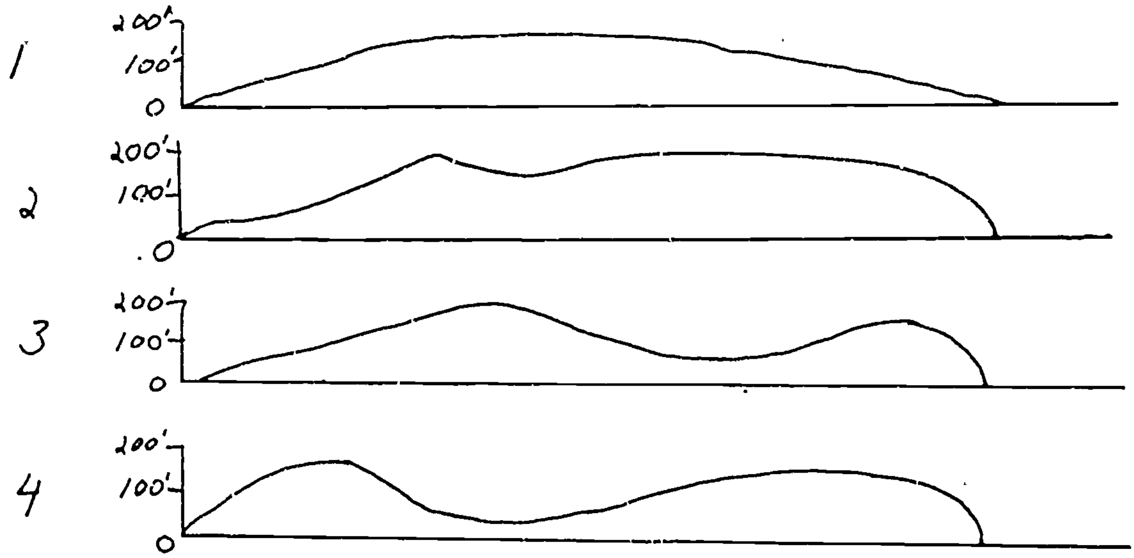


98. The elevation of point A is: N
    1. 100-150 feet
    2. 150-200 feet
    3. 200-250 feet
    4. 250-300 feet

99. The steepest slope indicated on the map is along: N
    1. AD
    2. AC
    3. FE
    4. FC

100. The entire contour map represents a (an): N
    1. isoline
    2. gradient
    3. field
    4. vector

101. The best profile of the section from H to D is: N



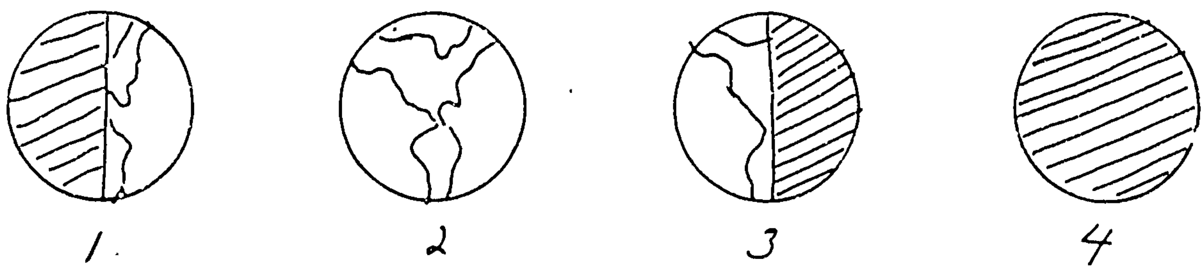
The next twenty questions are designed to test your knowledge of Earth Science. Please answer all items to the best of your ability. Begin now, and put your first answer after number 134 on your answer sheet.

134. Which eclipse occurs during the full moon phase? O
   1. lunar
   2. partial
   3. solar
   4. total

135. A graph of annual sunspot numbers for the years 1901- 1965 shows maximum sunspot activity for the years 1907, 1917, 1928, 1937, 1948 and 1958, and low sunspot activity for the years 1901, 1913, 1923, 1933, 1944, 1954, 1964. Based on this trend, the next period of maximum sunspot activity should be around the year: N
   1. 1966
   2. 1968
   3. 1971
   4. 1975

136. The earth is nearest the sun in which of our seasons? O
   1. Fall
   2. Spring
   3. Winter
   4. Summer

137. During the 'First Quarter' phase of the moon, the Apollo astronauts completed a lunar landing. When they looked back at earth, they would see which of the following? N



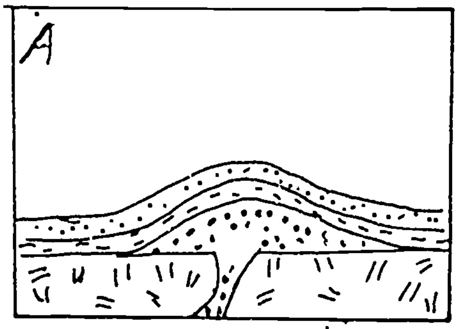
138. The seasonal winds that bring heavy rainfall to India blow from what direction? O
   1. northeast
   2. northwest
   3. southeast
   4. southwest

139. Two aluminum cans of the same size, one having a shiney surface, the other a black surface, were each filled with hot water of the same temperature, and covered. After 20 minutes, which statement do you expect the data would support? N
   1. the can with the black surface would cool most quickly
   2. the can with the shiney surface would cool most quickly
   3. both will cool at the same rate
   4. no cooling will occur

140. What is that portion of the atmosphere characterized by decreasing temperatures as altitude increases? O
    1. exosphere
    2. ionosphere
    3. stratosphere
    4. troposphere

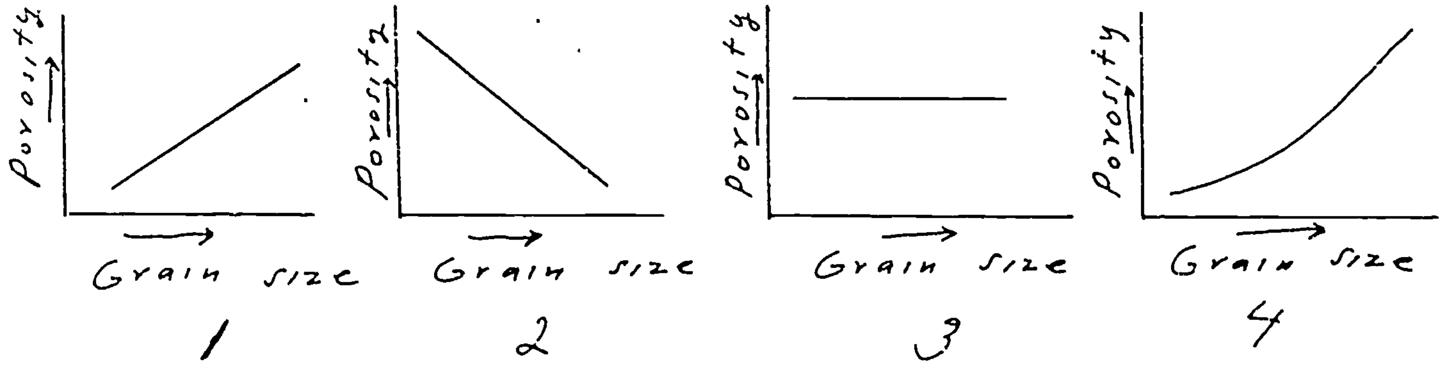
141. Temperature changes are somewhat greater during the year in the Northern Hemisphere than they are in the Southern Hemisphere. This is chiefly because the Northern Hemisphere: N
    1. receives more insolation during the year
    2. has less circulation of the atmosphere and hydrosphere
    3. has a greater amount of thermal pollution
    4. has less water mass to moderate the temperature

142. How was the mountain in diagram A formed? O
    1. by a block fault
    2. by a thrust fault
    3. by a laccolithic intrusion
    4. by the eruption of a volcano



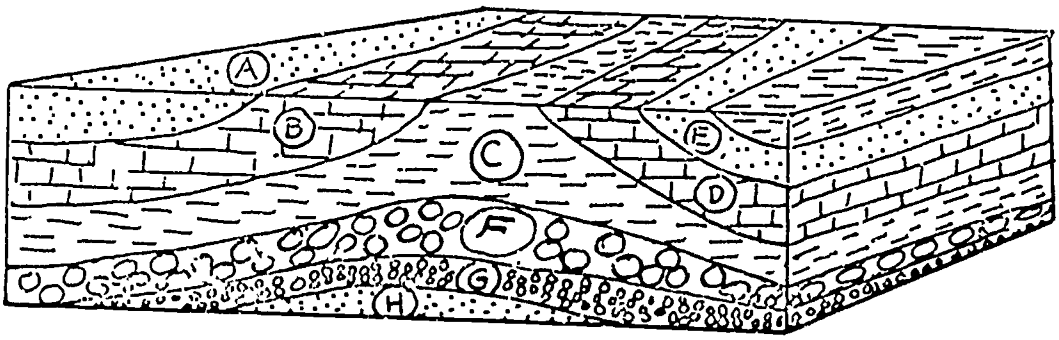
143. What type of mountain is indicated in diagram A? O
    1. block mountain
    2. complex mountain
    3. dome mountain
    4. volcanic mountain

144. Which graph best represents the relationship between porosity and grain size? Assume the grains are perfect spheres and in the closest packed arrangement. N



145. A course-grained igneous rock that always contains quartz and feldspar is: O
    1. granite
    2. pumice
    3. obsidian
    4. basalt

The diagram below is a block diagram of sedimentary rocks. Layers A and E contain mica flakes, layers B and D contain seashells and layers F and G are made of rounded quartz pebbles. Use this information to answer questions 146-9.



146. It is likely that layer A: N
   1. was deposited under the same conditions as layer B
   2. was deposited at the same time as layer C
   3. is part of the same formation as layer C
   4. is part of the same formation as layer E

147. It is likely that: N
   1. layer F was deposited after layer C was deposited
   2. particles in layer F were formed where they were deposited
   3. particles in layer F were rounded before they were deposited
   4. rock layer F is not sedimentary

148. In comparing rock layers F and G, it is likely that: N
   1. the particles in layer F were transported a shorter distance
   2. the particles in layer G were transported a shorter distance
   3. particles in layers F and G were transported the same distance
   4. particles in layers F and G were deposited in different media

149. The sequence of outcrops from left to right, can most probably be attributed to: N
   1. deposition of sediments along the ridge
   2. two unrelated depositional environments
   3. deposition of various materials, folding, and subsequent erosion
   4. chance

150. Which particle below would probably settle the fastest in a quiet pond? N
   1. spherical high density particle
   2. a flat high density particle
   3. a round low density particle
   4. a flat low density particle

151. What are the principle materials in granite? 0
   1. calcite and gypsum
   2. hornblend and augite
   3. pyroxene and amphibole
   4. quartz and orthoclase

152. What are the large cracks that develop in the ice as the results of strains set up by the uneven rate of movement of glaciers? 0
   1. crevasses
   2. drumlins
   3. eskers
   4. striae

153. In what stage of its erosional cycle is a river that is cutting sideward but in which downward erosion has stopped 0
   1. maturity
   2. old age
   3. rejuvenated
   4. youth

THANK YOU!
(Please turn in booklets and answer sheets seperately.)

END

DEPT. OF HEW

NAT'L INSTITUTE OF EDUCATION

ERIC

DATE FILMED

SEPT 13 74