SCIENCE CONTENT PREPARATION OF PROSPECTIVE ELEMENTARY SCHOOL TEACHERS IN EIGHT OKLAHOMA INSTITUTIONS OF HIGHER EDUCATION

By

ANDREW JACKSON KISNER

Bachelor of Science
Northeastern State College
Tahlequah, Oklahoma
1932

Master of Education
University of Oklahoma
Norman, Oklahoma
1939

Submitted to the faculty of the Graduate School of
the Oklahoma State University
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Thesis Approved:

Ira T. Smith
Thesis Adviser

James E. Frasier

W Ware Marsden

Homer L. Knight

Dean of the Graduate School

To

My wife, Shirley,

whose love, understanding and encouragement have made graduate study and this writing a reality.

PREFACE

The status of the elementary school teacher with reference to his preparation and ability to teach science has become the concern of many persons since World War II. The writer has been interested in the area of teaching science for thirty years. This study has offered an opportunity and challenge to the writer to compare the college preparation of prospective elementary school teachers with the recommendations of authorities.

The writer is indebted to many people for their contributions to this study. These persons served in various capacities.

Deepest gratitude is expressed to Dr. Ida T. Smith, Professor of Education, whose inspiration, guidance and encouragement has made this study possible. Appreciation is expressed to Dr. Ware Marsden, Head of the Department of Education; Dr. Homer L. Knight, Head of the History Department; and Dr. James E. Frasier, Education Department, for their interest in the writer's professional growth.

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A. J. K.

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CHAPTER I

INTRODUCTION

The world of today reflects an ever growing interest in science. Many writings predict the wonder age of a scientific tomorrow, not far distant, while radio and television bring into the American home a realization of the impact of science upon mankind everywhere. The utilization of scientific discoveries, inventions, and methods offers tangible testimony to the comforts and conveniences of modern living, and to the satisfaction of one's individual needs and wants through progress in science. The combination of improved standards of health, of miracle drugs, and of automation gives promise of both greater longevity and heretofore unrealized leisure to enjoy it.

Increasingly, since the midpoint of the twentieth century, with the growing appreciation of the importance of science in peace and survival, there has developed a concern not only for greater competency and skill in the use of scientific method, but more fundamentally, for basic literacy in science itself. This concern suggests a need of every person for increased familiarity with the scientific world. Such familiarity should begin in the elementary grades, where lifetime interests and habits are often developed. In the grades girls and boys seek answers to questions that spring from normal and natural curiosity growing out of new and meaningful experiences.

As early as 1932 an influential report in science education

advocated a twelve year science sequence beginning in elementary school and extending through high school.[1]

Craig, in 1957, emphasized the importance of science in the elementary grades:

> Elementary science in its present form must be considered a very recent arrival in the curriculum. Looking back less than two decades, one finds science was little more than a fad and an extra-curriculum matter to be taught more or less incidentally and accidentally, if at all. Events of recent years on the national and on the international scene have convinced the public that science must be a basic concern in the curriculum of the elementary school.[2]

The Fifty-Ninth Yearbook of the National Society for the Study of Education, published in 1960, reemphasizes the importance of science in the elementary schools:

> No one can understand our culture, our institutions, or the prevailing philosophies without some knowledge of science and its origin. Elementary education, of necessity, includes more science than has been taught heretofore; elementary teachers must be prepared to teach it.[3]

As a result of these reports and other investigations, much progress has been made in the teaching of science in the elementary grades.

A teacher, before he can successfully plan science lessons for the

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[1]S. Ralph Powers, "The Plan of the Public Schools and the Program of Science Teaching," A Program for Teaching Science, National Society for the Study of Education, Thirty-first Yearbook, Part I, ed. Guy M. Whipple (Bloomington, Illinois, 1932), p. 10.

[2]Gerald S. Craig, Science in the Elementary Schools, National Education Association (Washington, 1957), p. 3.

[3]John S. Richardson, "The Education of the Science Teacher," Rethinking Science Education, National Society for the Study of Education, Fifty-ninth Yearbook, Part I, ed. Nelson B. Henry (Chicago, 1960), p. 261.

elementary grades, must possess a background of knowledge of science. Therefore, the current investigation is concerned with the science preparation of persons who may teach science in the elementary grades of Oklahoma schools. The study is further concerned with how this preparation compares with the recommendations of professional authorities in the field of elementary school science teaching.

Need for the Study

The need for rapid expansion of scientific knowledge is greater today than ever before. If the United States is to maintain its proper place in the age of atomic power, American youth must be given a well-rounded and integrated twelve year program of science instruction. Curtis writes:

> The scientific training during the preadolescent period is of tremendous importance. It must function to counteract the early development of unscientific habits of thinking, prejudices, and misconceptions. It must also facilitate the adjustment of youth to a social order which science is making more complicated at an unprecedented rate.
>
> The elementary teachers are responsible for the scientific training of our children during the most formative stage of their development. It is imperative, therefore, that they be thoroughly and adequately prepared for the task. They must be provided with sufficient training in science to meet the ever increasing scientific needs and interests of pupils. If this training is to serve to improve the caliber of instruction in elementary science, it must be far more intensive and extensive than it has been in the past.[4]

The Committee on Science, reporting in the Fifty-Ninth Yearbook of the National Society for the Study of Education, places emphasis upon the significance of science education:

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[4]William C. Curtis, "Improvement of Instruction in Elementary Science," Science Education, XXXIV (1950), 235.

> That science has played a significant role in the development of our culture is an obvious fact; that it will play an increasingly important role in our future development is in light of present progress, taken for granted. What the exact nature of that role will be is a question with which all educators need to be concerned. Educational programs in schools and colleges must be appropriately conceived of and skillfully planned.[5]

As is true of other areas of education, science education has undergone change. As early as the eighteenth century, science made its appearance in children's literature. Underhill states:

> During the late seventeen hundreds and early eighteen hundreds children's literature designed for the purpose of instruction came into prominence. ..... Directed observation of natural phenomena occupied an important place in this literature.[6]

Changes in elementary school science were slow until the middle of the nineteenth century. Since then changes in science for the elementary grades have occurred at an increasingly rapid pace, as evidenced by the appearance of nature study following the Civil War, and later a sequential science program, built around generalizations, for the elementary grades. The current elementary school science program bases its philosophy and materials on a knowledge of how children grow and develop.

The changing needs of society necessitate a study of college curricula for preparing teachers. The Fifty-Ninth Yearbook of the National Society for the Study of Education states:

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[5]J. Darrell Barnard, "The Role of Science in Our Culture," Rethinking Science Education, National Society for the Study of Education, Fifty-Ninth Yearbook, Part I, ed. Nelson B. Henry (Chicago, 1960), p. 1.

[6]Ora E. Underhill, The Origin and Development of Elementary Science (New York, 1941), p. 15.

> In late 1957, a Russian Sputnick streaked into orbit. This greatly intensified the concern and the activities of those already engaged in the improvement of science teaching and aroused the concern of many who had appeared to be unaware of the situation. The general result was a furor of activity directly related to scientific and technical instruction.[7]

A review of literature in the field of teacher preparation for teaching science reveals that science courses, offered in college curricula, do not meet the needs of persons who will teach science in the elementary grades. Curtis writes:

> The elementary teachers are receiving some practical preparation from the science courses now available in the teachers colleges and universities. In general, however, these courses are not cognizant of the actual science activities carried on by the elementary teachers and, therefore, fail to provide those teachers with an appropriate basis for the planning of organized and stimulating science instruction.[8]

This point of view is further supported by Smith and Anderson who state:

> There is evidence that the typical science courses taken by elementary school teachers do not make the proper contribution to the teaching effectiveness of classroom teachers in the elementary grades.[9]

There is current criticism concerning the teaching of science in the elementary grades. Wells writes:

> Science is a subject field which many teachers of the elementary grades feel unqualified to handle in an adequate

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[7]Robert Stollberg, "The Status of Science-Teaching in Elementary and Secondary Schools," Rethinking Science Education, National Society for the Study of Education, Fifty-ninth Yearbook, Part I, ed. Nelson B. Henry (Chicago, 1960), p. 83.

[8]Curtis, p. 235.

[9]Herbert A. Smith and Kenneth E. Anderson, "Science," Encyclopedia of Educational Research, ed. Chester W. Harris (New York, 1960), p. 1226.

> manner. Pupils in the classroom frequently know more about certain physical phenomena and facts of nature than the teacher.[10]

As early as 1937, in his book, Science in the Elementary School, Croxton says:

> One of the handicaps in making science effective in the elementary grades has been the teacher's lack of training in this field. So long as the subject was regarded as incidental in the elementary program, there was little attempt to prepare teachers in science. Now it has become a regularly scheduled subject in some elementary schools and an important part of the integrated program in others, teachers and teacher-training institutions must make as definite preparation in science as in any other field.[11]

Contact with elementary teachers in Oklahoma indicates that many teachers feel an insecurity in their attempts to teach science in the elementary grades. The Oklahoma Science Teachers Association[12] recognized this insecurity among teachers as early as 1949, and, in an attempt to develop an improved science and health program for Oklahoma, organized science centers in nine locations within the state. In June of 1958, the Oklahoma Curriculum Improvement Commission authorized the appointment of a state science committee, for a three year period, on the improvement of the teaching of science. After considerable study, this committee reports that the following ways of improving science instruction in Oklahoma are feasible:

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[10]Harrington Wells, Elementary Science Education (New York, 1951), p. 4.

[11]W. C. Croxton, Science in the Elementary School (New York, 1937), p. 86.

[12]Oliver Hodge, A Suggestive Guide in Elementary Science for Oklahoma, Oklahoma State Department of Education Bulletin No. 12 (Oklahoma City, 1950), pp. 1-2.

(a) A modification of the science curriculum throughout the school system from grades one through twelve will result in a greatly improved program of science instruction in the state.
(b) Modification in the teacher certification program and the school accreditation program might result in considerable improvement in science instruction.
(c) The activities of the colleges and universities might result in improved preparation of teachers which would also contribute to the improvement of science instruction.[13]

It is apparent that authorities recognize the importance of teacher training for effective teaching of science. A study which will show the present status of the college preparation of teachers who may teach science in the elementary grades of Oklahoma schools, and a comparison of this preparation with the recommendations of professional authorities in the field of elementary science teaching, will provide a basis for improving the pre-service preparation of elementary teachers in colleges and universities of Oklahoma.

Basic Assumptions

The basic assumptions of this study are as follows:

1. Science teaching in the elementary grades is related to the preparation of the teachers who teach the science.

2. A study of the course descriptions for required or recommended courses in science and for the professional methods courses for teaching science, together with the judgments of the instructors who teach these courses, will give reliable information concerning course content.

3. A comparison of the current programs of science preparation for elementary school teachers with recommendations for such programs

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[13] The Improvement of Science Instruction in Oklahoma Grades K-12, Oklahoma State Department of Education, 1960, p. 1-2.

by authorities will reveal strengths and weaknesses of such programs in relation to the content taught.

Hypothesis of the Study

The science preparation of Oklahoma teachers who may teach science in the elementary grades in Oklahoma schools is not compatible with the recommendations of professional authorities in the field of science teaching.

The Purpose of the Study

The purpose of the study is to ascertain the science content preparation of elementary school teachers who are to teach science in the elementary grades as provided in eight Oklahoma institutions of higher education and to compare this preparation with the recommendations of authorities.

Definition of Terms

The following terms are defined as they are used throughout this study:

Elementary school teachers: teachers in grades one through six.

Science in the elementary grades: both the incidental and the direct teaching of science in the elementary grades. This may include subject matter content in botany, zoology, physics, geology, geography, chemistry, astronomy, meterology, and physiology.

The eight Oklahoma institutions of higher education: those colleges or universities located at Ada, Alva, Durant, Edmond, Norman, Stillwater, Tahlequah, and Weatherford.

Authorities: those persons who have achieved recognition through research or professional writing in the field of science teaching.

The Scope of the Study

The study is concerned with an analysis of the content of science courses or programs and the professional methods courses in the teaching of science required or recommended for the Oklahoma elementary teaching certificate in eight institutions of higher education in Oklahoma. The analysis of course content is based on the judgments of the instructors of the science courses and of the professional methods courses in the teaching of science in eight selected Oklahoma institutions of higher education.

Certain limitations in the method used for gathering data in the study are acknowledged. The questionnaire, as an instrument for collecting data, may be limited by the biased judgments of the respondents. All respondents may not react from a common frame of reference. Statements may not be understood by the respondent. In order to compensate, at least in part, for the limitations, the questionnaire was used as an interview checklist in a personal interview with the respondents.

The study is limited to eight of the seventeen Oklahoma institutions of higher education accredited for teacher certification. These eight institutions certify eighty per cent of the elementary teachers of Oklahoma.

The study is further limited to the content of the science courses and the professional methods courses in the teaching of science required or recommended in the eight colleges for the Oklahoma elementary

teaching certificate. The sciences included are the biological, physical, and earth sciences.

Plan for the Study

A review of literature in the field of teacher preparation in science education was made to identify the findings of research and the opinions of authorities concerning desirable science content preparation of elementary school teachers who may teach science in the elementary grades.

From the review of the literature, guide lines for programs to prepare teachers to teach science in the elementary grades were selected. Items for the guide lines were based on frequency of mention in professional literature. A structured interview checklist was then designed based on these guide lines.

The structured interview checklist was submitted to twenty-five persons trained in elementary school science education and was then revised in accordance with their suggestions. The structured interview checklist was then used at eight Oklahoma institutions of higher education in interviews with instructors of the required or recommended courses in science and of the professional methods courses in science for the elementary school teacher.

Summary

The need for the study and the general nature of the study are discussed in Chapter I. Chapter II contains a review of the literature in the field of teacher preparation in science education to identify the findings of research and the opinions of authorities concerning

desirable science course content preparation of elementary school teachers to teach science in the elementary grades. Chapter III contains an explanation of the procedure followed in conducting the study, an explanation of how the interview checklist was designed, and a report of the judgments of the respondents. Chapter IV includes a description of the data and an interpretation of the findings. Chapter V contains the conclusions based upon the findings as well as recommendations for further investigations which could be extensions of the current study.

CHAPTER II

REVIEW OF THE LITERATURE

As early as 1931, a Committee on the Teaching of Science, appointed by the National Society for the Study of Education, initiated a plan for the reorganization of science teaching. This plan was presented in the Committee's report, the Thirty-First Yearbook, A Program for Teaching Science. The central feature of the plan was a "continuous and correlated program of study from kindergarten to senior high school inclusive, built around the development through organized experiences of certain basic and generalized truths."[1] The committee reported:

> A principle that seems to have full acceptance among educators is that education should be seen as a continuous process that begins with the learning experiences of early childhood and continues throughout the period of life.[2]

Until 1931, the science programs in many schools had been uncoordinated. Science for the elementary school had often been organized as nature study, while science for the secondary school had consisted of organized bodies of knowledge selected from the special fields of science. Because of this lack of coordination, science had not attained the

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[1] J. Cayce Morrison, "Comments on the Yearbook by a School Administrator," A Program for Teaching Science, National Society for the Study of Education, Thirty-first Yearbook, Part I, ed. Guy Montrose Whipple (Bloomington, Illinois, 1932), p. 359.

[2] Ibid., p. ix.

recognition in the schools that it deserved.

A study of teacher's colleges, selected at random by the committee, revealed the same unrealistic approach to the teaching of science for students preparing to teach in the elementary grades. Based on findings of the committee, this statement was made:

> It is quite common to find in practice that a single course in "Nature Study" of two or three periods each week for a term constitutes the total preparation of elementary-school teachers for their work in science. This short course is commonly one in which the major work is in the nature of learning the names of trees, flowers, birds, and other living things, making collections of minerals and rocks, and learning the names of constellations.[3]

The committee concluded that:

> The typical offering in science in normal schools and state teachers colleges consists of relatively few courses, uniquely named, with a decided tendency to make each course a unit unto itself, with few or no prerequisites, and with little or no recognition of sequence between courses.[4]

The committee's recommendation for the reorganization of science teaching was:

> ..... a continuous program of science beginning in the kindergarten and extending through the elementary and secondary schools.
>
> The science of the elementary school should be well-balanced and derived from the major fields of science. It should, however, not be organized or treated about the separate sciences, but rather about the problems and situations which are challenging, many of which may integrate the separate fields.[5]

The college science training of future elementary school teachers advocated by this committee would function as a foundation for

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[3]Ibid., p. 329-330.

[4]Ibid., p. 344.

[5]Ibid., p. 161.

attainment of the foregoing recommendation and would consist of a minimum (in semester hours) of the following:

> (1) Orientation. A course required of all elementary school ..... teachers. The units of this work will be built around those generalizations and principles of science that relate most immediately to the needs and interests of liberally educated people . . . . . 8 hours
> (2) Introductory course in one special science . 8 hours
> (3) Professional course in elementary science. . 4 hours
> (4) Electives in science . . . . . 8 hours[6]

The committee recognized that many teachers colleges were, at that time, unprepared to offer such a program.

The findings and recommendations of the Thirty-First Yearbook aroused an interest in the improvement of science teaching. The interest spread throughout the country and has continued with increasing momentum until the present time. Countless surveys and studies have been conducted in an effort to improve science curricula, beginning in the kindergarten and extending through the college training of future science teachers. Out of the wealth of findings, certain conclusions appear again and again. The findings can be summarized in a statement made by Craig in 1927:

> ..... the elementary teacher must have at least elementary knowledge covering the fields of astronomy, biology, chemistry, geology, and physics. The teacher should recognize, however, that her work is with elementary children and that her knowledge need not be detailed and specialized but rather broad and liberal.[7]

In order to devise a program for the preparing of teachers in

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[6]Ibid., p. 342.

[7]Gerald S. Craig, Certain Techniques Used in Developing a Course of Study in Science for the Horace Mann Elementary School, University of Columbia Contribution to Education No. 276 (New York, 1927), pp. 58-59.

elementary science, Gemmill maintained that if the program outlined by the Thirty-first Yearbook was "to be put into effect, it would seem that the teacher-training institutions, in turn, need to make revision in their science programs."[8] In order to obtain a picture of practices, she studied the elementary science requirements in "sixteen representative institutions in ten states in various parts of the country."[9] With this study completed, each of the institutions was asked to send records concerning the type of science taken by fifty of their students during the last five years.[10] Records were received on 398 students from nine institutions. These records revealed that the majority of the students had taken courses in biology and nature study, whereas very few had taken courses in physics and chemistry.[12] Eleven of the group had no science and 202 had only one course in science. Of these 202 students, 102 had nature study and 66 had biology, nine had chemistry and not one student had taken a course in physics.[13] Of science sequences taken, "83.73 per cent"[14] were of biological nature. In constructing the proposed orientation course, Gemmill stated:

> It seemed best to make a selection of generalizations from several sources. The first source was Dr. Craig's study,

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[8]Anna M. Gemmill, An Experimental Study at New York State Teachers College at Buffalo to Determine a Science Program for the Education of Elementary Class-room Teachers, University of Columbia Contribution to Education No. 715 (New York, 1937), p. 13.

[9]Ibid., p. 4.

[10]Ibid., p. 11.

[11]Ibid., p. 14.

[12]Ibid., p. 15.

[13]Ibid., p. 16.

[14]Ibid., p. 21.

> the second was an unpublished series of generalizations developed by graduate students in the classes of Professor S. R. Powers of Teachers College, Columbia University, and the third source was the list of generalizations in Part I of the Thirty-First Yearbook of the National Society for the Study of Education. Once the generalizations had been selected, they were broken down into teaching material. . . . . The material was then ready for trial in the classroom.[15]

At the end of the experimental program, the conclusion that "two years of generalized science, one year biological and the second physical, seemed to fit the needs of the elementary teachers."[16] Gemmill further stated that these two years of science preparation should be followed by a semester's course in science methods.[17]

Floyd, in 1937, devised a test composed of facts of physical science taken from a course of study covering the first six years in elementary school. The highest possible score was thirty-seven. He administered this test to students of junior and senior colleges. The mean for the senior college students was 18.4 and that of the junior college students was 13.6.[18] As a result of the above, he stated:

> There must be formulated and emphasized a general physical science course offering in the college which will supply those values which are vital to the success of the science world that is definitely coming into the elementary schools.[19]

In 1938, Lynn and Lillian Ralya constructed and administered a true-false test consisting of science facts, concepts, and superstitions

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[15]Ibid., p. 41.

[16]Ibid., p. 50.

[17]Ibid., p. 51.

[18]W. W. Floyd, "Training for Teachers of Elementary Science," The Texas Outlook, Sept., 1937, pp. 33-34.

[19]Ibid., p. 34.

to 130 students in training to become elementary teachers. All had some college training in science and all had had a methods course in science.[20] Concerning the results, the authors noted:

> A significant percentage of those prospective teachers exhibited ignorance or misconception of many simple and basic facts and principles, knowledge and understanding of which would be necessary for any adequate presentation of elementary science in the classroom.[21]

As a result, a special science course with laboratory was recommended to be given in association with the methods course.[22]

In studying requirements for the training of teachers in science in Kentucky in 1938, Ambrose compared the state requirements of 14 semester hours with the 28 hours recommended by the Thirty-First Yearbook. With concern, Ambrose stated that, "The science requirements for elementary teachers should be extended."[23] He recommended a general science course and a professional methods course.[24]

A study of the preparation of Ohio elementary teachers in 1940, by Davis, indicated that the average number of credits in science taken by teachers was 8.328 semester hours. As a result of this study, Davis recommended wide science subject-matter experience with some degree of specialization in one field of science in addition to a course in methods

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[20]Lynn L. Ralya and Lillian L. Ralya, "Some Misconceptions in Science Held by Prospective Elementary Teachers," Science Education, XXII (1938), 244-251.

[21]Ibid., p. 250.

[22]Ibid.

[23]Luther M. Ambrose, "The Training of Teachers of Science in Kentucky," School Science and Mathematics, XXXVIII (1938), 132.

[24]Ibid.

of teaching science.[25]

Ford made a study in 1940 of fourteen Midwest teachers colleges and six Minnesota teachers colleges to determine the preparation of teachers. He concluded that none of the included colleges was meeting the requirements thought necessary by authorities. Perhaps the reason for the science requirements being so low was the crowded college program for the preparation of elementary teachers. Ford believed that one way to overcome this lack of science preparation was for the science educators to have a greater voice in the construction of the curriculum.[26]

In 1941, from a study of courses of study and workbooks in science, and from analysis of the science courses in thirty-one Texas senior colleges, Madeline Rudy recommended that colleges require six semester hours of biological science, six semester hours of physical science, an introductory course in one of the special fields, and finally, a one-semester-hour course in methods for the preparation of elementary teachers.[27]

In 1946, the Committee on Science, reporting in the Forty-Sixth Yearbook of the National Society for the Study of Education, identified specific recommendations for preparing elementary teachers to teach science in the elementary grades:

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[25]Warren H. Davis, "Preparation of Ohio Elementary Teachers in the Field of Science," School Science and Mathematics, XL (1940), 238-243.

[26]Leonard A. Ford, "Science Requirements in Midwest Teachers Colleges," Science Education, XXIV (1940), 272-275.

[27]Madeline Rudy, "Science Education for Elementary Teachers in Texas Teacher Training Institutions," Science Education, XXV (1941), 267-273.

> The importance of science in our daily lives justifies the suggestion that approximately twenty semester hours be devoted to science during the four-year college course. ..... It is suggested that these twenty hours be utilized in the following manner.
>
> There should be three six-semester-hour courses in subject matter. In the three subject-matter courses, the subject matter will be organized in large units which will develop the major generalizations within each area and which will, to a large degree, cut across artificial subject-matter barriers. The criteria for the selection of subject matter will be:
> 1) Does the subject matter contribute to the development of a well-educated individual?
> 2) Does the subject matter contribute to the preparation of a well-equipped elementary school teacher?
>
> Each of these three courses should provide for laboratory and field work, and each should be professionalized. The content usually covered in courses of special methods and problems of teaching should preferably be combined with these courses, although it may be offered as a separate course.
>
> One of the recommended courses should be concerned with the earth sciences. This would include materials from astronomy, geology, and meteorology.
>
> A second course would include the study of the physical sciences incorporating material from chemistry and physics. Although chemistry is of importance in our culture, at least half of the materials of this course should be drawn from the field of physics.
>
> The third subject matter course should be biological science. As with the other courses, this course should be built around general problems without reference to subject-matter boundaries. In other words, one general course is preferable to several courses in the special fields of botany, zoology, physiology, etc.[28]

This same committee, reporting elsewhere in the Forty-Sixth Yearbook, made recommendations as to the science content which they believed should

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[28] "The Improvement of Instruction in Science in the Elementary School," Science Education in American Schools, National Society for the Study of Education, Forty-Sixth Yearbook, Part I, ed. Nelson B. Henry (Chicago, 1947), p. 128.

be taught to children in the elementary grades. The committee stated that by the end of each year, children in the elementary grades should experience some growth in the broader areas of the environment, such as the following:

> The Universe. Here provision is made for the study of the stars, the sun, the moon, the planets, and their relationships. Pertinent materials would include those essential to an understanding of the causes of day and night, seasonal changes, tides, eclipses, and (less completely) of the vastness of the Milky Way galaxy and galactic systems beyond our own.
> The Earth. Among the pertinent topics in this phase of the environment are such problems as the origin of the earth, the formation of mountains, weathering of rock into soil, erosion, volcanism, prehistoric life, and the forces which have changed and are still changing the surface of the earth.
> Conditions Necessary to Life. What living things need in order to exist, how they are affected by changes in the environment, and the struggle for the conditions necessary to life are suggested materials in the development of this aspect of the environment.
> Living Things. Suitable materials include the variety of living things, the social life of animals, adaptations for protection, life cycles of plants and animals, how living things obtain their food, the economic importance of living things, and man's influence upon nature.
> Physical and Chemical Phenomena. Such chemical phenomena as rusting are considered in this phase of the environment. Physical phenomena which may be appropriate include: light, sound, gravity, magnetism and electricity, changes in state of matter, and the phenomena associated with radiant energy and atmospheric changes.
> Man's Attempt to Control His Environment. In this aspect of science the child may study man's control in gardens, on farms, in orchards; his inventions and discoveries; his use of power, of minerals; his control over living things; his study of places he cannot reach directly; and other such topics.[29]

If the preceding was to constitute the science content recommended for the elementary grades, then it should, of necessity, constitute the content of the science courses taught to college students preparing to teach in the elementary grades and should become the basis of the subject

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[29]Ibid., pp. 75-76.

matter making up the courses in the earth sciences, physical sciences, and biological sciences mentioned earlier.

The Forty-Sixth Yearbook further stated that a methods course in science should follow the basic content courses. In this special methods course for the teaching of elementary school science, the Yearbook suggests:

> The student should be given opportunity to see how the materials of the preceding courses in science can be organized into teaching units for the grades in which he is preparing to teach. The student should in this course have an opportunity to become acquainted with textbooks in science, and other literature written for children, as well as with courses of study. He should learn about sources of materials, such as free and low-cost motion pictures, lantern slides, apparatus, and museum materials. ..... Here also will be summarized the aims and objectives of science teaching in the elementary school and methods of evaluating these. The student should by all means observe a number of lessons taught by a superior classroom teacher and later discuss and evaluate the techniques employed.[30]

In pointing up the inadequate preparation of teachers to teach science in the elementary grades, Maddux, in 1949, visited 114 elementary schools in Cleveland, Ohio. From these visits she sensed a feeling of insecurity among teachers concerning science. To get a definite picture of the situation, she sent questionnaires concerning college preparation to the teachers of the upper elementary grades. Of 145 teachers to whom the questionnaires were sent, thirty-two had no science courses in college, whereas three had bachelors' degrees in science. The remaining teachers had from one to eight courses in science, with the greater number on the lower end of the scale.[31]

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[30]Ibid., p. 128.

[31]Grace Maddux, "Helping the Elementary Science Teachers," School Science and Mathematics, XLIX (1949), 534-537.

In surveying certification requirements in science for elementary school teachers, Mallinson, in 1949, reported that "in 32 states it is possible for a teacher to be certified to teach in the elementary grades without having any courses in science.[32] Of those few states requiring science, the "number of semester hours ranges from 3-12."[33]

Research, prompted by Mallinson's report of state requirements, was done by Snyder on college degree requirements for teachers in elementary science. The study covered 60 colleges, located in thirty-four states. Snyder found:

> 1) The average amount of science required for the four year elementary curriculum is 13.6 QH.
> 2) Only two of the sixty colleges do not require a science in any form.
> 3) Forty-three colleges require that the science be general biological and physical science survey courses.
> 4) Three colleges included a course in methods of teaching science in the elementary school as part of the science requirement.[34]

This study indicated that colleges had taken the initiative in setting requirements. As a result of his survey, Snyder recommended for prospective elementary teachers: "Thirty Q.H. of science divided between general biological and physical science and science teaching methods."[35]

Chamberlain, in his study to ascertain what the present day programs

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[32]George Greisen Mallinson, "State Requirements for Certification of Teachers of Elementary Science," Science Education, XXXIII (1949), 291.

[33]Ibid.

[34]Ernest E. Snyder, "College Degree Requirements for Teachers of Elementary Science," Science Education, XXXIV (1950), 31.

[35]Ibid.

offer in science education for elementary school teachers, examined college catalogs of 765 accredited colleges which offered a four year elementary education curriculum. He concluded that:

> Of this number, 442 listed courses in elementary school science in their catalogs, and 323 did not list such courses. The 765 colleges were located in the forty-eight states and the District of Columbia. Of the total of 765 colleges, 469 were supported by private means, while 296 colleges were publicly supported. More public institutions offered courses in elementary school science than private institutions. Many colleges which offered such courses were accredited by the American Association of Colleges for Teacher Education.
>
> The mean number of required semester hours of science background for colleges which offered courses in elementary school science was 9.21 semester hours, while the colleges which did not offer such courses required a mean of 8.83 semester hours. Of the 765 colleges, 523 did not specify what type of science courses the prospective elementary school teacher was to take, and only eighty institutions required that the science courses taken be laboratory courses. The median number of semester hours of methods and/or materials of elementary school science offered was three semester hours, and more than three-fourths of the institutions offering such courses ..... offered only one course or part of a course which was combined with other elementary school curriculum areas.[36]

Chamberlain sent a questionnaire to sixty-four college graduates in forty communities in thirteen states to get an evaluation of their college science courses. He stated:

> These teachers evaluated their college science courses. Generally speaking, they found basic courses in all sciences helpful, were quite positive on the value of field courses, did not feel the need for advanced chemistry, considered the field of physics most essential, and teachers who had not had astronomy or geology wished they had taken these subjects more than any other course. They also accented the helpfulness of professional science courses, and no teacher considered such

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[36]William D. Chamberlain, "Development and Status of Teacher Education in the Field of Science for the Elementary School" (unpub. Ed.D. dissertation, Wayne University, 1955), p. 150.

> courses not helpful. They considered professional courses other than science beneficial, especially courses in elementary school methods and child growth and development.[37]

The National Science Teachers Association received a grant, in 1958, from the National Science Foundation to make a study and hold a conference on elementary school science. The conference was confined to a discussion of five problems, one of which was: What pre-service science experiences characterize good programs for elementary teachers? The conference group included representatives of school superintendents, general elementary supervisors, supervisors of elementary and secondary school science, representatives of State Departments of Education, elementary school principals and classroom teachers, scientists, and persons responsible for the pre-service education of elementary teachers.

The conference reported that two general types of science courses are appropriate for the science education of an elementary school teacher. These are science courses and professionalized science courses. Concerning the science courses, the report stated:

> In a general way, the basic science courses should give an orderly concept of the physical and biological world. They would do well to concentrate on developing an understanding of important principles and generalizations in these areas of science. Such courses would be general in character, not going too deeply into any one area of science but developing the principles sufficiently to give an understanding of their importance.[38]

The report also stated that the following should characterize the

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[37]Ibid., pp. 151-152.

[38]Glenn O. Blough, It's Time for Better Elementary School Science, National Science Teachers Association Publication (Washington, 1958), pp. 35-36.

science courses that are offered to prospective elementary teachers:

> Opportunity to learn appropriate content of importance to them as teachers and as educated adults. ..... Opportunity to see interrelationships of the various fields of science in contrast to separate, isolated courses, for example, in botany and zoology.[39]

Concerning the professional science courses, the conference reported:

> In addition to the basic science courses offered to equip the elementary teachers for their work, certain professionalized courses (commonly called "methods courses") are considered essential. There is no reason to believe that knowledge of subject matter also means automatically ability to teach it skillfully. Here again we examine the objectives of such a course and then design the course to achieve them. Teachers need to understand how problems are identified, what can be done to solve them, how these activities can be carried out, what materials are needed to proceed, where the materials can be obtained, how they can be used, and how the complete process can be evaluated. These are among the most pressing needs of teachers.[40]

The report also stated that:

> Since subject matter and the methods of presentation are so closely related, it is reasonable to believe that the two may be combined in the professionalized course ..... The methods of effective use of experiments and field trips and the use of other teaching techniques are learned as the teachers themselves explore the problems realted to weather, astronomy, magnetism, electricity, and other areas of science. .....
>
> There should also be opportunity to observe some good science teaching in the elementary school under the guidance of a well prepared teacher.[41]

Blough and Huggett believe that a professionalized science course for the student preparing to teach in the elementary grades should include the science areas that are taught in the elementary grades such

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[39]Ibid., p. 37.

[40]Ibid.

[41]Ibid., p. 37-38.

as: the earth and heavenly bodies, the earth and its surface, the air and the weather, ancient plants and animals, growth of plants and animals, living things and the seasons, behavior and habits of animals, human body and how it grows, conservation of our resources, composition of things, heat and its uses, atomic energy and its uses, machines and how they work, magnetism and electricity, sound and its uses, light and its uses, and aviation.[42]

Craig, in his book, Science for the Elementary-School Teacher, stated that the professionalized science course should include the science areas that are taught in the elementary grades.[43] Craig's listings of these areas were consistent with the listings of Blough and Huggett.

John Gabriel Navarra and Joseph Zafforoni, in the preface to their book, Science Today for the Elementary-School Teacher, stressed the importance of including science content in the professional science course for preparing elementary teachers to teach science. These science content areas are consistent with the ones listed by Blough and Huggett, and Craig, as indicated by the following:

> Current ideas in science are developed within these pages in nine major areas - air, weather, and aviation; space, time, and the earth; matter, energy, and life.[44]

The Committee on Science reporting in the Fifty-Ninth Yearbook of the National Society for the Study of Education re-emphasized the course

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[42]Glenn O. Blough and Albert J. Huggett, Elementary School Science and How to Teach It (New York, 1951), pp. ix-xi.

[43]Gerald S. Craig, Science for the Elementary-School Teacher (New ed., Boston, 1958), p. iii.

[44]John Gabriel Navarra and Joseph Zafforoni, Science Today for the Elementary-School Teacher (Evanston, 1960), p. v.

content of the elementary grades:

> The universe and all its parts are the subject matter of science in the elementary school. It is not uncommon to find the content patterned somewhat as follows:
>
> Life Science: Plant Life
> Animal Life
> Human Beings and Health
>
> Earth Science: Rocks, Soils, Geological Processes
> Weather and Climate
> Earth in Space, Solar System and Beyond
>
> Other Physical Sciences: Machines and Engines, Forces, Motion, Energy, Heat, Sound, Light, Other Radiant Energy, Magnetism and Electricity, Structure of Matter, Chemical Change[45]

Summary

From the review of literature, the conclusion may be drawn that experts in the field of science teaching, writers of science textbooks, school administrators, science teachers, elementary teachers who teach science, and lay people doing research in the field of science are in almost complete agreement as to what the basic areas in the college science curriculum for future elementary teachers should be. These basic areas are: General Biological Science, General Physical Science, Earth Science, and a professional methods course in science teaching.

The following basic recommendations for the college science training of students preparing to teach in the elementary grades have emerged from the investigator's review of the literature: A total of 20 semester hours of science divided among general biological science, general physical

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[45]Robert Stollberg, "The Status of Science-Teaching in Elementary and Secondary Schools," Rethinking Science Education, National Society for the Study of Education, Fifty-ninth Yearbook, Part I, ed. Nelson B. Henry (Chicago, 1960), p. 84.

science, and a professionalized methods course in science; or six semester hours of biological science, six semester hours of physical science, six semester hours of earth science, and two semester hours of a professionalized methods course in science.

These foregoing recommendations constitute the framework around which the investigator built the interview checklist to be used in the study. The items of subject matter content making up the main body of the checklist were adopted from recommendations of authorities, taken directly from the literature that was reviewed. The checklist was designed to be used as an instrument to determine how closely the eight Oklahoma institutions of higher education included in the study adhere to these recommendations in preparing future elementary teachers to teach science. Development of the interview checklist will be described in Chapter III.

CHAPTER III

DEVELOPMENT OF THE INTERVIEW CHECKLIST

The problem of the study was to ascertain the content of the college science courses presently being taught to prospective elementary school teachers in eight Oklahoma colleges. An interview checklist was the instrument decided upon for obtaining this information. The checklist was to be used in personal interviews with those college instructors who are currently teaching the required or recommended science courses in the eight institutions. In addition to establishing the content of the courses, the responses recorded on the checklist were expected to reveal to what extent the content being taught paralleled what authorities in the field believe should be taught, since the checklist was composed of the recommendations of these authorities, as reported in Chapter II.

The Preliminary Checklist

Certain procedures were necessary to develop the checklist. The first important consideration was the selection of authorities in the field of science teaching in elementary schools. The investigator chose a number of outstanding persons in this field. The authorities chosen were persons who have achieved recognition through the authorship of widely accepted professional books and textbooks on the teaching and content of elementary school science and who have carried on outstanding

research in the field. These authorities were Glenn O. Blough, R. Will Burnett, Gerald S. Craig, Clark Hubler, Albert J. Huggett, June E. Lewis, John Gabriel Navarra, Irene C. Potter, and Joseph Zafforoni. The qualifications of these authorities are listed in Appendix A.

After the authorities had been chosen, a thorough study was made of the available writings of these authorities relative to the teaching of elementary school science. The titles of the books surveyed for this study are listed in Appendix B. The items of the original checklist were taken from these writings. The investigator selected for the checklist those areas, sub-areas, and items of a more specific nature relating to the sub-areas, that were considered by the authorities to be necessary in the science curriculum of the elementary school. The frequency with which each item was mentioned in the available writings of the authorities is shown in Table I.

From the data in Table I, the preliminary version of the checklist was developed. The preliminary checklist of 120 items is shown as Appendix C. The preliminary checklist was then submitted to a group of consultants for their criticisms and suggestions.

The Consultants and Their Qualifications

Thirty-two persons trained in elementary school science education were selected by the investigator to study the preliminary checklist to determine its suitability for use in planned interviews with college teachers. The checklist, accompanied by a letter and a personal data sheet, was mailed to these thirty-two persons. The letter and data sheet may be found in Appendix D. The names and addresses of the consultant group are listed in Appendix E.

TABLE I

THE FREQUENCY WITH WHICH EACH ITEM WAS MENTIONED IN THE AVAILABLE WRITINGS OF THE AUTHORITIES

ITEMS	WRITINGS A	B	C	D	E	F	G
I. A knowledge, understanding, and appreciation of the earth and the universe	x	x	x	x	x	x	x
A. Knowledge and understanding of the relationship of the earth and the heavenly bodies	x	x	x	x	x	x	x
1. The sun and the sun's family	x	x	x	x	x	x	x
2. Nature of the planets, their relative size, and their distance from the sun	x	x	x	x	x	x	x
3. The nature of comets, meteors, and planetoids	x	x	x	x	x	x	x
4. The nature of stars, their size, movement, and distance from earth	x	x	x	x	x	x	x
5. The moon, its size and movements, causes of tides, eclipses, and why the moon appears to change its shape	x	x	x	x	x	x	x
6. Causes of day and night and the seasons of the year	x	x	x	x	x	x	x
7. The vastness and orderliness of the universe	x	x	x	x	x	x	x
8. Man-made satellites		x	x			x	x
9. Gravitation and gravity	x	x	x	x	x	x	x
10. Constellations and galaxies	x	x	x	x	x	x	x
B. Knowledge and understanding of the earth's structure and its surface	x	x	x	x	x	x	x
1. The shape, size, and composition of the earth	x	x	x	x	x	x	x
2. The kinds of rock and their formation	x	x	x	x	x	x	x
3. The causes of mountains, earthquakes, volcanoes, hot springs, and geysers	x	x	x	x	x	x	x
4. Formation of soil	x	x	x	x	x	x	x
5. History of the earth	x	x	x	x	x	x	x
6. Forces that have changed and are still changing the surface of the earth	x	x	x	x	x	x	x
7. The continents	x	x		x		x	
8. Oceans, lakes, and streams		x		x	x	x	

TABLE I (Continued)

ITEMS	WRITINGS A	B	C	D	E	F	G
9. The nature of the earth's interior		x	x	x		x	
C. Knowledge and understanding of the composition and characteristics of air and the causes of weather	x	x	x	x	x	x	x
1. Composition, characteristics, and pressure of the atmosphere	x	x	x	x	x	x	x
2. The water cycle	x	x	x	x	x	x	
3. Forms of precipitation and their causes	x	x	x	x	x	x	x
4. Causes of winds and the wind belts of the world	x	x	x	x	x	x	x
5. Causes of hurricanes, tornadoes, and thunderstorms	x	x	x	x	x	x	
6. Weather forecasting		x	x	x	x	x	x
7. Climates of the earth	x	x	x	x		x	x
D. Knowledge and understanding of how natural resources can be conserved and why they need to be conserved	x	x	x	x	x	x	
1. Vanishing natural resources	x	x	x	x	x		
2. Dependence on natural resources	x	x	x	x	x		
3. Conservation of the soil by preventing erosion and maintaining soil fertility	x	x	x	x	x	x	
4. Conservation of coal, oil, gas, and minerals stored in the ground	x	x	x	x	x		
5. Conservation of water supplies	x	x	x		x		
II. A knowledge, understanding, and appreciation of living things	x	x	x	x	x	x	x
A. Understanding the growth and development of plants and animals	x	x	x	x	x	x	x
1. Prehistoric life	x	x	x	x	x	x	
2. The variety of living things and their classification	x	x		x	x		x
3. Conditions necessary for life	x	x	x	x	x	x	x
4. Struggle for existance and the balance of nature	x	x	x	x	x	x	x
5. Protective adaptation	x	x	x		x	x	
6. Reproduction of plants and animals	x	x	x	x	x	x	x
7. Growth of plants and animals	x	x	x	x	x	x	x
8. Obtaining and storing of food by plants and animals	x	x	x	x	x	x	x
9. Man's influence on living things and his dependence upon them	x	x	x	x	x	x	x
10. Plants and animals live in characteristic communities		x	x	x		x	
B. Understanding how the seasons of the year affect living things	x	x	x	x	x	x	
1. Hibernation of animals	x	x	x	x	x	x	

TABLE I (Continued)

ITEMS	WRITINGS A	B	C	D	E	F	G
2. Survival of insects	x	x	x	x	x	x	
3. Migration of animals	x	x	x			x	
4. Seasonal changes in plants and animals	x	x	x	x	x	x	
C. Knowledge of some of the behaviors and habits of animals	x	x	x	x	x	x	
1. Hermit animals	x	x	x		x		
2. Communal life among animals	x	x	x	x	x	x	
3. Home building of animals	x	x	x	x	x	x	
4. Animals protecting themselves and caring for their young	x	x	x	x	x		
D. Understanding the human body and how it works		x	x	x	x		x
1. Kinds of food and their uses in the human body		x	x	x	x		x
2. The systems of the body and their functions		x	x	x	x		x
3. Effect of alcohol, tobacco, and narcotics upon the human body			x	x	x		x
4. Causes of diseases and methods of control		x	x	x	x		
5. Reproduction		x	x	x	x		x
E. Understanding how living things can be conserved and why they need to be conserved	x	x	x	x	x		
1. Economic importance of living things	x	x	x	x	x		
2. Conservation of wild life	x	x	x	x	x		
3. Conservation of and need for forests	x	x	x	x	x		
III. A knowledge, understanding, and appreciation of matter and energy	x	x	x	x	x	x	x
A. Knowledge of the composition of things	x	x	x	x	x	x	x
1. The nature of atoms, molecules, elements, and compounds	x	x	x	x	x	x	x
2. Composition of matter	x	x	x	x	x	x	x
3. Physical and chemical change	x	x	x	x	x	x	x
4. Chemistry in man's everyday life	x	x	x		x	x	
B. Understanding the characteristics of heat and how it is used	x	x	x	x	x	x	
1. Heat as a form of energy	x	x	x	x	x	x	
2. Sources of heat and its measurement	x	x	x	x	x	x	
3. Effect of heat upon matter	x	x	x	x	x	x	
4. Producing and using heat	x	x	x	x		x	
5. Eliminating heat		x	x	x		x	

TABLE I (Continued)

ITEMS	WRITINGS A	B	C	D	E	F	G
6. Fire, its prevention and control	x	x	x	x		x	
C. Understanding atomic energy and knowledge of some of its uses		x	x	x	x	x	x
1. Structure of the atom		x	x	x	x	x	x
2. Forces within atoms		x	x	x	x	x	x
3. The fission process		x	x	x	x	x	x
4. The fusion process		x		x	x	x	x
5. Military uses of atomic energy			x	x	x		x
6. Nonmilitary uses of atomic energy		x	x	x	x	x	x
7. Radioisotopes				x	x	x	x
D. Gaining a knowledge of machines and how they work	x	x	x	x	x	x	
1. Simple machines such as the lever, the pulley, the wheel and axle, the inclined plane, the screw, and how they work	x	x	x	x	x	x	
2. Complex machines such as the steam engine, gasoline engine, diesel engine, power turbines, and how they work	x	x	x	x	x	x	
3. Friction	x	x	x	x	x	x	
E. Knowledge of some of the characteristics and uses of magnetism and electricity	x	x	x	x	x	x	x
1. Natural magnets and man-made magnets	x	x	x	x	x	x	x
2. Characteristics of magnets	x	x	x	x	x	x	x
3. The theory of magnetism	x	x	x	x	x	x	x
4. Static electricity	x	x	x	x	x	x	x
5. Generating electricity	x	x	x	x	x	x	x
6. Uses of electricity	x	x	x	x	x	x	x
F. Understanding what sound is and knowledge of some of its uses	x	x	x	x	x	x	
1. Causes of sound	x	x	x	x	x	x	
2. Characteristics of sound	x	x	x	x	x	x	
3. Using sound to produce music	x	x	x	x	x		
4. How we speak and how we hear	x	x	x	x	x		
G. Understanding the characteristics of light and knowledge of how light can be used	x	x	x	x	x	x	
1. Characteristics of light	x	x	x	x	x	x	
2. Reflection and refraction of light	x	x	x	x	x	x	

TABLE I (Continued)

ITEMS	WRITINGS A	B	C	D	E	F	G
3. How we see objects	x	x	x	x	x	x	
4. Uses of light in motion pictures, microscopes, telescopes, and cameras		x	x	x	x	x	
5. Formation of colors		x	x	x	x	x	
6. Providing proper lighting in our homes	x	x	x	x	x		
7. Correcting eye defects with lenses	x	x	x	x	x		
H. Knowledge and understanding of aviation	x	x	x	x	x	x	
1. How an airplane flies	x	x	x	x	x	x	
2. Types of aircraft		x	x	x	x	x	
3. Aircraft instruments and their uses			x	x	x	x	
4. Characteristics of jet propulsion		x	x		x	x	x
5. Characteristics of rockets and missiles		x	x			x	x
6. Aviation and weather		x	x	x	x	x	

Twenty-five of the thirty-two persons to whom this checklist was sent returned completed questionnaires and data sheets. Seven persons did not reply. From the personal data sheets returned by these twenty-five consultants, certain facts emerged which point to their competence to pass judgment on the checklist. These facts are tabulated in Table II.

Because the elementary science program is departmentalized in the Tulsa school system, approximately one-third of the thirty-two consultants selected by the investigator were teachers in the Tulsa Public Schools. The investigator felt that, because these teachers are specialists in the field of teaching elementary school science, their responses would strengthen the survey.

Eighteen of the twenty-five responding consultants have at one time taught, or are now teaching, science in the elementary grades. Nineteen of the responding consultants have at one time taught, or are now teaching, science in the secondary grades.

One of the consultants is presently a coordinator of student teachers of the elementary grades in an Oklahoma state college. He was at one time a supervisor of science teachers and has had eight years experience teaching science in the elementary and secondary grades.

Four of the consultants are presently school administrators. Two of these persons have taught both elementary and high school science; one has taught only elementary school science; and one, who is a superintendent of schools, has had twenty years experience as a supervisor of science teachers.

One of the consultants is the chairman of the science department in a Tulsa high school where he also teachers science.

TABLE II

QUALIFICATIONS OF CONSULTANTS

CON-SULTANT	BACHELOR'S DEGREE		MASTER'S DEGREE		HOURS OF COLLEGE SCIENCE		YEARS OF SCIENCE TEACHING EXPERIENCE			PRESENT POSITION
	MAJOR	MINOR	MAJOR	MINOR	BIOLOGICAL	PHYSICAL	ELEM.	HIGH SCHOOL	COLLEGE	
1	Chemistry	Mathematics				56	5	8		High School Science
2	Sociology	Psychology	Administration	Administration	12	14	6	9		Elementary Science
3	Science	English			18	30		4		High School Science
4	Chemistry	Biology			35	31	2			Elementary Principal
5	Science	Mathematics	Science		14	35	10	4		Junior High Science
6	Physics	Biology			28	51		3		Junior High Science
7	Elementary	Business			13	10	2			Junior High Science
8	Biology	Mathematics	Administration		28	50		13		General Science
9	History	Speech	Education		11	4	20			Elementary Science
10	Physical Ed.	Biology			27	10		6		Junior High Science
11	Elementary	English			16	4	5			Elementary Science
12	Education	Gen. Science	Horticulture	Education	63	32	10	6		Elementary Science
13	Chemistry	Biology	Chemistry	Biology	25	90	6	5		Chemistry
14	Soc. Studies	Science			9	27	3	1		Junior High Science
15	English	Science			13	29	13			Elementary Science
16	Biology	Geography			28	26		3		General Science
17	Elementary	Physical Ed.	Administration	Guidance	15	4	1	2		Principal and Supervisor
18	Biology	Chemistry	Education	Audio Visual	28	34	5	28	8	Junior High Science
19	Soc. Studies	Mathematics	Administration	Soc. Studies	16	12	2	4		Superintendent
20	Mathematics	Physics			4	35	2	3		General Science
21	Chemistry	Biology			13	41		2		General Science
22	History	Elementary	History	English	6	8	12			Elementary Science
23	Physical Ed.	Chemistry			16	24		4		General Science
24	Chemistry	Biology	Administration	Science	28	76	1	18		Instructor of Elementary Science Teachers
25	Mathematics	Science	Administration		15	16	6	2	1	Coordinator of Student Teachers

Four of the twenty-five responding consultants have bachelors' degrees with majors in elementary education. One consultant has a bachelor's degree with a minor in elementary education. Eleven of the consultants have bachelors' degrees with majors in science, while fifteen hold bachelors' degrees with minors in science. Twelve of the consultants hold masters' degrees, three of them with majors in science, and two with minors in science. In summary, this group of consultants, through professional preparation and experience, seemed well qualified to pass judgment on the items in the original checklist.

The consultants were instructed to examine the checklist to determine its suitability for use in personal interviews with instructors of science in eight Oklahoma colleges. An explanation was made that the checklist was to be used to determine how the science course content, now being offered in these colleges to students who are preparing to teach in the elementary grades, compared with recommendations of authorities in the field of elementary school science education. The consultants were instructed to make corrections or additions that would improve the instrument by making the statements clearer or the checklist more complete. If no corrections or additions were deemed necessary, the consultants were asked to indicate that no change was needed.

Analysis of Suggestions Made by the Group of Consultants

The twenty-five consultants suggested a number of corrections and additions, some of which were accepted by the writer as being valid, while others were rejected. The responses of the consultants are shown in Table III. A study of the table indicates which items of the original checklist were considered by the consultants as acceptable with no changes

TABLE III

RESPONSES OF THE CONSULTANTS AND PRELIMINARY INSTRUMENT

ORIGINAL CHECKLIST	SUGGESTED CORRECTIONS AND ADDITIONS
I. A knowledge, understanding, and appreciation of the earth and the universe	No change
A. Knowledge and understanding of the relationship of the earth and the heavenly bodies	No change
1. The sun and the sun's family	No change
2. Nature of the planets, their relative size, and their distance from the sun	No change
3. Nature of comets, meteors, and planetoids	No change
4. Nature of stars, their size, movement, and distance from earth	No change
5. The moon, its size and movements, causes of tides, eclipses, and why the moon appears to change its shape	No change
6. Causes of day and night and the seasons of the year	Only one consultant suggested a change. He suggested that this item be placed under subdivision C., "Knowledge and understanding of the composition and characteristics of air and the causes of weather." The writer rejected this idea because this phenomena is directly related to the movement of the earth and not to atmospheric conditions.
7. The vastness and orderliness of the universe	No change
8. Man-made satellites	Only one consultant suggested that, to the original statement, "Man-made satellites," be added "and problems of space flight." The writer agreed that "Problems of space flight" should be included in the checklist but placed it as item 7 under major division III, subdivision H, "Knowledge and understanding of aviation." According to the reviewed literature,

TABLE III (Continued)

ORIGINAL CHECKLIST	SUGGESTED CORRECTIONS AND ADDITIONS
9. Gravitation and gravity	this is the more logical place for its inclusion. The original statement, "Gravitation and gravity," was modified by only one of the consultants to read, "Gravitation, gravity, and inertia." The writer considered this an improvement and revised the statement accordingly.
10. Constellations and galaxies	No change
11. Others (list and check)	"Solar energy and cosmic rays" was suggested as a needed addition by three consultants. Also, "Theories of the formation of the earth" was considered an item of sufficient importance to warrent inclusion in the checklist by five consultants. These additions were accepted by the investigator and placed in the checklist as items I.A.11 and I.A.12.
B. Knowledge and understanding of the earth's structure and its surface	No change
1. The shape, size, and composition of the earth	No change
2. The kinds of rock and their formation	No change
3. The causes of mountains, earthquakes, volcanoes, hot springs, and geysers	No change
4. Formation of soil	No change
5. History of the earth	"Knowledge of the geological time chart" was considered by only one respondent an important item which had been omitted under this division. The geological time chart deals with eras, periods, and epochs of the earth's history. Therefore, the investigator revised item I.B.5, "History of the earth," to read, "History of the earth - the geological time chart" to include this item.
6. Forces that have changed and are still changing the surface of the earth	No change

TABLE III (Continued)

ORIGINAL CHECKLIST	SUGGESTED CORRECTIONS AND ADDITIONS
7. The continents	No change
8. Oceans, lakes, and streams	No change
9. The nature of the earth's interior	Due to the fact that concepts and theories regarding the nature of the earth's interior are changing, one consultant questioned the factual tone of this statement. This criticism was considered by the writer to be well-founded. Therefore, the statement was revised to read, "Theories concerning the earth's interior."
10. Others (list and check)	"The polar regions" was an item added by two of the consultants. The investigator considered this a valid addition in view of the present day stress being placed on these regions and included it as item I.B.8.
C. Knowledge and understanding of the composition and characteristics of air and the causes of weather	No change
1. Composition, characteristics, and pressure of the atmosphere	No change
2. The water cycle	No change
3. Forms of precipitation and their causes	No change
4. Causes of winds and the wind belts of the world	No change
5. Causes of hurricanes, tornadoes, and thunderstorms	No change
6. Weather forecasting	The instruments used in forecasting weather should have been mentioned in this statement, according to one respondent. The item was revised to read, "Weather forecasting and instruments used."
7. Climates of the earth	No change
8. Others (list and check)	The opinion of only one of the consultants was that "Types of clouds and their elevations" is a

TABLE III (Continued)

ORIGINAL CHECKLIST	SUGGESTED CORRECTIONS AND ADDITIONS
	subject of sufficient importance to be included under this division. The writer concurred with this idea, reworded the consultant's statement to read, "Cloud formations," and made this addition to the checklist as item I.C.4.
D. Knowledge and understanding of how natural resources can be conserved and why they need to be conserved	No change
1. Vanishing natural resources	No change
2. Dependence on natural resources	No change
3. Conservation of the soil by preventing erosion and maintaining soil fertility	No change
4. Conservation of coal, oil, gas, and minerals stored in the ground	No change
5. Conservation of water supplies	No change
6. Others (list and check)	No change
II. A knowledge, understanding and appreciation of living things	No change
A. Understanding the growth and development of plants and animals	No change
1. Prehistoric life	Two respondents commented that, since the theory of evolution is currently being given a place in the teaching of science, it should be included. On reviewing the literature, the investigator found this theory stressed and modified this item to read, "Prehistoric life and evolution of living things."
2. The variety of living things and their classification	No change
3. Conditions necessary for life	No change
4. Struggle for existance and the balance of nature	Only one consultant was of the opinion that

TABLE III (Continued)

ORIGINAL CHECKLIST	SUGGESTED CORRECTIONS AND ADDITIONS
	"struggle for existence" implies "the balance of nature." To clarify the statement and at the same time make it more inclusive, he suggested it be revised to read, "Interrelationship of living things and the balance of nature." This was considered to be a well-founded idea and the consultant's statement was substituted for the original one.
5. Protective adaptation	No change
6. Reproduction of plants and animals	No change
7. Growth of plants and animals	No change
8. Obtaining of food and storing it by plants and animals	No change
9. Man's influence on living things and his dependence upon them	No change
10. Plants and animals live in characteristic communities	A suggestion of only one of the twenty-five persons who examined the checklist was that this item was the same as item II.C.2, "Communal life among animals." This reasoning is incorrect in that "characteristic communities" refers to where plants and animals normally live locally and universally and why. To study communal life of plants and animals is to study which ones of these live in communities with one another and why. Therefore, this suggestions was rejected. However, the writer reworded the statement to "Normal habitats of plants and animals" to clarify the meaning.
11. Others (list and check)	No change
B. Understanding how the seasons of the year affect living things	No change

TABLE III (Continued)

ORIGINAL CHECKLIST	SUGGESTED CORRECTIONS AND ADDITIONS
1. Hibernation of animals	No change
2. Survival of insects	No change
3. Migration of some animals	No change
4. Seasonal changes of plants and animals	No change
5. Others (list and check)	Only one respondent suggested that "Human adaptations to seasonal changes and to climate" be added to this subdivision. This was accepted and included in the checklist as item II.B.5.
C. Knowledge of some of the behaviors and habits of animals	No change
1. Hermit animals	No change
2. Communal life among animals	No change
3. Home building of animals	No change
4. Animals protecting themselves and caring for their young	No change
5. Others (list and check)	Only one consultant expressed the opinion that "Foods used by animals" should be added to this subdivision. This was not done because the foods of animals is included in item II.A.8, "Obtaining and storing of food by plants and animals."
D. Understanding the human body and how it works	No change
1. Kinds of food and their uses in the human body	No change
2. The systems of the body and their functions	No change
3. Effect of alcohol, tobacco, and narcotics upon the human body	No change
4. Causes of diseases and methods of control	No change
5. Reproduction	No change
6. Others (list and check)	Only one of the persons examining the checklist suggested that "something on the professional aspect of human health, physicians, etc.," be incorporated here. The writer rejected this suggestion because this would be covered in health

TABLE III (Continued)

ORIGINAL CHECKLIST	SUGGESTED CORRECTIONS AND ADDITIONS
	courses rather than in science courses.
E. Understanding how living things can be conserved and why they need to be conserved	No change
1. Economic importance of living things	No change
2. Conservation of wild life	No change
3. Conservation of and need for forests	No change
4. Others (list and check)	"Man's part in maintaining the balance of life in nature" was a suggested item by one of the consultants. This item was accepted by the writer and included as item II.E.4.
	"Protection of beneficial wild life" was suggested as an addition by only one consultant. This is a repetition of item II.E.3, "Conservation of wild life," and for this reason was rejected.
III. A knowledge, understanding, and appreciation of matter and energy	No change
A. Knowledge of the composition of things	No change
1. The nature of atoms, molecules, elements, and compounds	To this item should be added the term "mixtures," according to only one respondent. This was considered correct and the item was revised accordingly.
2. Composition of matter	No change
3. Physical and chemical change	No change
4. Chemistry in man's everyday life	No change
5. Others (list and check)	Only one of the consultants felt that "forms of energy and their source" should be fitted into this division on the composition of things. On the original checklist the different forms of energy are interwoven throughout major Division III under subdivisions of their respective sources. Since

TABLE III (Continued)

ORIGINAL CHECKLIST	SUGGESTED CORRECTIONS AND ADDITIONS
	it would be repetitious to include this in the checklist as a separate item, this idea was not used.
	The fact that the Periodic Table was not mentioned was questioned by two of the persons examining the checklist. The investigator found no instance in which the Periodic Table was discussed in books by authorities on elementary school science. This table is probably too technical to be presented at the elementary level. Therefore, this item has not been included.
B. Understanding the characteristics of heat and how it is used	No change
1. Heat as a form of energy	No change
2. Sources of heat and its measurement	No change
3. Effect of heat upon matter	No change
4. Producing and using heat	No change
5. Eliminating heat	This statement was considered by three of the consultants to be rather poorly worded, or confusing. "Refrigeration and air conditioning" was suggested as a better way of stating this. The writer welcomed this change as a needed improvement. This item became III.B.6 on the revised checklist.
6. Fire, its prevention and control	No change
7. Others (list and check)	Only one consultant pointed out the necessity of adding conduction, convection, and radiation in this category. In concurrence with this, item 5, "Methods of heat transference" was added.
C. Understanding atomic energy and knowledge of some of its uses	No change

TABLE III (Continued)

ORIGINAL CHECKLIST	SUGGESTED CORRECTIONS AND ADDITIONS
1. The structure of the atom	No change
2. Forces within atoms	No change
3. The fission process	No change
4. The fusion process	No change
5. Military uses of atomic energy	No change
6. Nonmilitary uses of atomic energy	No change
7. Radioisotopes	No change
8. Others (list and check)	Four respondents noted that "fall-out" had not been mentioned, and, in their opinions, it should have been. The writer has included this item as III.C.8, "Radioactive fall-out."
D. Gaining a knowledge of machines and how they work	No change
1. Simple machines such as the lever, the pulley, the wheel and axle, the inclined plane, the screw, and how they work	No change
2. Complex machines such as the steam engine, gasoline engine, diesel engine, power turbines, and how they work	No change
3. Friction	No change
4. Others (list and check)	"What work is and how it is measured" was suggested for inclusion by five of the respondents. The writer considered this a valid addition after examining the literature and placed it under subdivision D as item 1.
E. Knowledge of some of the characteristics and uses of magnetism and electricity	No change
1. Natural magnets and man-made magnets	No change
2. Characteristics of magnets	No change
3. The theory of magnetism	No change
4. Static electricity	No change
5. Generating electricity	No change

TABLE III (Continued)

ORIGINAL CHECKLIST	SUGGESTED CORRECTIONS AND ADDITIONS
6. Uses of electricity	No change
7. Others (list and check)	"Measuring electricity" and "Electrical circuits" were considered important additions by only one consultant. On reviewing the literature, these ideas were found to be justified and have become items 6 and 7 under division III, subdivision E.
F. Understanding what sound is and knowledge of some of its uses	No change
1. Causes of sound	No change
2. Characteristics of sound	No change
3. Using sound to produce music	No change
4. How we speak and how we hear	No change
5. Others (list and check)	No change
G. Understanding the characteristics of light and knowledge of how light can be used	No change
1. Characteristics of light	No change
2. Reflection and refraction of light	No change
3. How we see objects	No change
4. Uses of light in motion pictures, microscopes, telescopes, and cameras	No change
5. Formation of colors	No change
6. Providing proper lighting in our homes	No change
7. Correcting eye defects with lenses	No change
8. Others (list and check)	No change
H. Knowledge and understanding of aviation	No change
1. How an airplane flies	No change
2. Types of aircraft	No change
3. Aircraft instruments and their uses	No change
4. Characteristics of jet propulsion	No change
5. Characteristics of rockets and missiles	No change
6. Aviation and weather	No change
7. Others (list and check)	Please see item I.A.8.

needed. Further study of the table indicates all corrections and additions suggested by the respondents and shows why the investigator incorporated these ideas into the checklist or why he rejected them.

Of the total of 120 statements on the original checklist, 111 were found acceptable and were left unchanged by the consultants. Nine changes were suggested to clarify the meaning of certain statements. These were made. Two changes were suggested which were rejected by the investigator. In no instance was a deletion suggested. Twelve of the items which consultants suggested for addition to the checklist were added to the data-gathering instrument by the investigator. Five additions suggested by the consultants were rejected by the investigator. The consultant's responses formed the basis for the revision of the original checklist into its final form, which is shown in Appendix F.

Numerous general comments were made regarding the content of the checklist. Seven of the twenty-five consultants who examined the checklist felt that it was clear and complete. They made no additions or corrections. Representative comments of these seven were: "No corrections or additions are necessary. Very good checklist;" "The checklist looks complete to me;" "I have checked this content list and I believe it covers the areas quite well;" "I have read the checklist, as you requested, and I find that it is well stated and adequate for this study."

Other consultants stated: "I find only one fault, that being the length;" "I think your interview checklist is excellent. I think the questions are worded well, and I believe this checklist will accomplish what you have intended;" "I thought the checklist a very thorough one. It closely adheres to my course of study ..... ;" "I think you have a very fine checklist. I enjoyed going over this material very much."

Validation of the Revised Checklist

Next, the investigator arranged for interviews with the science instructors at Northeastern State College, Tahlequah, Oklahoma. These first interviews, made at the investigator's school, were to serve a double purpose. In addition to determining course content, the workability and clarity of the revised checklist were to be observed carefully. The writer believed that this "trial run" was necessary before he visited the seven other institutions.

A letter was sent to the chairman of the science department of Northeastern State College (Appendix G) giving instructions as to how Parts I and II of the interview checklist were to be filled out. Accompanying this letter was one copy of Part I of the checklist (Appendix G). Part I represents, in different patterns, the college science curriculum recommended by the authorities for future elementary school teachers, as stated in Chapter II of this study. Part I also includes a listing of the various science areas used in this study, including geography, which is considered an ecological science. In preparing Part I of the instrument, several sections were necessary, since the pattern of courses offered or recommended varies considerably among the eight institutions included in the study. Part I was to be completed by any member of the college teaching staff acquainted with the science requirements of Northeastern State College for the preparation of elementary school teachers.

Accompanying the letter to the chairman of the science department was one copy of Part II of the checklist (Appendix F) for each member of the staff of Northeastern State College who teaches a science course

that is required or recommended for the standard elementary certificate. A letter of explanation and instruction (Appendix G) was attached to each checklist. A personal data sheet was included for each instructor concerned (Appendix G).

A schedule of interviews was arranged by the chairman of the department and the writer then had an interview with each instructor concerned. The interview checklist proved to be a clearly stated and a workable instrument, as testified to by the success of the interviews.

Summary

A checklist, to be used in interviews with college science instructors, was the instrument decided upon for use in establishing the science content now being taught to future elementary school teachers in eight Oklahoma institutions of higher education. The original checklist of 120 items was a compilation of the areas and sub-areas of science consistently considered by nine authorities as essential in the curriculum of elementary school science.

A group of thirty-two persons, trained in elementary school science, was selected to examine this original checklist for the purpose of determining its suitability for use in the planned interviews. Twenty-five of these persons made corrections and additions that improved the original checklist, making it a more workable instrument. Of a total of 120 statements on the original checklist, 111 were found acceptable and were left unchanged by the consultants. Nine changes were suggested and were made to clarify the meaning of certain statements. Two changes were suggested which were rejected by the investigator. In no instance was a deletion suggested. Twelve items which consultants suggested for addition

to the checklist were added to the checklist by the investigator. Five additions suggested by the consultants were rejected by the investigator. Seven of the twenty-five consultants who were asked to examine the checklist felt that it was clear and complete and made no additions or corrections.

Using the revised checklist, the investigator made a trial run at Northeastern State College. As a result of these first interviews, the investigator found that the checklist was a clearly stated and workable instrument which could be used successfully in establishing reliable information for this study.

CHAPTER IV

DATA OF THE STUDY

In Chapter III the procedures followed at College A during the trial run of the checklist were described. The same procedures were followed at each of the other institutions included in the study.

Procedures for Gathering Data

The investigator first corresponded with the presidents of five of the colleges (Appendix H) seeking permission to interview the teachers of the science courses required or recommended for future elementary school teachers. At the two remaining institutions, the investigator contacted the chairman of the science division rather than the president of the school. These were large, multiple purpose institutions. After having received permission from these people to hold the interviews, telephone calls were made to the department chairmen explaining the study and the necessity of conferring personally with certain members of the teaching staff. Appointments for interviews were arranged at this time.

Several days before the interview dates, a letter was sent to the chairman of the science division of each of the seven remaining institutions (Appendix G) giving instructions as to how Parts I and II of the interview checklist were to be filled out. Accompanying this letter was one copy of Part I of the checklist (Appendix G). This part was to be completed by any member of the teaching staff acquainted with the science

requirements of that particular college for the preparation of elementary school teachers.

Also accompanying the letter to the chairman of the science department was one copy of Part II of the checklist (Appendix F) with a letter of explanation and instruction attached (Appendix G) for each member of the staff of that particular college who teaches a science course that is required or recommended by that college for the standard elementary certificate. A personal data sheet (Appendix G) was also included to be completed by each instructor concerned. The division chairman was asked to distribute this material to the science instructors in advance of the interview date so that the instructors would have time to study the checklist and check it before the interview.

At six of the remaining seven schools, the investigator first met with the science division chairman. Part I of the checklist was discussed with him to determine what science courses are presently being required or recommended by that school for the preparation of the elementary school teacher and to obtain the names of the instructors who teach these courses. The current catalog of the school was examined for a description of these same courses (Appendix I).

Personal interviews were then held with each member of the staff who teaches a course or courses pertinent to the study. The entire interview checklist, which had been previously completed by the instructor, was discussed. The investigator encouraged comments on the checklist and on the study as a whole.

When the investigator arrived at the seventh institution, all the science instructors affected by the study, and the chairman of the science department of that school, were in conference for the purpose of the

interview. The chairman felt that a round-table discussion involving all of the members of the staff affected by the elementary science requirements of that school would be a most effective way of conducting the interview. As was done in each of the individual interviews at the other schools, the purpose of the study was explained and the investigator outlined what he wanted the interview checklist to determine. Parts I and II of the checklist were then discussed in detail.

In no instance did any instructor object to filling out the checklist. All persons interviewed were cooperative and showed an interest in the study, expressing the conviction that such a study could serve a needed and useful purpose. Several instructors commented that, heretofore, they had not had a clear overall picture of what the complete curriculum of science for the elementary grades should include, and that the checklist had summarized this in an enlightening way for them. The persons interviewed felt that the statements on the checklist were clearly stated. The interviewer felt confident that this was true, as very few instructors asked for interpretations.

Procedures for Tabulation and Interpretation of Data

To interpret and understand the data gathered from each school, the writer decided to combine the results of all the individual teacher checklists at each institution into one table for each institution. There are five categories into which the responses to each item on the checklist could fall. These categories and the key used to indicate stress are shown in Plate I. Tables IV to XI are to be interpreted with the use of the symbols shown in the plate.

In referring to Plate I, the item in Category 1 is taught and stressed

to each student in at least one of the four subjects pursued, even though there are three possible teachers for the biological science course (B), two possible teachers for the physical science course (P), two possible teachers for the geography course (G), and one teacher for the methods course (M). If an item is taught and stressed by one teacher in any one of the four courses pursued by each student, it is considered to be taught and stressed, as indicated in the Résumé column. The symbol used to denote this in the table is "x".

PLATE I

SAMPLE TABULATION SHEET

	Courses								
	B			P		G		M	
Category	1	2	3	1	2	1	2	1	Résumé
1	-		x	-	-	-	-	x	x
2	-	-	-				-	-	-
3	-	-	x	-	-	x	-	-	-x
4	-		x		-		-		?
5									no

Key

x	Taught and stressed
-	Taught but not stressed
-x	May be taught but not stressed or taught and stressed
?	May or may not be taught
no	Is not taught

In Category 2, the item is taught but not stressed to each student, regardless of the science courses taken or the teachers who teach these courses. The symbol used to denote this in the table is "-".

In Category 3, the item may be taught and stressed, or it may be

taught but not stressed, depending upon the combination of teachers selected for the courses taken by the student. The symbol used to denote this in the table is "-x".

In Category 4, the item may be taught, or it may not be taught to the student, depending upon the teacher selected for those science courses having more than one teacher. The symbol used to denote this in the table is "?".

In Category 5, the item is not taught by any of the teachers of the science courses. Therefore, a student will not receive instruction concerning this item. The symbol used to denote this in the table is "no".

Data Gathered From the Eight Schools

School A

The science curriculum required or recommended for the preparation of the prospective elementary school teacher at School A consists of the following courses:

General Biology 104	4 hours
General Physical Science 104	4 hours
Geography for the Elementary Teacher NE353	3 hours
Science for the Elementary Teacher 402	2 hours

The catalog description of these courses is given in Appendix I.

The two general survey courses, General Biology 104 and General Physical Science 104, are recommended for all students in college. Some exceptions can be made, but over ninety per cent of the students who are preparing to be elementary school teachers take these courses. The instructors of these courses stated that separate courses in these areas should be offered for students who are preparing to be elementary school teachers. These separate courses should be directed toward the knowledge

and skills necessary to teach science in the elementary grades and should replace regular survey courses.

The science courses required or recommended for the prospective elementary school teacher include the areas of astronomy, botany, chemistry, geology, meteorology, physics, physiology, and zoology.

The two-hour methods course in science now offered and required for students preparing to be elementary school teachers includes certain selected areas in natural science that the instructor feels should be stressed more than they are stressed in the general survey courses in science. The prerequisites to this methods course are Mathematics 113, Biology 104, and General Physical Science 104. The methods course is primarily subject matter. However, methods are included as well as scope and sequence.

The specific content of the science courses pursued by each student preparing for the elementary school certificate depends upon the combination of teachers selected by the student. Three different teachers teach the general biological science course (B), two teach the general physical science course (P), and two teach the geography course (G). However, all the students will have the same teacher in the methods course in science for the elementary school teacher (M).

A study of Table IV reveals that sixty-six of the 112 items listed in the areas and sub-areas of the checklist are taught and stressed in at least one of the science courses taken by each student. Nineteen items are either taught and stressed or taught but not stressed, depending upon the combination of teachers selected by a student.

Eleven items are included but not stressed, regardless of the science instructors selected by the student preparing for the elementary school

TABLE IV

INTERVIEW RESPONSES TO CHECKLIST AT COLLEGE A

COURSE CONTENT	COURSES								
	B			P		G		M	
	1	2	3	1	2	1	2	1	RÉSUMÉ
I. A knowledge, understanding, and appreciation of the earth and the universe									
A. Knowledge and understanding of the relationship of the earth and the heavenly bodies									
1. The sun and the sun's family				x	x	x	x		x
2. Nature of the planets, their relative size, and their distance from the sun				x	x	-	x		x
3. Nature of comets, meteors, and planetoids				x	x	-	-		x
4. The moon, its size and movements, causes of tides, eclipses, and why the moon appears to change its shape				x	x	-	-		x
5. Nature of stars, their size, movement, and distance from earth				x	x	-	-	x	x
6. Causes of day and night and the seasons of the year				x	x	x	x		x
7. The vastness and orderliness of the universe			-	x	-	x	x	x	x
8. Man-made satellites			-	-	-	-	-	-	-
9. Gravitation, gravity, and inertia			-	x	x	-	-		x
10. Constellations and galaxies				x	-	-	-	x	x
11. Solar energy and cosmic rays		-	-	x	-	-	-	-	-x
12. Theories of the formation of the earth		-	-	-	-				-
B. Knowledge and understanding of the earth's structure and its surface									
1. The shape, size, and composition of the earth		-		x	x	x			x
2. Kinds of rock and their formation			-	x	x	-	x		x
3. The causes of mountains, earthquakes, volcanoes, hot springs, and geysers			-	x	x	x	x		x
4. Formation of soil		-	-	-	-	x	x		x
5. History of the earth - the geological time chart		-	-	x	-	-	-	x	x
6. Forces that have changed and are still changing the surface of the earth		-	-	x	x	-	-		x

TABLE IV (Continued)

COURSE CONTENT	COURSES								RÉSUMÉ
	B			P		G		M	
	1	2	3	1	2	1	2	1	
7. The continents			-	x	-	x	x		x
8. The polar regions						x	x		x
9. Oceans, lakes, and streams			-	x	x	x	x		x
10. Theories concerning the earth's interior			-	x			-	-	-x
C. Knowledge and understanding of the composition and characteristics of air and the causes of weather									
1. Composition, characteristics, and pressure of the atmosphere		-	-	x	x	x		x	x
2. The water cycle			-	x		x	x	-	x
3. Forms of precipitation and their causes			-	-		x	x	x	x
4. Cloud formation			-	-		x	x	-	x
5. Causes of winds and the wind belts of the world			-			x	x		x
6. Causes of hurricanes, tornadoes, and thunderstorms			-			x	x	x	x
7. Weather forecasting and instruments used						x	x	x	x
8. Climates of the earth			-			x	x		x
D. Knowledge and understanding of how natural resources can be conserved and why they need to be conserved									
1. Vanishing natural resources			-			x	x		x
2. Dependence on natural resources			-			x	x		x
3. Conservation of the soil by preventing erosion and maintaining soil fertility			-			x	x		x
4. Conservation of coal, oil, gas, and minerals stored in the ground			-			x	x		x
5. Conservation of water supplies			-			x	x		x
II. A knowledge, understanding and appreciation of living things									
A. Understanding the growth and development of plants and animals									
1. Prehistoric life and evolution of living things		x	x	x	-			x	x
2. The variety of living things and their classification	-	-	x					x	x
3. Conditions necessary for life	x	x	x						x
4. Interrelationship of living things and balance of nature	-	x	x			-			-x
5. Protective adaptation	-	-	x						-x

TABLE IV (Continued)

COURSE CONTENT	COURSES B 1	B 2	B 3	P 1	P 2	G 1	G 2	M 1	RÉSUMÉ
6. Reproduction of plants and animals	-	x	x						-x
7. Growth of plants and animals	x	x	x			-			x
8. Obtaining and storing of food by plants and animals	x	x	x			-		-	x
9. Man's influence on living things and his dependence upon them	-		x			-		-	-x
10. Normal habitats of plants and animals			x			-			?
B. Understanding how the seasons of the year affect living things									
1. Hibernation of animals		-	-						?
2. Survival of insects			-						?
3. Migration of some animals			-			-			?
4. Seasonal changes in plants and animals		-	x			-	x		-x
5. Human adaptations to seasonal changes and to climate			x			-	x		-x
C. Knowledge of some of the behaviors and habits of animals									
1. Hermit animals									no
2. Communal life among animals			-						?
3. Home building of animals			-						?
4. Animals protecting themselves and caring for their young		-	x						?
D. Understanding the human body and how it works									
1. Kinds of food and their uses in the human body	x	x	x						x
2. The systems of the body and their functions	x	x	x						x
3. Effect of alcohol, tobacco, and narcotics upon the human body	-		-						?
4. Causes of diseases and methods of control	-	-	x						-x
5. Reproduction	x	x	x						x
E. Understanding how living things can be conserved and why they need to be conserved									
1. Economic importance of living things	-		x			x	x		x
2. Conservation of wild life			x			x	x		x
3. Conservation of and need for forests			x			x	x		x
4. Man's part in maintaining the balance of life in nature			x			x	x		x

TABLE IV (Continued)

COURSE CONTENT	COURSES B 1	B 2	B 3	P 1	P 2	G 1	G 2	M 1	RESUME
III. A knowledge, understanding, and appreciation of matter and energy									
A. Knowledge of the composition of things									
1. The nature of atoms, molecules, elements, mixtures, and compounds	x	x	x	x				x	x
2. Composition of matter	-	x	x	x				x	x
3. Physical and chemical change	-	x	x	x					x
4. Chemistry in man's everyday life		x	-	x				-	-x
B. Understanding the characteristics of heat and how it is used									
1. Heat as a form of energy		x	x	x					x
2. Sources of heat and its measurement		x	x	x					x
3. Effect of heat upon matter		x	x	x					x
4. Producing and using heat		x	x	x				-	x
5. Methods of heat transference		x	x	x				-	x
6. Refrigeration and air conditioning		-		x				-	-x
7. Fire, its prevention and control		-		-					?
C. Understanding atomic energy and knowledge of some of its uses									
1. The structure of the atom	-	x	x	x				x	x
2. Forces within atoms		x	x	-				x	x
3. The fission process	-	x	x	-				x	x
4. The fusion process	-	x	x	-				x	x
5. Military uses of atomic energy		-	-	-				-	-
6. Nonmilitary uses of atomic energy		-	-	x		-		x	x
7. Radioisotopes		x	-	x				x	x
8. Radioactive "fall out"	-	-	-					-	-
D. Gaining a knowledge of machines and how they work									
1. What work is and how it is measured		-	x	x					x
2. Simple machines such as the lever, the pulley, the wheel and axle, the inclined plane, the screw, and how they work			x	x					x
3. Complex machines such as the steam engine, gasoline engine, power turbines, and how they work			-	-				-	-

TABLE IV (Continued)

COURSE CONTENT	COURSES B 1	B 2	B 3	P 1	P 2	G 1	G 2	M 1	RÉSUMÉ
4. Friction				-	-			-	-
E. Knowledge of some of the characteristics and uses of magnetism and electricity									
1. Natural magnets and man-made magnets								x	x
2. Characteristics of magnets								x	x
3. The theory of magnetism								x	x
4. Static electricity								x	x
5. Generating electricity				-				x	x
6. Measuring electricity				-				-	-
7. Electrical circuits				-				x	x
8. Uses of electricity				-		-		-	-
F. Understanding what sound is and knowledge of some of its uses									
1. Causes of sound	-	x	x	-	x				-x
2. Characteristics of sound	-	-	x	-	x				-x
3. Using sound to produce music			-		x				?
4. How we speak and how we hear	-	x	x	-	x				-x
G. Understanding the characteristics of light and knowledge of how light can be used									
1. Characteristics of light		x	x	-	x				-x
2. Reflection and refraction of light		-	x	-	x				-x
3. How we see objects	x	x	x		x				x
4. Uses of light in motion pictures, microscopes, telescopes, and cameras			-		x				?
5. Formation of colors		-	x		x			-	-x
6. Providing proper lighting in our homes			-		x			-	-x
7. Correcting eye defects with lenses	x	-	x		-			-	-x
H. Knowledge and understanding of aviation									
1. How an airplane flies						-		-	-
2. Types of aircraft									no

TABLE IV (Continued)

COURSE CONTENT	COURSES								RÉSUMÉ
	B			P		G		M	
	1	2	3	1	2	1	2	1	
3. Aircraft instruments and their uses					-				?
4. Characteristics of jet propulsion								-	-
5. Characteristics of rockets and missiles						-		-	-
6. Aviation and weather						-			?
7. Problems of space flight					-	-			?

certificate. These eleven items are:

Man-made satellites
Theories of the formation of the earth
Military uses of atomic energy
Radioactive "fall out"
Friction
Complex machines such as the steam engine, gasoline engine, diesel engine, power turbines, and how they work
Measuring electricity
Uses of electricity
How an airplane flies
Characteristics of jet propulsion
Characteristics of rockets and missiles

Fourteen items may or may not be included in the science instruction for prospective elementary school teachers, depending upon the teachers selected. These fourteen items are:

Normal habitats of plants and animals
Hibernation of animals
Migration of some animals
Survival of insects
Communal life among animals
Home building of animals
Animals protecting themselves and caring for their young
Effect of alcohol, tobacco, and narcotics upon the human body
Fire, its prevention and control
Using sound to produce music
Uses of light in motion pictures, microscopes, telescopes, and cameras
Aircraft instruments and their uses
Aviation and weather
Problems of space flight

Two items are not included in the science preparation of the prospective elementary school teacher, regardless of the instructors selected. These two items are:

Hermit animals
Types of aircraft

The instructors at School A stated that they also included and stressed in their instruction the following additional items which they believe are important in the preparation of prospective elementary school teachers:

Mountains, plains, and plateaus
World distribution of plants

Heredity
Function of endocrine glands
Weights and measures
Fluids and fluid pressures

The names of the instructors of the science courses at School A are included in the alphabetical list of respondents given in Appendix J. Information concerning their preparation and experience is also given in Appendix J.

School B

The science curriculum required or recommended for the preparation of the prospective elementary school teacher at School B consists of the following areas and recommended courses:

Area 1. Biological Science, consisting of at least three hours, with Biological Science 114 recommended.
Area 2. Geography, consisting of at least three hours, with Geography 210 recommended.
Area 3. Physical Science, consisting of a three-hour course in either Geology 214, Physics 104, Astronomy 104, or Chemistry 113.
Area 4. Science in the Elementary School Curriculum, consisting of at least two hours, with Education 4K2 recommended.

The catalog description of these courses is given in Appendix I.

It is necessary for the student to take four hours in each of the first three areas given above in order to obtain at least three hours of credit, because each recommended course in these areas is a four-hour course.

Over ninety per cent of the students preparing to be elementary school teachers take Biology 114, and Geography 210. Approximately eighty-five per cent of these students take Geology 214, with about five per cent taking Physics 104, five per cent taking Astronomy 104, and five per cent taking Chemistry 113 in order to fulfill the physical science requirement.

Since the majority of the prospective elementary school teachers in School B take biology, geography, and geology, these were the only courses used to obtain data for the study.

The same introductory courses in science are offered to students who are preparing to teach in the elementary grades as are offered to those students who are preparing for other professions.

Education 4K2, Science in the Elementary School Curriculum, is taught by the education department. The students are given an opportunity to review the content of science learned in the other courses in science and to become acquainted with the science concepts thought necessary to teach science in the elementary grades.

The specific content of the science courses pursued by each student preparing for the elementary school certificate depends upon the combination of teachers selected by the student. Three different teachers teach the general geology course (P), but all have the same instructors for the courses in biological science (B), regional geography (G), and Science in the Elementary School Curriculum (M).

A study of Table V shows that sixty-seven of the 112 items listed in the areas and sub-areas of the checklist are taught and stressed in at least one of the science courses taken by each student. Seven items are either taught and stressed or taught but not stressed, depending upon which one of the three instructors is selected for the general geology course.

Thirty-seven items are included but not stressed, regardless of the science instructors selected by the student preparing for the elementary school certificate. These thirty-seven items are:

Nature of comets, meteors, and planetoids
Nature of stars, their size, movement, and distance from earth
Constellations and galaxies

TABLE V

INTERVIEW RESPONSES TO CHECKLIST AT COLLEGE B

COURSE CONTENT	COURSES B	P			G	M	RÉSUMÉ
	1	1	2	3	1	1	
I. A knowledge, understanding, and appreciation of the earth and the universe							
A. Knowledge and understanding of the relationship of the earth and the heavenly bodies							
1. The sun and the sun's family	x	-	-	x	x		x
2. Nature of the planets, their relative size, and their distance from the sun	-		-	x	-		x
3. Nature of comets, meteors, and planetoids	-		-	-	-		-
4. Nature of stars, their size, movement, and distance from earth	-		-	-	-		-
5. The moon, its size and movements, causes of tides, eclipses, and why the moon appears to change its shape	x	-	-	x	-		x
6. Causes of day and night and the seasons of the year	x		-	x	x		x
7. The vastness and orderliness of the universe	-	-	-	x	x		x
8. Man-made satellites			-	x	-		x
9. Gravitation, gravity, and inertia	-	-	-	x	-		x
10. Constellations and galaxies			-	-	-		-
11. Solar energy and cosmic rays			-	x	-		x
12. Theories of the formation of the earth	-	x	-		-		-x
B. Knowledge and understanding of the earth's structure and its surface							
1. The shape, size, and composition of the earth	x	x	-	x	x		x
2. Kinds of rock and their formation	x	x	-	x	x		x
3. The causes of mountains, earthquakes, volcanoes, hot springs, and geysers	x	x	-	x	-		x
4. Formation of soil	x	x	-	x	x		x
5. History of the earth - the geological time chart	x	x	-	-	-		-x
6. Forces that have changed and are still changing the surface of the earth	x	x	-	x	-		x
7. The continents	x	x	-	x	x		x
8. The polar regions	-	-	-	x	-		x

TABLE V (Continued)

COURSE CONTENT	COURSES B 1	P 1	P 2	P 3	G 1	M 1	RESUME
9. Oceans, lakes, and streams		x	x	-	x	x	x
10. Theories concerning the earth's interior		x	x	-	-	-	-x
C. Knowledge and understanding of the composition and characteristics of air and the causes of weather							
1. Composition, characteristics, and pressure of the atmosphere		x	-	-	x	x	x
2. The water cycle		x	x	-	x	x	x
3. Forms of precipitation and their causes		x		-	x	-	x
4. Cloud formation		-			x	-	x
5. Causes of winds and the wind belts of the world		x	x	-	x	x	x
6. Causes of hurricanes, tornadoes, and thunderstorms		-			x	-	x
7. Weather forecasting and instruments used		-			-	x	x
8. Climates of the earth		-		-	-	-	-
D. Knowledge and understanding of how natural resources can be conserved and why they need to be conserved							
1. Vanishing natural resources		-	-		x	-	x
2. Dependence on natural resources		-	-	-	x	-	x
3. Conservation of the soil by preventing erosion and maintaining soil fertility		-	-	-	x	-	x
4. Conservation of coal, oil, gas, and minerals stored in the ground		-	-		x		x
5. Conservation of water supplies		-	x		x		x
II. A knowledge, understanding and appreciation of living things							
A. Understanding the growth and development of plants and animals							
1. Prehistoric life and evolution of living things		x	x	-	-	-	-x
2. The variety of living things and their classification		x		-	-	-	-x
3. Conditions necessary for life	-	x	x	-	x	x	x
4. Interrelationship of living things and balance of nature		x	x	-	x	x	x
5. Protective adaptation		x			x	-	x
6. Reproduction of plants and animals	x	-				x	x
7. Growth of plants and animals	-	-			-	x	x
8. Obtaining and storing of food by plants and animals	x	-			x	x	x

TABLE V (Continued)

COURSE CONTENT	COURSES B 1	P 1	P 2	P 3	G 1	M 1	RÉSUMÉ
9. Man's influence on living things and his dependence upon them		-			x	-	x
10. Normal habitats of plants and animals		x			x	-	x
B. Understanding how the seasons of the year affect living things							
1. Hibernation of animals					x	-	x
2. Survival of insects					x		x
3. Migration of some animals		-			x	-	x
4. Seasonal changes in plants and animals					x	-	x
5. Human adaptations to seasonal changes and to climate				-	x		x
C. Knowledge of some of the behaviors and habits of animals							
1. Hermit animals					-		-
2. Communal life among animals		-			-	-	-
3. Home building of animals		-			-	-	-
4. Animals protecting themselves and caring for their young					-	-	-
D. Understanding the human body and how it works							
1. Kinds of food and their uses in the human body	x				x	x	x
2. The systems of the body and their functions	x				-	x	x
3. Effect of alcohol, tobacco, and narcotics upon the human body					-	-	-
4. Causes of diseases and methods of control	-				-	-	-
5. Reproduction	x					-	-x
E. Understanding how living things can be conserved and why they need to be conserved							
1. Economic importance of living things					x	-	x
2. Conservation of wild life		-			x		x
3. Conservation of and need for forests		-			x		x
4. Man's part in maintaining the balance of life in nature		-			x	-	x
III. A knowledge, understanding, and appreciation of matter and energy							
A. Knowledge of the composition of things							
1. The nature of atoms, molecules, elements, mixtures, and compounds		x		-	x	x	x
2. Composition of matter		x		-	-	x	x
3. Physical and chemical change		x		-	-	x	x

TABLE V (Continued)

COURSE CONTENT	COURSES B 1	P 1	P 2	P 3	G 1	M 1	RÉSUMÉ
4. Chemistry in man's everyday life	-			x	x	x
B. Understanding the characteristics of heat and how it is used						
1. Heat as a form of energy	-		-	x	-	x
2. Sources of heat and its measurement	-		-	-	-	-
3. Effect of heat upon matter	-		-	-	-	-
4. Producing and using heat					-	-
5. Methods of heat transference				-	-	-
6. Refrigeration and air conditioning				-	-	-
7. Fire, its prevention and control				x	-	x
C. Understanding atomic energy and knowledge of some of its uses						
1. The structure of the atom	x		-	-	x	x
2. Forces within atoms	-		-	-	-	-
3. The fission process	-		-	-	-	-
4. The fusion process	-		-	-	-	-
5. Military uses of atomic energy				-	-	-
6. Nonmilitary uses of atomic energy			-	-	-	-
7. Radioisotopes	-		-	-	-	-
8. Radioactive "fall out"			-	x	-	-x
D. Gaining a knowledge of machines and how they work						
1. What work is and how it is measured					x	x
2. Simple machines such as the lever, the pulley, the wheel and axle, the inclined plane, the screw, and how they work					x	x
3. Complex machines such as the steam engine, gasoline engine, diesel engine, power turbines, and how they work					-	-
4. Friction					x	x
E. Knowledge of some of the characteristics of magnetism and electricity and how they are used						
1. Natural magnets and man-made magnets	-				x	x
2. Characteristics of magnets	-				x	x
3. The theory of magnetism					x	x

TABLE V (Continued)

COURSE CONTENT	COURSES B	P			G	M	RÉSUMÉ
	1	1	2	3	1	1	
4. Static electricity					-	x	x
5. Generating electricity						x	x
6. Measuring electricity						-	-
7. Electrical circuits						x	x
8. Uses of electricity					-	-	-
F. Understanding what sound is and knowledge of some of its uses							
1. Causes of sound						x	x
2. Characteristics of sound						x	x
3. Using sound to produce music						-	-
4. How we speak and how we hear					-	-	-
G. Understanding the characteristics of light and knowledge of how light can be used							
1. Characteristics of light		-			-	-	-
2. Reflection and refraction of light		-			-	x	x
3. How we see objects					-	-	-
4. Uses of light in motion pictures, microscopes, telescopes, and cameras						-	-
5. Formation of colors						-	-
6. Providing proper lighting in our homes						-	-
7. Correcting eye defects with lenses						-	-
H. Knowledge and understanding of aviation							
1. How an airplane flies					-	x	x
2. Types of aircraft							no
3. Aircraft instruments and their uses						-	-
4. Characteristics of jet propulsion						-	-
5. Characteristics of rockets and missiles						-	-
6. Aviation and weather					-	-	-
7. Problems of space flight					-	-	-

Climates of the earth
Hermit animals
Communal life among animals
Home building of animals
Animals protecting themselves and caring for their young
Effect of alcohol, tobacco, and narcotics upon the human body
Causes of diseases and methods of control
Sources of heat and its measurement
Effect of heat upon matter
Producing and using heat
Methods of heat transference
Refrigeration and air conditioning
Forces within atoms
Fission process
Fusion process
Military uses of atomic energy
Non-military uses of atomic energy
Radioisotopes
Complex machines such as the steam engine, gasoline engine, diesel engine, power turbines, and how they work
Measuring electricity
Uses of electricity
Using sound to produce music
How we speak and how we hear
Characteristics of light
How we see objects
Uses of light in motion pictures, microscopes, telescopes, and cameras
Formation of colors
Providing proper lighting in our homes
Correcting eye defects with lenses
Aircraft instruments and their uses
Characteristics of jet propulsion
Characteristics of rockets and missiles
Aviation and weather
Problems of space flight

There are no items that may or may not be taught, depending upon which one of the instructors is selected for the general geology course.

One item is not included in the science preparation of the prospective elementary school teacher, regardless of the instructors selected. This item is:

Types of aircraft

The instructors at School B stated that they also included and stressed in their instruction the following additional items which they believe

are important in the preparation of prospective elementary school teachers:

The cell and its structure
Mitosis and meiosis
Cellular metabolism
Genetics

The names of the instructors of the science courses at School B are included in the alphabetical list of respondents given in Appendix J. Information concerning their preparation and experience is also given in Appendix J.

School C

The science curriculum required or recommended for the preparation of the prospective elementary school teacher at School C consists of the following courses:

Science 314, Science for the Elementary Teacher. . . 4 hours
Science 324, Science for the Elementary Teacher. . . 4 hours
Geography 103, Human Geography . . . . . 3 hours

A catalog description of these courses is given in Appendix I.

The two science courses, 314 and 324, are combined to form eight hours of instruction and are taught by the same instructor. These are not survey courses in the usual sense of broad selection and little depth. The topics covered are drawn from various areas and the concepts selected are correlated with, and followed through several branches of science. The branches of science included are astronomy, botany, chemistry, geography, geology, meteorology, physics, physiology, and zoology. An attempt is made to give a depth approach to basic concepts that are important and appropriate to teach in grades one through six.

These two science courses, 314 and 324, are for the elementary school teacher and are different courses than those offered to students who are

preparing for other professions. A student must be at least a junior in college before he can take Science 314 and 324. Each of these courses is a laboratory course with three one-hour lectures and one three-hour laboratory each week.

A special methods course in science is not offered for students preparing to teach in the elementary grades because methods are combined with subject matter in the science survey courses. The instructor stated that it is as easy to do an experiment appropriate for use in the elementary school to illustrate a science concept as it is to follow traditional college-type demonstrations. An attempt is made to teach for direct transfer to the elementary teaching situation wherever possible.

All students preparing for the elementary certificate at School C have the same instruction in science because only one teacher teaches Geography 103 and one teacher teaches both of the courses in science for the elementary teacher.

A study of Table VI reveals that eighty-one of the 112 items listed in the areas and sub-areas of the checklist are taught and stressed in at least one of the science courses taken by each student. There are no items that are taught and stressed or taught but not stressed, depending upon the combination of teachers selected by the student.

Twenty-nine items are included but not stressed. These items are:

Nature of comets, meteors, and planetoids
Constellations and galaxies
Solar energy and cosmic rays
Theories of the formation of the earth
Theories concerning the earth's interior
Weather forecasting and instruments used
Reproduction of plants and animals
Growth of plants and animals
Obtaining and storing of food by plants and animals
Hibernation of animals
Migration of some animals

TABLE VI

INTERVIEW RESPONSES TO CHECKLIST AT COLLEGE C

COURSE CONTENT	COURSES S I	COURSES G I	RÉSUMÉ
I. A knowledge, understanding, and appreciation of the earth and the universe			
A. Knowledge and understanding of the relationship of the earth and the heavenly bodies			
1. The sun and the sun's family	x	x	x
2. Nature of the planets, their relative size, and their distance from the sun	x	x	x
3. Nature of comets, meteors, and planetoids	-	-	-
4. Nature of stars, their size, movement, and distance from earth	x	-	x
5. The moon, its size and movements, causes of tides, eclipses, and why the moon appears to change its shape	x	-	x
6. Causes of day and night and the seasons of the year	x	x	x
7. The vastness and orderliness of the universe	x	x	x
8. Man-made satellites	x	-	x
9. Gravitation, gravity, and inertia	x		x
10. Constellations and galaxies	-	-	-
11. Solar energy and cosmic rays	-	-	-
12. Theories of the formation of the earth	-	-	-
B. Knowledge and understanding of the earth's structure and its surface			
1. The shape, size, and composition of the earth	x	x	x
2. Kinds of rock and their formation	x	-	x
3. The causes of mountains, earthquakes, volcanoes, hot springs, and geysers	x	-	x
4. Formation of soil	x	-	x
5. History of the earth - the geological time chart	x	-	x
6. Forces that have changed and are still changing the surface of the earth	x	x	x
7. The continents	-	x	x
8. The polar regions	-	x	x
9. Oceans, lakes, and streams	-	x	x
10. Theories concerning the earth's interior	-	-	-

TABLE VI (Continued)

COURSE CONTENT	COURSES S 1	COURSES G 1	RÉSUMÉ
C. Knowledge and understanding of the composition and characteristics of air and the causes of weather			
1. Composition, characteristics, and pressure of the atmosphere	x	x	x
2. The water cycle	x	x	x
3. Forms of precipitation and their causes	x	x	x
4. Cloud formation	x	x	x
5. Causes of winds and the wind belts of the world	x	x	x
6. Causes of hurricanes, tornadoes, and thunderstorms	x	x	x
7. Weather forecasting and instruments used	-	-	-
8. Climates of the earth	-	x	x
D. Knowledge and understanding of how natural resources can be conserved and why they need to be conserved			
1. Vanishing natural resources	x	x	x
2. Dependence on natural resources	x	x	x
3. Conservation of the soil by preventing erosion and maintaining soil fertility	x	x	x
4. Conservation of coal, oil, gas, and minerals stored in the ground	x	x	x
5. Conservation of water supplies	x	x	x
II. A knowledge, understanding, and appreciation of living things			
A. Understanding the growth and development of plants and animals			
1. Prehistoric life and evolution of living things	x		x
2. The variety of living things and their classification	x	-	x
3. Conditions necessary for life	x	-	x
4. Interrelationship of living things and balance of nature	x	-	x
5. Protective adaptation	x	-	x
6. Reproduction of plants and animals	-	-	-
7. Growth of plants and animals	-	-	-
8. Obtaining and storing of food by plants and animals	-		-
9. Man's influence on living things and his dependence upon them	x	x	x
10. Normal habitats of plants and animals	x	x	x
B. Understanding how the seasons of the year affect living things			
1. Hibernation of animals	-		-

TABLE VI (Continued)

COURSE CONTENT	COURSES S I	COURSES G I	RESUME
2. Survival of insects			no
3. Migration of some animals	-	-	-
4. Seasonal changes in plants and animals	-	-	-
5. Human adaptations to seasonal changes and to climate	x	x	x
C. Knowledge of some of the behaviors and habits of animals			
1. Hermit animals			no
2. Communal life among animals	x		x
3. Home building of animals	x		x
4. Animals protecting themselves and caring for their young	x		x
D. Understanding the human body and how it works			
1. Kinds of food and their uses in the human body	x		x
2. The systems of the body and their functions	x		x
3. Effect of alcohol, tobacco, and narcotics upon the human body	-		-
4. Causes of diseases and methods of control	x		x
5. Reproduction	-		-
E. Understanding how living things can be conserved and why they need to be conserved			
1. Economic importance of living things	-	x	x
2. Conservation of wild life	-	x	x
3. Conservation of and need for forests	-	x	x
4. Man's part in maintaining the balance of life in nature	x	x	x
III. A knowledge, understanding, and appreciation of matter and energy			
A. Knowledge of the composition of things			
1. The nature of atoms, molecules, elements, mixtures, and compounds	x		x
2. Composition of matter	x		x
3. Physical and chemical change	x		x
4. Chemistry in man's everyday life	x		x
B. Understanding the characteristics of heat and how it is used			
1. Heat as a form of energy	x		x
2. Sources of heat and its measurement	x		x
3. Effect of heat upon matter	-		-

TABLE VI (Continued)

COURSE CONTENT	COURSES S I	COURSES G I	RÉSUMÉ
4. Producing and using heat	-		-
5. Methods of heat transference	-		-
6. Refrigeration and air conditioning	-		-
7. Fire, its prevention and control	-		-
C. Understanding atomic energy and knowledge of some of its uses			
1. The structure of the atom	x		x
2. Forces within atoms	x		x
3. The fission process	x		x
4. The fusion process	x		x
5. Military uses of atomic energy	-		-
6. Nonmilitary uses of atomic energy	-		-
7. Radioisotopes	x		x
8. Radioactive "fall out"	x		x
D. Gaining a knowledge of machines and how they work			
1. What work is and how it is measured	x		x
2. Simple machines such as the lever, the pulley, the wheel and axle, the inclined plane, the screw, and how they work	x		x
3. Complex machines such as the steam engine, gasoline engine, diesel engine, power turbines, and how they work	-		-
4. Friction	x		x
E. Knowledge of some of the characteristics and uses of magnetism and electricity			
1. Natural magnets and man-made magnets	x		x
2. Characteristics of magnets	x		x
3. The theory of magnetism	x		x
4. Static electricity	x		x
5. Generating electricity	x		x
6. Measuring electricity	-		-
7. Electrical circuits	x		x
8. Uses of electricity	x	-	x

TABLE VI (Continued)

COURSE CONTENT	COURSES S 1	COURSES G 1	RÉSUMÉ
F. Understanding what sound is and knowledge of some of its uses			
1. Causes of sound	x		x
2. Characteristics of sound	x		x
3. Using sound to produce music	-		-
4. How we speak and how we hear	x		x
G. Understanding the characteristics of light and knowledge of how light can be used			
1. Characteristics of light	x		x
2. Reflection and refraction of light	x		x
3. How we see objects	x		x
4. Uses of light in motion pictures, microscopes, telescopes, and cameras	-		-
5. Formation of colors	x		x
6. Providing proper lighting in our homes	-		-
7. Correcting eye defects with lenses	-		-
H. Knowledge and understanding of aviation			
1. How an airplane flies	x		x
2. Types of aircraft	x		x
3. Aircraft instruments and their uses	-		-
4. Characteristics of jet propulsion	x		x
5. Characteristics of rockets and missiles	x		x
6. Aviation and weather	x	x	x
7. Problems of space flight	x	-	x

Seasonal changes in plants and animals
Effect of alcohol, tobacco, and narcotics upon the human body
Reproduction
Effect of heat upon matter
Producing and using heat
Methods of heat transference
Refrigeration and air conditioning
Fire, its prevention and control
Military uses of atomic energy
Non-military uses of atomic energy
Radioisotopes
Complex machines such as the steam engine, gasoline engine, diesel engine, power turbines, and how they work
Measuring electricity
Using sound to produce music
Uses of light in motion pictures, microscopes, telescopes, and cameras
Providing proper lighting in our homes
Correcting eye defects with lenses
Aircraft instruments and their uses

There are no items that may or may not be included in the science instruction for prospective elementary school teachers, depending upon the teachers selected.

Two items are not included in the science preparation of the prospective elementary school teacher. These items are:

Survival of insects
Hermit animals

The instructors at School C made no suggestions concerning additional items for the checklist.

The names of the instructors of the science courses at School C are included in the alphabetical list of respondents given in Appendix J. Information concerning their preparation and experience is also given in Appendix J.

School D

The science curriculum required or recommended for the preparation of the prospective elementary school teacher at School D consists of the

following courses:

Botany 4, Biology for Teachers . . . . . 5 hours
Physics 4, Science for Teachers . . . . . 5 hours
Geography 61, Geography for Elementary Teachers. . 3 hours
Education 244, Science in Elementary Schools . . . 2 hours

A catalog description of these courses is given in Appendix I.

Physics 4 and Botany 4 are general survey courses in science and are required for those students who are preparing to be teachers. These courses are limited to those students who are in the teacher certification program and are different from the introductory science courses offered to students who are preparing for other professions.

Geography 61 is a required course for those students working for the standard elementary certificate. The methods course, Education 244, is taught by the education department and is required for all students preparing to be elementary school teachers.

The science areas of astronomy, botany, chemistry, geography, geology, meteorology, physics, physiology, and zoology are included in the above science courses.

The content of the total science preparation of each student may vary, depending upon which one of the three teachers is selected by the student for his Botany 4 course. Three different teachers teach Botany 4 (B), whereas Physics 4 (P), Geography 61 (G), and Education 244 (M) each have only one instructor.

A study of Table VII shows that fifty-seven of 112 items listed in the areas and sub-areas of the checklist are taught and stressed in at least one of the science courses taken by each student. Fifteen items are either taught and stressed or taught but not stressed, depending upon which instructor the student selects for his Botany 4 course.

TABLE VII

INTERVIEW RESPONSES TO CHECKLIST AT COLLEGE D

COURSE CONTENT	COURSES B 1	B 2	B 3	P 1	G 1	M 1	RÉSUMÉ
I. A knowledge, understanding, and appreciation of the earth and the universe							
A. Knowledge and understanding of the relationship of the earth and the heavenly bodies							
1. The sun and the sun's family				-	x	-	x
2. Nature of the planets, their relative size, and their distance from the sun					x	-	x
3. Nature of comets, meteors, and planetoids						-	-
4. Nature of stars, their size, movement, and distance from earth				-	-	-	-
5. The moon, its size and movements, causes of tides, eclipses, and why the moon appears to change its shape				-		-	-
6. Causes of day and night and the seasons of the year				-	x	-	x
7. The vastness and orderliness of the universe					-	-	-
8. Man-made satellites				x		-	x
9. Gravitation, gravity, and inertia				x	-	-	x
10. Constellations and galaxies						-	-
11. Solar energy and cosmic rays						-	-
12. Theories of the formation of the earth						-	-
B. Knowledge and understanding of the earth's structure and its surface							
1. The shape, size, and composition of the earth					x	-	x
2. Kinds of rock and their formation					x	-	x
3. The causes of mountains, earthquakes, volcanoes, hot springs, and geysers					-	-	-
4. Formation of soil			-		-	-	-
5. History of the earth - the geological time chart			-			-	-
6. Forces that have changed and are still changing the surface of the earth					-	-	-
7. The continents					x	-	x
8. The polar regions					x	-	x
9. Oceans, lakes, and streams			-		x	-	x
10. Theories concerning the earth's interior					-	-	-

TABLE VII (Continued)

COURSE CONTENT	COURSES B 1	B 2	B 3	P 1	G 1	M 1	RÉSUMÉ
C. Knowledge and understanding of the composition and characteristics of air and the causes of weather							
1. Composition, characteristics, and pressure of the atmosphere				x	x	-	-
2. The water cycle			-	-	x	-	x
3. Forms of precipitation and their causes				-	x	-	x
4. Cloud formation					-	-	-
5. Causes of winds and the wind belts of the world					x	-	x
6. Causes of hurricanes, tornadoes, and thunderstorms					-	-	-
7. Weather forecasting and instruments used					-	-	-
8. Climates of the earth					x	-	x
D. Knowledge and understanding of how natural resources can be conserved and why they need to be conserved							
1. Vanishing natural resources			-		x	-	x
2. Dependence on natural resources			x		-	-	-x
3. Conservation of the soil by preventing erosion and maintaining soil fertility			-		-	-	-
4. Conservation of coal, oil, gas, and minerals stored in the ground					-	-	-
5. Conservation of water supplies			-			-	-
II. A knowledge, understanding and appreciation of living things							
A. Understanding the growth and development of plants and animals							
1. Prehistoric life and evolution of living things	x	x	-			-	-x
2. The variety of living things and their classification	x	x	x			-	x
3. Conditions necessary for life	x	x	x			-	x
4. Interrelationship of living things and balance of nature	x	x	x		-	-	x
5. Protective adaptation	-		-			-	-
6. Reproduction of plants and animals	x	x	x			-	x
7. Growth of plants and animals	x	x	x			-	x
8. Obtaining and storing of food by plants and animals	x	x	x			-	x
9. Man's influence on living things and his dependence upon them	x	x	-		x	-	-x
10. Normal habitats of plants and animals	x	x	x			-	x

TABLE VII (Continued)

COURSE CONTENT	COURSES B 1	B 2	B 3	P 1	G 1	M 1	RÉSUMÉ
B. Understanding how the seasons of the year affect living things							
1. Hibernation of animals	x	-	-			-	-x
2. Survival of insects	-		x			-	-x
3. Migration of some animals	x	-	-			-	-x
4. Seasonal changes in plants and animals	x	-	x			-	-x
5. Human adaptations to seasonal changes and to climate	x		-			-	-x
C. Knowledge of some of the behaviors and habits of animals							
1. Hermit animals	-					-	-
2. Communal life among animals	-		-			-	-
3. Home building of animals	-		-			-	-
4. Animals protecting themselves and caring for their young	x		-			-	-x
D. Understanding the human body and how it works							
1. Kinds of food and their uses in the human body	x	x	x			-	x
2. The systems of the body and their functions	x	x	x			-	x
3. Effect of alcohol, tobacco, and narcotics upon the human body	-		-			-	-
4. Causes of diseases and methods of control	-	-	-			-	-
5. Reproduction	x	x	x			-	x
E. Understanding how living things can be conserved and why they need to be conserved							
1. Economic importance of living things	-		-		-	-	-
2. Conservation of wild life	-		x		-	-	-x
3. Conservation of and need for forests	-	-	-		x	-	x
4. Man's part in maintaining the balance of life in nature	x		-		-	-	-x
III. A knowledge, understanding, and appreciation of matter and energy							
A. Knowledge of the composition of things							
1. The nature of atoms, molecules, elements, mixtures, and compounds	-	-	x	-		-	-x
2. Composition of matter	-	-	x	-		-	-x
3. Physical and chemical change	-		x	x		-	x
4. Chemistry in man's everyday life	-		x	-		-	-x

TABLE VII (Continued)

COURSE CONTENT	COURSES						
	B			P	G	M	
	1	2	3	1	1	1	RÉSUMÉ
B. Understanding the characteristics of heat and how it is used							
1. Heat as a form of energy	-		x	x		-	x
2. Sources of heat and its measurement				x		-	x
3. Effect of heat upon matter				x		-	x
4. Producing and using heat				x		-	x
5. Methods of heat transference				x		-	x
6. Refrigeration and air conditioning			-	x		-	x
7. Fire, its prevention and control				-		-	-
C. Understanding atomic energy and knowledge of some of its uses							
1. The structure of the atom	-			x		-	x
2. Forces within atoms				-			-
3. The fission process				-			-
4. The fusion process				-			-
5. Military uses of atomic energy				-		-	-
6. Non-military uses of atomic energy				-		-	-
7. Radioisotopes	-					-	-
8. Radioactive "fall out"	-					-	-
D. Gaining a knowledge of machines and how they work							
1. What work is and how it is measured				x		-	x
2. Simple machines such as the lever, the pulley, the wheel and axle, the inclined plane, the screw, and how they work				x		-	x
3. Complex machines such as the steam engine, gasoline engine, diesel engine, power turbines, and how they work				x		-	x
4. Friction				x		-	x
E. Knowledge of some of the characteristics and uses of magnetism and electricity							
1. Natural magnets and man-made magnets				x		-	x
2. Characteristics of magnets				x		-	x
3. The theory of magnetism				x		-	x
4. Static electricity				x		-	x

TABLE VII (Continued)

COURSE CONTENT	COURSES B 1	B 2	B 3	P 1	G 1	M 1	RÉSUMÉ
5. Generating electricity				x	-		x
6. Measuring electricity				x	-		x
7. Electrical circuits				x	-		x
8. Uses of electricity				x	-		x
F. Understanding what sound is and knowledge of some of its uses							
1. Causes of sound				x	-		x
2. Characteristics of sound				x	-		x
3. Using sound to produce music				x	-		x
4. How we speak and how we hear				x	-		x
G. Understanding the characteristics of light and knowledge of how light can be used							
1. Characteristics of light			-	x	-		x
2. Reflection and refraction of light			-	x	-		x
3. How we see objects			-	x	-		x
4. Uses of light in motion pictures, microscopes, telescopes, and cameras			x	-	-		-x
5. Formation of colors			-	x	-		x
6. Providing proper lighting in our homes					-		-
7. Correcting eye defects with lenses				-	-		-
H. Knowledge and understanding of aviation							
1. How an airplane flies				-	-		-
2. Types of aircraft				-	-		-
3. Aircraft instruments and their uses					-		-
4. Characteristics of jet propulsion				x	-		x
5. Characteristics of rockets and missiles				x	-		x
6. Aviation and weather					-		-
7. Problems of space flight				-	-		-

Forty items are included but not stressed, regardless of the science instructors selected by the student preparing for the elementary school certificate. These forty items are:

Nature of comets, meteors, and planetoids
Nature of stars, their size, movement, and distance from earth
The moon, its size and movements, causes of tides, eclipses, and why the moon appears to change its shape
The vastness and orderliness of the universe
Constellations and galaxies
Solar energy and cosmic rays
Theories of the formation of the earth
Causes of mountains, earthquakes, volcanoes, hot springs, and geysers
Formation of soil
History of the earth - the geological time chart
Forces that have changed and are still changing the surface of the earth
Theories concerning the earth's interior
Cloud formation
Causes of hurricanes, tornadoes, and thunderstorms
Weather forecasting and instruments used
Conservation of the soil by preventing erosion and maintaining soil fertility
Conservation of coal, oil, gas, and minerals stored in the ground
Conservation of water supplies
Protective adaptation
Hermit animals
Communal life among animals
Home building of animals
Effect of alcohol, tobacco, and narcotics upon the human body
Causes of diseases and methods of control
Economic importance of living things
Fire, its prevention and control
Forces within atoms
The fission process
The fusion process
Military uses of atomic energy
Non-military uses of atomic energy
Radioisotopes
Radioactive "fall out"
Providing proper lighting in our homes
Correcting eye defects with lenses
How an airplane flies
Types of aircraft
Aircraft instruments and their uses
Aviation and weather
Problems of space flight

There are no items that may or may not be included in the science instruction for prospective elementary school teachers, depending upon

the teachers selected.

Each item on the checklist is taught in at least one science course taken by the student.

The instructors at School D stated that they also included and stressed in their instruction the following items, which they believe are important in the preparation of prospective elementary school teachers:

Map construction
Map reading
Motors

The instructors of the botany courses stated that they use field trips extensively and spend about one-third of their time on identification of living things.

The names of the instructors of the science courses at School D are included in the alphabetical list of respondents given in Appendix J. Information concerning their preparation and experience is also given in Appendix J.

School E

The science curriculum required or recommended for the preparation of the prospective elementary school teacher at School E consists of the following courses:

General Biology 104	4 hours
General Physical Science 104	4 hours
Geography for the Elementary Teacher 103	3 hours
Methods and Materials in Elementary School Science Education 362	2 hours

The catalog description of these courses is given in Appendix I.

All students who are preparing to be elementary school teachers are required to take General Biology 104, General Physical Science 104, Geography 103 and Education 362. Some exceptions may be made concerning

these requirements but less than five per cent of the students use these exceptions.

The introductory courses in science that are offered to students who are preparing to teach in the elementary grades are the same courses offered to students preparing for other professions. The science areas of astronomy, botany, chemistry, geography, geology, meteorology, physics, physiology, and zoology are included in these courses.

The content of the science courses will be the same for all prospective elementary school teachers at School E because each student has the same instructors for his science courses.

A study of Table VIII indicates that ninety-seven of the 112 items listed in the areas and sub-areas of the checklist are taught and stressed in at least one of the science courses taken by each student. There are no items that are either taught and stressed or taught but not stressed, depending upon the combination of teachers selected by a student.

Fifteen items are included but not stressed. These items are:

Nature of stars, their size, movement, and distance from the earth
Constellations and galaxies
Solar energy and cosmic rays
The polar regions
Theories concerning the earth's interior
Conservation of coal, oil, gas, and minerals stored in the ground
Survival of insects
Migration of some animals
Human adaptations to seasonal changes and to climate
Hermit animals
Effect of alcohol, tobacco, and narcotics upon the human body
Military uses of atomic energy
Measuring electricity
Electrical circuits
Uses of electricity

There are no items that may or may not be included in the science instruction for prospective elementary school teachers, depending upon the

TABLE VIII

INTERVIEW RESPONSES TO CHECKLIST AT COLLEGE E

COURSE CONTENT	COURSES B I	P I	G I	M I	RÉSUMÉ
I. A knowledge, understanding, and appreciation of the earth and the universe					
A. Knowledge and understanding of the relationship of the earth and the heavenly bodies					
1. The sun and the sun's family		x	x	x	x
2. Nature of the planets, their relative size, and their distance from the sun		-	x	x	x
3. Nature of comets, meteors, and planetoids		-	-	x	x
4. Nature of stars, their size, movement, and distance from the earth		-	-	-	-
5. The moon, its size and movements, causes of tides, eclipses, and why the moon appears to change its shape		-	-	x	x
6. Causes of day and night and the seasons of the year		x	x	x	x
7. The vastness and orderliness of the universe	-	-	-	x	x
8. Man-made satellites				x	x
9. Gravitation, gravity, and inertia		-		x	x
10. Constellations and galaxies		-		-	-
11. Solar energy and cosmic rays		-		-	-
12. Theories of the formation of the earth		-		x	x
B. Knowledge and understanding of the earth's structure and its surface					
1. The shape, size, and composition of the earth		x	x	x	x
2. Kinds of rock and their formation		x	-	x	x
3. The causes of mountains, earthquakes, volcanoes, hot springs, and geysers	-	-	-	x	x
4. Formation of soil	-	-	x	x	x
5. History of the earth - the geological time chart	-	-		x	x
6. Forces that have changed and are still changing the surface of the earth	-	x	x	x	x
7. The continents		-	x	-	x
8. The polar regions		-		-	-
9. Oceans, lakes, and streams	-	-	x	-	x
10. Theories concerning the earth's interior	-	-		-	-

TABLE VIII (Continued)

COURSE CONTENT	COURSES B 1	P 1	G 1	M 1	RÉSUMÉ
C. Knowledge and understanding of the composition and characteristics of air and the causes of weather					
1. Composition, characteristics, and pressure of the atmosphere		-	x	x	x
2. The water cycle	-	-	x	x	x
3. Forms of precipitation and their causes	-	-	x	x	x
4. Cloud formation		-		x	x
5. Causes of winds and the wind belts of the world	-	x	x	x	x
6. Causes of hurricanes, tornadoes, and thunderstorms		-	-	x	x
7. Weather forecasting and instruments used		-	-	x	x
8. Climates of the earth	-		x	x	x
D. Knowledge and understanding of how natural resources can be conserved and why they need to be conserved					
1. Vanishing natural resources	-		x	x	x
2. Dependence on natural resources	-		x	x	x
3. Conservation of the soil by preventing erosion and maintaining soil fertility	-		x	-	x
4. Conservation of coal, oil, gas, and minerals stored in the ground			-	-	-
5. Conservation of water supplies	-		-	x	x
II. A knowledge, understanding and appreciation of living things					
A. Understanding the growth and development of plants and animals					
1. Prehistoric life and evolution of living things	x	-		x	x
2. The variety of living things and their classification	x			x	x
3. Conditions necessary for life	x	-		x	x
4. Interrelationship of living things and balance of nature	x		-	x	x
5. Protective adaptation	x	-		x	x
6. Reproduction of plants and animals	x			x	x
7. Growth of plants and animals	x			x	x
8. Obtaining and storing of food by plants and animals	x			x	x
9. Man's influence on living things and his dependence upon them	x		-	x	x
10. Normal habitats of plants and animals	x		-	x	x

TABLE VIII (Continued)

COURSE CONTENT	COURSES B I	P I	G I	M I	RÉSUMÉ
B. Understanding how the seasons of the year affect living things					
1. Hibernation of animals	-			x	x
2. Survival of insects	-		-	-	-
3. Migration of some animals	-			-	-
4. Seasonal changes in plants and animals	-		-	x	x
5. Human adaptations to seasonal changes and to climate	-		-	-	-
C. Knowledge of some of the behaviors and habits of animals					
1. Hermit animals	-			-	-
2. Communal life among animals	x			x	x
3. Home building of animals	-			x	x
4. Animals protecting themselves and caring for their young	-			x	x
D. Understanding the human body and how it works					
1. Kinds of food and their uses in the human body	-			x	x
2. The systems of the body and their functions	-			x	x
3. Effect of alcohol, tobacco, and narcotics upon the human body	-			-	-
4. Causes of diseases and methods of control	-		-	x	x
5. Reproduction	x			-	x
E. Understanding how living things can be conserved and why they need to be conserved					
1. Economic importance of living things	-		-	x	x
2. Conservation of wild life	-		-	x	x
3. Conservation of and need for forests	-		x	x	x
4. Man's part in maintaining the balance of life in nature	-		-	x	x
III. A knowledge, understanding, and appreciation of matter and energy					
A. Knowledge of the composition of things					
1. The nature of atoms, molecules, elements, mixtures, and compounds	x	x		x	x
2. Composition of matter	-	x		x	x
3. Physical and chemical change	-	x		x	x
4. Chemistry in man's everyday life	x	-		x	x

TABLE VIII (Continued)

COURSE CONTENT	COURSES B 1	P 1	G 1	M 1	RÉSUMÉ
B. Understanding the characteristics of heat and how it is used					
1. Heat as a form of energy	-	x	-	x	x
2. Sources of heat and its measurement	-	x		x	x
3. Effect of heat upon matter	-	-	-	x	x
4. Producing and using heat		-		x	x
5. Methods of heat transference		-		x	x
6. Refrigeration and air conditioning		-	-	x	x
7. Fire, its prevention and control				x	x
C. Understanding atomic energy and knowledge of some of its uses					
1. The structure of the atom	-	-		x	x
2. Forces within atoms		-		x	x
3. The fission process		-		x	x
4. The fusion process		-		x	x
5. Military uses of atomic energy		-		-	-
6. Non-military uses of atomic energy		-		x	x
7. Radioisotopes		-		x	x
8. Radioactive "fall out"				x	x
D. Gaining a knowledge of machines and how they work					
1. What work is and how it is measured		x		x	x
2. Simple machines such as the lever, the pulley, the wheel and axle, the inclined plane, the screw, and how they work		-	x		x
3. Complex machines such as the steam engine, gasoline engine, diesel engine, power turbines, and how they work		-		x	x
4. Friction		x		x	x
E. Knowledge of some of the characteristics and uses of magnetism and electricity					
1. Natural magnets and man-made magnets		x		x	x
2. Characteristics of magnets		x		x	x
3. The theory of magnetism		x		-	x
4. Static electricity		x		x	x
5. Generating electricity		-		x	x

TABLE VIII (Continued)

COURSE CONTENT	COURSES B I	P I	G I	M I	RÉSUMÉ
6. Measuring electricity		-		-	-
7. Electrical circuits		-		-	-
8. Uses of electricity		-		-	-
F. Understanding what sound is and knowledge of some of its uses					
1. Causes of sound		x		x	x
2. Characteristics of sound		x		x	x
3. Using sound to produce music		x		x	x
4. How we speak and how we hear		-		x	x
G. Understanding the characteristics of light and knowledge of how light can be used					
1. Characteristics of light	-	x		x	x
2. Reflection and refraction of light	-	x		x	x
3. How we see objects		-		x	x
4. Uses of light in motion pictures, microscopes, telescopes, and cameras		-		x	x
5. Formation of colors		-		x	x
6. Providing proper lighting in our homes				x	x
7. Correcting eye defects with lenses		-		x	x
H. Knowledge and understanding of aviation					
1. How an airplane flies				x	x
2. Types of aircraft				x	x
3. Aircraft instruments and their uses				x	x
4. Characteristics of jet propulsion		-		x	x
5. Characteristics of rockets and missiles		-		x	x
6. Aviation and weather				x	x
7. Problems of space flight				x	x

teachers selected.

All the items on the checklist are included in the science instruction given to prospective elementary school teachers.

The instructors of the science courses used in this study in School E made no additions to the interview checklist.

The names of the instructors of the science courses at School E are included in the alphabetical list of respondents given in Appendix J. Information concerning their preparation and experience is also given in Appendix J.

School F

The science curriculum required or recommended for the preparation of the prospective elementary school teacher at School F consists of the following courses:

General Biology 104	4 hours
General Physical Science 104	4 hours
Human Geography 103	3 hours
Methods and Materials in Elementary Science 362	2 hours

The catalog description of these courses is given in Appendix I.

The two courses, General Biology 104 and General Physical Science 104, are general survey courses in science required of most of the students in School F. Biology 104 is further divided into two sections, Biology 104a and Biology 104b. Biology 104b is for those students expecting to become science majors or those students who are premedical majors, and general students having good background and high rating in high school biology. Over ninety per cent of those students working toward an elementary certificate take General Biology 104a and General Physical Science 104. These courses include the science areas of astronomy, botany,

chemistry, geography, geology, meteorology, physics, physiology, and zoology.

Human Geography 103 is required of all students working for a standard elementary certificate. A two-hour course in methods and materials in elementary science is also a requirement for this elementary certificate. The methods course in science is taught by the education department.

In the science methods course for elementary school teachers an attempt is made to teach practical applications of various science concepts. Students demonstrate the concepts and generalizations are drawn. The use of resource materials is stressed. The teaching of biological science principles is less extensive than the teaching of physical science principles because the instructor finds that the students seem to know less about physical science principles.

The specific content of the science courses pursued by each student preparing for the elementary school certificate depends upon the combination of teachers selected by the student. Three different teachers teach the general biology course (B), three teach the general physical science course (P), and two teach the human geography course (G). Each student has the same instructor for the course in methods and materials in elementary science (M).

A study of Table IX reveals that sixty of the 112 items listed in the areas and sub-areas of the checklist are taught and stressed in at least one of the science courses taken by each student. Twenty-eight items are either taught and stressed or taught but not stressed, depending upon the combination of teachers selected by a student.

Ten items are included but not stressed, regardless of the science instructors selected by the student preparing for the elementary school

TABLE IX

INTERVIEW RESPONSES TO CHECKLIST AT COLLEGE F

COURSE CONTENT	COURSES B 1	B 2	B 3	P 1	P 2	P 3	G 1	G 2	M 1	RÉSUMÉ
I. A knowledge, understanding, and appreciation of the earth and the universe										
A. Knowledge and understanding of the relationship of the earth and the heavenly bodies										
1. The sun and the sun's family			-	x	x	-	-	-	x	x
2. Nature of the planets, their relative size, and their distance from the sun				x	x	-			-	-x
3. Nature of comets, meteors, and planetoids				x	-	-				-x
4. Nature of stars, their size, movement, and distance from earth				x	-	-				-x
5. The moon, its size and movements, causes of tides, eclipses, and why the moon appears to change its shape				x	x	-			x	x
6. Causes of day and night and the seasons of the year				x	x	-	x	x	x	x
7. The vastness and orderliness of the universe				x	x	-	x	x	-	x
8. Man-made satellites				-	-	-				-
9. Gravitation, gravity, and inertia			-	x	x	x			x	x
10. Constellations and galaxies				x	-	-				-x
11. Solar energy and cosmic rays	x		-	x	-	-	-	-	-	-x
12. Theories of the formation of the earth	-		-	x	x	-	-	-		-x
B. Knowledge and understanding of the earth's structure and its surface										
1. The shape, size, and composition of the earth				x	x	-	x	x	-	x
2. Kinds of rock and their formation					x	-	x	x	-	x
3. The causes of mountains, earthquakes, volcanoes, hot springs, and geysers			-	-	x		x	x	x	x
4. Formation of soil	x		-		x		x	x	-	x
5. History of the earth - the geological time chart	-		x		-	-	-	-	-	-x
6. Forces that have changed and are still changing the surface of the earth	-		-		x		x	x	x	x

TABLE IX (Continued)

COURSE CONTENT	COURSES									RÉSUMÉ
	B			P			G		M	
	1	2	3	1	2	3	1	2	1	
7. The continents			-	-	-		X	X		X
8. The polar regions			-		-		X	X		X
9. Oceans, lakes, and streams			-				X	X		X
10. Theories concerning the earth's interior				X	-		-	-	-	-X
C. Knowledge and understanding of the composition and characteristics of air and the causes of weather										
1. Composition, characteristics, and pressure of the atmosphere	-		X	X	X	X	-	-	X	X
2. The water cycle	-		X	-	-	-	-	-	X	X
3. Forms of precipitation and their causes				X	-	-	-	-	X	X
4. Cloud formation				X	X	-	-	-		-X
5. Causes of winds and the wind belts of the world				X	X	-	-	-	-	-X
6. Causes of hurricanes, tornadoes, and thunderstorms				X	-	-	-	-	-	-X
7. Weather forecasting and instruments used				X	X				X	X
8. Climates of the earth	-			-		-	X	X		X
D. Knowledge and understanding of how natural resources can be conserved and why they need to be conserved										
1. Vanishing natural resources					X		-	-	-	-X
2. Dependence on natural resources			-		X		-	-	-	-X
3. Conservation of the soil by preventing erosion and maintaining soil fertility	-		-		-		-	-	-	-
4. Conservation of coal, oil, gas, and minerals stored in the ground					-		-	-		-
5. Conservation of water supplies			-	X	-		-	-	-	-X
II. A knowledge, understanding, and appreciation of living things										
A. Understanding the growth and development of plants and animals										
1. Prehistoric life and evolution of living things	X		X		-		-	-	-	-X
2. The variety of living things and their classification	X	X	X				-	-		X
3. Conditions necessary for life	X	X	X				-	-	-	X

TABLE IX (Continued)

COURSE CONTENT	COURSES B 1	B 2	B 3	P 1	P 2	P 3	G 1	G 2	M 1	RESUME
4. Interrelationship of living things and balance of nature	x	-	x				x	x		x
5. Protective adaptation	x	-	x				-	-		-x
6. Reproduction of plants and animals	x	x	x				-	-		x
7. Growth of plants and animals	x	x	x				-	-		x
8. Obtaining and storing of food by plants and animals	x	x	x							x
9. Man's influence on living things and his dependence upon them	x	-	x				-	-		-x
10. Normal habitats of plants and animals	x	-	x				x	x		x
B. Understanding how the seasons of the year affect living things										
1. Hibernation of animals	-		x							?
2. Survival of insects	-									?
3. Migration of some animals	-						-	-		-
4. Seasonal changes in plants and animals	-						-	-		-
5. Human adaptations to seasonal changes and to climate	-						x	x	-	x
C. Knowledge of some of the behaviors and habits of animals										
1. Hermit animals										no
2. Communal life among animals	-									?
3. Home building of animals										no
4. Animals protecting themselves and caring for their young	-									?
D. Understanding the human body and how it works										
1. Kinds of food and their uses in the human body	x	x	x							x
2. The systems of the body and their functions	-	-	x							-x
3. Effect of alcohol, tobacco, and narcotics upon the human body			x							?
4. Causes of diseases and methods of control	-		x							?
5. Reproduction	-	-	x							-x
E. Understanding how living things can be conserved and why they need to be conserved										
1. Economic importance of living things			x							?

TABLE IX (Continued)

COURSE CONTENT	COURSES B 1	B 2	B 3	P 1	P 2	P 3	G 1	G 2	M 1	RÉSUMÉ
2. Conservation of wild life										no
3. Conservation and need for forests			-							?
4. Man's part in maintaining the balance of life in nature	x		-				-	-		-x
III. A knowledge, understanding, and appreciation of matter and energy										
A. Knowledge of the composition of things										
1. The nature of atoms, molecules, elements, mixtures, and compounds	x	x	-	x	x	x			-	x
2. Composition of matter		x	-	x	x	x				x
3. Physical and chemical change	x	x	-	x	x	x			-	x
4. Chemistry in man's everyday life			-	x	x	-				-x
B. Understanding the characteristics of heat and how it is used										
1. Heat as a form of energy	-	-	x	x	x	x			x	x
2. Sources of heat and its measurement			x	x	-	-			x	x
3. Effect of heat upon matter	-		x	x	x	-			x	x
4. Producing and using heat				x	-	-			x	x
5. Methods of heat transference				x	-	-			x	x
6. Refrigeration and air conditioning				x	x	-			-	-x
7. Fire, its prevention and control			-		-				x	x
C. Understanding atomic energy and knowledge of some of its uses										
1. The structure of the atom	-		-	x	x	x			-	x
2. Forces within atoms			-	x	x	x				x
3. The fission process				x	-	x				-x
4. The fusion process				x	-	x				-x
5. Military uses of atomic energy			-	x	-	-				-x
6. Non-military uses of atomic energy	-		-	x	x	-				-x
7. Radioisotopes	-		x	x	x	x				x
8. Radioactive "fall out"	-		x	x		x				?
D. Gaining a knowledge of machines and how they work										
1. What work is and how it is measured	-			x	x	x			x	x
2. Simple machines such as the lever, the pulley, the wheel and axle, the inclined plane, the screw, and how they work				x	-	-			x	x
3. Complex machines such as the steam engine, gasoline engine, diesel engine, power turbines, and how they work				x	-				x	x

TABLE IX (Continued)

COURSE CONTENT	COURSES									
	B			P			G		M	RESUME
	1	2	3	1	2	3	1	2	1	
4. Friction	-			-	-	-			x	x
E. Knowledge of some of the characteristics and uses of magnetism and electricity										
1. Natural magnets and man-made magnets				x	x	-			x	x
2. Characteristics of magnets				x	x	-			x	x
3. The theory of magnetism				x	x	x			x	x
4. Static electricity				x	x	x			x	x
5. Generating electricity				x	x	x			x	x
6. Measuring electricity				-	x	-			-	-x
7. Electrical circuits				-	-	-			x	x
8. Uses of electricity				x	x	-			x	x
F. Understanding what sound is and knowledge of some of its uses										
1. Causes of sound	-			x	-	-			x	x
2. Characteristics of sound				x	-	-			x	x
3. Using sound to produce music				x	-	-			x	x
4. How we speak and how we hear	-			-	-	-			x	x
G. Understanding the characteristics of light and knowledge of how light can be used										
1. Characteristics of light	-		-	x	x	x			x	x
2. Reflection and refraction of light			x	x	x	-			x	x
3. How we see objects			-	x	-	-			x	x
4. Uses of light in motion pictures, microscopes, telescopes, and cameras	-		-	x	-	-			x	x
5. Formation of colors	-		-	x	x	-			x	x
6. Providing proper lighting in our homes				-	-				-	-
7. Correcting eye defects with lenses				-	x	-			-	-x
H. Knowledge and understanding of aviation										
1. How an airplane flies				x					x	x
2. Types of aircraft										no
3. Aircraft instruments and their uses					-				-	-
4. Characteristics of jet propulsion				-	-	-			-	-
5. Characteristics of rockets and missiles				-	-	-			-	-
6. Aviation and weather					-				-	-
7. Problems of space flight	x		-	-		-				?

certificate. These ten items are:

Man-made satellites
Conservation of the soil by preventing erosion and maintaining soil fertility
Conservation of coal, oil, gas, and minerals stored in the ground
Migration of some animals
Seasonal changes in plants and animals
Providing proper lighting in our homes
Aircraft instruments and their uses
Characteristics of jet propulsion
Characteristics of rockets and missiles
Aviation and weather

Ten items may or may not be included in the science instruction for prospective elementary school teachers, depending upon the teachers selected. These ten items are:

Hibernation of animals
Survival of insects
Communal life among animals
Animals protecting themselves and caring for their young
Effect of alcohol, tobacco, and narcotics upon the human body
Causes of diseases and methods of control
Economic importance of living things
Conservation of and need for forests
Radioactive "fall out"
Problems of space flight

Four items are not included in the science preparation of the prospective elementary school teacher, regardless of the instructors selected. These four items are:

Hermit animals
Home building of animals
Conservation of wild life
Types of aircraft

The instructors at School F stated that they also included and stressed in their instruction the following additional items which they believe are important in the preparation of prospective elementary school teachers:

Nebulae
Genetics
Nitrogen cycle
Food cycle
Limitation of population rise
Chemistry of protoplasm

Kinetic and potential energy
Fluid dynamics
Newton's Laws of Motion
Vector quantities

The names of the instructors of the science courses at School F are included in the alphabetical list of respondents given in Appendix J. Information concerning their preparation and experience is also given in Appendix J.

School G

The science curriculum required or recommended for the preparation of the prospective elementary school teacher at School G consists of the following courses:

General Biology 104	4 hours
General Physical Science 104	4 hours
Elements of Human Geography 103	3 hours
Methods of Elementary Natural Science 362	2 hours

The catalog description of these courses is given in Appendix I.

Biology 104 and General Physical Science 104 are required science courses for most all students and are, therefore, offered to students who are preparing for other professions as well as those who are preparing to be elementary school teachers. These courses include the science areas of astronomy, botany, chemistry, geography, geology, meteorology, physics, physiology, and zoology.

To meet the geography requirement for the elementary school teacher, a student may take Human Geography 103, Earth Science 123, or World Regional Geography 453. Over eighty per cent of the students take Geography 103 to satisfy this requirement.

A methods course in elementary natural science is required of all students who are preparing to be elementary school teachers. This course is taught by the education department.

The specific content of the science courses pursued by each student preparing for the elementary school certificate depends upon the combination of teachers selected by the student. Three different teachers teach the general biology course (B), two teach the general physical science course (P), and two teach the human geography course (G). Each student has the same instructor for the course in methods in elementary natural science (M).

A study of Table X shows that eighty-two of the 112 items listed in the areas and sub-areas of the checklist are taught and stressed in at least one of the science courses taken by each student. Thirteen items are either taught and stressed or taught but not stressed, depending upon the combination of teachers selected by a student.

Sixteen items are included but not stressed, regardless of the science instructors selected by the student preparing for the elementary school certificate. These sixteen items are:

Nature of comets, meteors, and planetoids
Nature of stars, their size, movement, and distance from the earth
Man-made satellites
Constellations and galaxies
History of the earth - the geological time chart
Prehistoric life and evolution of living things
Hibernation of animals
Migration of some animals
Communal life among animals
Home building of animals
Complex machines such as the steam engine, gasoline engine, diesel engine, power turbines, and how they work
Using sound to produce music
Aircraft instruments and their uses
Characteristics of jet propulsion
Characteristics of rockets and missiles
Problems of space flight

There are no items that may or may not be included in the science instruction for prospective elementary school teachers, depending upon the teachers selected.

TABLE X

INTERVIEW RESPONSES TO CHECKLIST AT COLLEGE G

COURSE CONTENT	COURSES								RÉSUMÉ
	B			P		G		M	
	1	2	3	1	2	1	2	1	
I. A knowledge, understanding, and appreciation of the earth and the universe									
A. Knowledge and understanding of the relationship of the earth and the heavenly bodies									
1. The sun and the sun's family				x	-	x	x	x	x
2. Nature of the planets, their relative size, and their distance from the sun				-	-	x	x	-	x
3. Nature of comets, meteors, and planetoids					-	-		-	-
4. Nature of stars, their size, movement, and distance from earth				-	-	-	-	-	-
5. The moon, its size and movements, causes of tides, eclipses, and why the moon appears to change its shape				-	-	x	x	-	x
6. Causes of day and night and the seasons of the year					-	x	x		x
7. The vastness and orderliness of the universe				-	-	-	x		-x
8. Man-made satellites				-	-	-	-	-	-
9. Gravitation, gravity, and inertia				x	x	x	-	-	x
10. Constellations and galaxies				-	-	-		-	-
11. Solar energy and cosmic rays					-	x	-		-x
12. Theories of the formation of the earth				-	-	x		-	-x
B. Knowledge and understanding of the earth's structure and its surface									
1. The shape, size, and composition of the earth				x	-	x	x	-	x
2. Kinds of rock and their formation				-	-	x	x		x
3. The causes of mountains, earthquakes, volcanoes, hot springs, and geysers				-	-	x	x	-	x
4. Formation of soil			-		-	x	x	x	x
5. History of the earth - the geological time chart				-	-	-	-		-
6. Forces that have changed and are still changing the surface of the earth				x	-	x	x	x	x

TABLE X (Continued)

COURSE CONTENT	COURSES								RÉSUMÉ
	B			P		G		M	
	1	2	3	1	2	1	2	1	
7. The continents				-		x	x	x	x
8. The polar regions				-		x	x	-	x
9. Oceans, lakes, and streams				-		x	x	-	x
10. Theories concerning the earth's interior				-		x	x		x
C. Knowledge and understanding of the composition of air and the causes of weather									
1. Composition, characteristics, and pressure of the atmosphere				x	x	x	x	-	x
2. The water cycle	-			-	-	x	x	-	x
3. Forms of precipitation and their causes				x	-	x	x	-	x
4. Cloud formation				x		x	x	x	x
5. Causes of winds and the wind belts of the world				x	-	x	x	-	x
6. Causes of hurricanes, tornadoes, and thunderstorms				x		-	x	x	x
7. Weather forecasting and instruments used				-	-	-	x		-x
8. Climates of the earth				x		x	x	x	x
D. Knowledge and understanding of how natural resources can be conserved and why they need to be conserved									
1. Vanishing natural resources	-	-		-		-	x	x	x
2. Dependence on natural resources	-	-		-		x	x	x	x
3. Conservation of the soil by preventing erosion and maintaining soil fertility	-	-				x	x	x	x
4. Conservation of coal, oil, gas, and minerals stored in the ground		-				x	x	x	x
5. Conservation of water supplies	-	-		-		x	x	x	x
II. A knowledge, understanding, and appreciation of living things									
A. Understanding the growth and development of plants and animals									
1. Prehistoric life and evolution of living things	-	-	-			-	-	-	-
2. The variety of living things and their classification	x	-	x			-		-	-x
3. Conditions necessary for life	x	x	x			-	x	x	x
4. Interrelationship of living things and balance of nature	x	x	x			x	-	x	x
5. Protective adaptation	-	x				-		x	x
6. Reproduction of plants and animals	x	x	x			-		-	x

TABLE X (Continued)

COURSE CONTENT	COURSES								RÉSUMÉ
	B			P		G		M	
	1	2	3	1	2	1	2	1	
7. Growth of plants and animals	x	x	x			-		x	x
8. Obtaining and storing of food by plants and animals	x	-	x			-		x	x
9. Man's influence on living things and his dependence upon them	x	-	-	-		-	x	x	x
10. Normal habitats of plants and animals	-	x	-			x		-	-x
B. Understanding how the seasons of the year affect living things									
1. Hibernation of animals		-						-	-
2. Survival of insects	-	-						x	x
3. Migration of some animals	-	-				-		-	-
4. Seasonal changes in plants and animals	-	-				x		-	-x
5. Human adaptations to seasonal changes and to climate	-	-				x	x	x	x
C. Knowledge of some of the behaviors and habits of animals									
1. Hermit animals									no
2. Communal life among animals	-							-	-
3. Home building of animals	-							-	-
4. Animals protecting themselves and caring for their young	-	-						x	x
D. Understanding the human body and how it works									
1. Kinds of food and their uses in the human body	x	x	x					x	x
2. The systems of the body and their functions	x	x	x					x	x
3. Effect of alcohol, tobacco, and narcotics upon the human body	-	x	-					x	x
4. Causes of diseases and methods of control	-	x	-					x	x
5. Reproduction	x	x	x					-	x
E. Understanding how living things can be conserved and why they need to be conserved									
1. Economic importance of living things	x	-	-			x			-x
2. Conservation of wild life	-	-				-	x	-	-x
3. Conservation of and need for forests	-	-				x	x	x	x
4. Man's part in maintaining the balance of life in nature	x	-	-			x	x	x	x

TABLE X (Continued)

COURSE CONTENT	COURSES B 1	B 2	B 3	P 1	P 2	G 1	G 2	M 1	RÉSUMÉ
III. A knowledge, understanding, and appreciation of matter and energy									
A. Knowledge of the composition of things									
1. The nature of atoms, molecules, elements, mixtures, and compounds	-	x		x	x			-	x
2. Composition of matter	-	x		x	x			x	x
3. Physical and chemical change	-	x		x	x	-		x	x
4. Chemistry in man's everyday life		x		x	x			x	x
B. Understanding the characteristics of heat and how it is used									
1. Heat as a form of energy		-		x	x			-	x
2. Sources of heat and its measurement		-		x	x			-	x
3. Effect of heat upon matter		-		x	x			x	x
4. Producing and using heat		-		x	x			x	x
5. Methods of heat transference		x		x	x			x	x
6. Refrigeration and air conditioning				-	x			x	x
7. Fire, its prevention and control				-	x			x	x
C. Understanding atomic energy and knowledge of some of its uses									
1. The structure of the atom		-		x	x				x
2. Forces within atoms				x	x				x
3. The fission process				x	x				x
4. The fusion process				x	x				x
5. Military uses of atomic energy				-	x				-x
6. Non-military uses of atomic energy		-		-	x			-	-x
7. Radioisotopes		-		x	x				x
8. Radioactive "fall out"	-	-		-	x			-	-x
D. Gaining a knowledge of machines and how they work									
1. What work is and how it is measured				x	x			x	x
2. Simple machines such as the lever, the pulley, the wheel and axle, the inclined plane, the screw, and how they work				x	x			x	x

TABLE X (Continued)

COURSE CONTENT	COURSES								
	B			P		G		M	RÉSUMÉ
	1	2	3	1	2	1	2	1	
3. Complex machines such as the steam engine, gasoline engine, diesel engine, power turbines, and how they work				-	-			-	-
4. Friction				x	x			-	x
E. Knowledge of some of the characteristics and uses of magnetism and electricity									
1. Natural magnets and man-made magnets				x	x			x	x
2. Characteristics of magnets				x	x			x	x
3. The theory of magnetism				x	x			x	x
4. Static electricity				x	x			x	x
5. Generating electricity				x	x			x	x
6. Measuring electricity				x	x			-	x
7. Electrical circuits				-	-			x	x
8. Uses of electricity				x	x			-	x
F. Understanding what sound is and knowledge of some of its uses									
1. Causes of sound				x	x				x
2. Characteristics of sound				x	x			-	x
3. Using sound to produce music				-	-				-
4. How we speak and how we hear	x	-		x	x			x	x
G. Understanding the characteristics of light and knowledge of how light can be used									
1. Characteristics of light				x	x			-	x
2. Reflection and refraction of light				x	x			-	x
3. How we see objects	x	-		x	x			x	x
4. Uses of light in motion pictures, microscopes, telescopes, and cameras				x	-			x	x
5. Formation of colors				x	x			x	x
6. Providing proper lighting in our homes				-	-			x	x
7. Correcting eye defects with lenses	-	-		x	-			-	-x
H. Knowledge and understanding of aviation									
1. How an airplane flies				-				x	x

TABLE X (Continued)

COURSE CONTENT	COURSES B 1	B 2	B 3	P 1	P 2	G 1	G 2	M 1	RÉSUMÉ
2. Types of aircraft								x	x
3. Aircraft instruments and their uses						-		-	-
4. Characteristics of jet propulsion				-	-			-	-
5. Characteristics of rockets and missiles				-	-	-		-	-
6. Aviation and weather				-		x		x	x
7. Problems of space flight						-		-	-

One item is not included in the science preparation of the prospective elementary school teacher, regardless of the instructors selected. This item is:

Hermit animals

The instructors at School G stated that they also included and stressed in their instruction the following additional items which they believe are important in the preparation of prospective elementary school teachers:

Earth's magnetic field
Maps and how to use them
Mountains, plains and plateaus
Pressure gradients
Effect of climate on plants and animals
Cell concept and theory
Mechanical advantages

The names of the instructors of the science courses at School G are included in the alphabetical list of respondents given in Appendix J. Information concerning their preparation and experience is also given in Appendix J.

School H

The science curriculum required or recommended for the preparation of the prospective elementary school teacher at School H consists of the following courses:

General Biology 104	4 hours
General Physical Science 104	4 hours
Elements of Human Geography 103	3 hours
Methods and Materials in Elementary Natural Science 362	2 hours

The catalog description of these courses is given in Appendix I.

The two general survey courses, General Biology 104 and General Physical Science 104, are recommended for all students in college. Some exceptions can be made, but over ninety per cent of the students who are

preparing to be elementary school teachers take these courses. These courses include the science areas of astronomy, botany, chemistry, geography, geology, meteorology, physics, physiology, and zoology.

Geography 103 is required of all students working for a standard elementary school certificate. A two-hour course in methods and materials in elementary natural science is also a requirement for the elementary certificate. The methods course in science is taught by the education department.

The specific content of the science courses pursued by each student preparing for the elementary school certificate depends upon the combination of teachers selected by the student. Three different teachers teach the general biology course (B), and four teach the general physical science course (P). Each student has the same instructor for human geography (G), and each student has the same instructor for the course in methods and materials in elementary natural science (M).

A study of Table XI shows that ninety-four of the 112 items listed in the areas and sub-areas of the checklist are taught and stressed in at least one of the science courses taken by each student. Two items are either taught and stressed or taught but not stressed, depending upon the combination of teachers selected by a student.

Sixteen items are included but not stressed, regardless of the science instructors selected by the student preparing for the elementary school certificate. These sixteen items are:

Hermit animals
Communal life among animals
Home building of animals
Animals protecting themselves and caring for their young
Kinds of foods and their uses in the human body
The systems of the body and their functions
Effect of alcohol, tobacco, and narcotics upon the human body

TABLE XI

INTERVIEW RESPONSES TO CHECKLIST AT COLLEGE H

COURSE CONTENT	COURSES									RÉSUMÉ
	B			P				G	M	
	1	2	3	1	2	3	4	1	1	
I. A knowledge, understanding, and appreciation of the earth and the universe										
A. Knowledge and understanding of the relationship of the earth and the heavenly bodies										
1. The sun and the sun's family				x	x	x	x	x	x	x
2. Nature of the planets, their relative size, and their distance from the sun				x	x	-	-	-	x	x
3. Nature of comets, meteors, and planetoids				x	-	-	-	-	x	x
4. Nature of stars, their size, movement, and distance from earth				-	-	-	-	-	x	x
5. The moon, its size and movements, causes of tides, eclipses, and why the moon appears to change its shape				x	x	x	x	x	x	x
6. Causes of day and night and the seasons of the year				x	x	x	-	x	x	x
7. The vastness and orderliness of the universe				x	x	x	-	x	x	x
8. Man-made satellites						-		-	x	x
9. Gravitation, gravity, and inertia				x	x	x	x	-	x	x
10. Constellations and galaxies				-	-	-	-		x	x
11. Solar energy and cosmic rays				-	-	-	-	-	x	x
12. Theories of the formation of the earth			-	-		-	-	x	x	x
B. Knowledge and understanding of the earth's structure and its surface										
1. The shape, size, and composition of the earth				-		x	-	x	x	x
2. Kinds of rock and their formation			-			-	x	x	x	x
3. The causes of mountains, earthquakes, volcanoes, hot springs, and geysers							-	x	x	x
4. Formation of soil			x				-	x	x	x
5. History of the earth - the geological time chart			x					x	x	x

TABLE XI (Continued)

COURSE CONTENT	COURSES B 1	B 2	B 3	P 1	P 2	P 3	P 4	G 1	M 1	RÉSUMÉ
6. Forces that have changed and are still changing the surface of the earth						-	-	x	x	x
7. The continents								x	x	x
8. The polar regions								x	x	x
9. Oceans, lakes, and streams							-	x	x	x
10. Theories concerning the earth's interior								x	x	x
C. Knowledge and understanding of the composition and characteristics of air and the causes of weather										
1. Composition, characteristics, and pressure of the atmosphere					x	-		x	x	x
2. The water cycle								x	x	x
3. Forms of precipitation and their causes					-			x	x	x
4. Cloud formation								x	x	x
5. Causes of winds and the wind belts of the world								x	x	x
6. Causes of hurricanes, tornadoes, and thunderstorms								x	x	x
7. Weather forecasting and instruments used								x	x	x
8. Climates of the earth			-					x	x	x
D. Knowledge and understanding of how natural resources can be conserved and why they need to be conserved										
1. Vanishing natural resources			x			-	-	x	x	x
2. Dependence on natural resources			x		-	-	-	x	x	x
3. Conservation of the soil by preventing erosion and maintaining soil fertility			x				-	x	x	x
4. Conservation of coal, oil, gas, and minerals stored in the ground			-					x	x	x
5. Conservation of water supplies			-					x	x	x
II. A knowledge, understanding, and appreciation of living things										
A. Understanding the growth and development of plants and animals										
1. Prehistoric life and evolution of living things	-	-	x						x	x
2. The variety of living things and their classification	x	x	x						x	x
3. Conditions necessary for life	x	x	x	-				-	x	x

TABLE XI (Continued)

COURSE CONTENT	COURSES										RÉSUMÉ
	B			P				G	M		
	1	2	3	1	2	3	4	1	1		
4. Interrelationship of living things and balance of nature	-	x	x						x		x
5. Protective adaptation	-	-	x						x		x
6. Reproduction of plants and animals	x	x	x						x		x
7. Growth of plants and animals	-	x	x					x	x		x
8. Obtaining and storing of food by plants and animals	-	-	x						x		x
9. Man's influence on living things and his dependence upon them	x	-	x					x	x		x
10. Normal habitats of plants and animals			x					x	x		x
B. Understanding how the seasons of the year affect living things											
1. Hibernation of animals			x						x		x
2. Survival of insects		-	x						x		x
3. Migration of some animals		-	x						x		x
4. Seasonal changes in plants and animals	-		x						x		x
5. Human adaptations to seasonal changes and to climate		-	-					x	x		x
C. Knowledge of some of the behaviors and habits of animals											
1. Hermit animals			-						-		-
2. Communal life among animals			-						-		-
3. Home building of animals			-						-		-
4. Animals protecting themselves and caring for their young		-	-						-		-
D. Understanding the human body and how it works											
1. Kinds of food and their uses in the human body	-	-	-						-		-
2. The systems of the body and their functions	-	-	-						-		-
3. Effect of alcohol, tobacco, and narcotics upon the human body			-						-		-
4. Causes of diseases and methods of control	-	-	-						-		-
5. Reproduction	-	-	-						-		-
E. Understanding how living things can be conserved and why they need to be conserved											
1. Economic importance of living things	-	-	x					x	-		x
2. Conservation of wild life	-		x					x	-		x

TABLE XI (Continued)

COURSE CONTENT	COURSES B 1	B 2	B 3	P 1	P 2	P 3	P 4	G 1	M 1	RESUME
3. Conservation of and need for forests	-		x					x	-	x
4. Man's part in maintaining the balance of life in nature	-	-	x					x	-	x
III. A knowledge, understanding, and appreciation of matter and energy										
A. Knowledge of the composition of things										
1. The nature of atoms, molecules, elements, mixtures, and compounds			x	x	x	x	x	-	x	x
2. Composition of matter			x	x	x	x	x	-	x	x
3. Physical and chemical change			x	x	x	x	x	-	x	x
4. Chemistry in man's everyday life				-	x	-	-		x	x
B. Understanding the characteristics of heat and how it is used										
1. Heat as a form of energy				x	x	x		x	-	x
2. Sources of heat and its measurement			-	x	x	x		x	-	x
3. Effect of heat upon matter			x	x	x	x		x	-	x
4. Producing and using heat				x	x	-		x	-	x
5. Methods of heat transference			x	x	-	-		x	-	x
6. Refrigeration and air conditioning				x		-			-	-x
7. Fire, its prevention and control					-				-	-
C. Understanding atomic energy and knowledge of some of its uses										
1. The structure of the atom			x	x	x	x	x	-	x	x
2. Forces within atoms			x	x	x	x	-	-	x	x
3. The fission process				x	x	x	x		x	x
4. The fusion process				x	x	x	-		x	x
5. Military uses of atomic energy				-	-	-	-		-	-
6. Non-military uses of atomic energy				-	-	-	-		-	-
7. Radioisotopes			-	-	-	-	-		-	-
8. Radioactive "fall out"				-	-	-	x		-	-x
D. Gaining a knowledge of machines and how they work										
1. What work is and how it is measured				x	x	x	-		x	x

TABLE XI (Continued)

COURSE CONTENT	COURSES									RÉSUMÉ
	B			P				G	M	
	1	2	3	1	2	3	4	1	1	
2. Simple machines such as the lever, the pulley, the wheel and axle, the inclined plane, the screw, and how they work				-	-	-			x	x
3. Complex machines such as the steam engine, gasoline engine, diesel engine, power turbines, and how they work					-				x	x
4. Friction				x	-	x			x	x
E. Knowledge of some of the characteristics and uses of magnetism and electricity										
1. Natural magnets and man-made magnets				x	-	x	x		x	x
2. Characteristics of magnets				x	-	x	x		x	x
3. The theory of magnetism				x	x	x	x		x	x
4. Static electricity				x	x	x	x		x	x
5. Generating electricity				x	x	x	x		x	x
6. Measuring electricity				x	x	x	-		x	x
7. Electrical circuits				x	-	x	-		x	x
8. Uses of electricity				x	-	-	-		x	x
F. Understanding what sound is and knowledge of some of its uses										
1. Causes of sound				x	-	-			x	x
2. Characteristics of sound				x	x	-			x	x
3. Using sound to produce music						-			x	x
4. How we speak and how we hear					-	-			x	x
G. Understanding the characteristics of light and knowledge of how light can be used										
1. Characteristics of light				x	x	x	x	x	x	x
2. Reflection and refraction of light				x	x	x	-	x	x	x
3. How we see objects				x	-	x	-	-	x	x
4. Uses of light in motion pictures, microscopes, telescopes, and cameras				x					x	x
5. Formation of colors				-	x	x	-	x	x	x
6. Providing proper lighting in our homes					-				x	x
7. Correcting eye defects with lenses					-				x	x

TABLE XI (Continued)

COURSE CONTENT	COURSES									RÉSUMÉ
	B			P				G	M	
	1	2	3	1	2	3	4	1	1	
H. Knowledge and understanding of aviation										
1. How an airplane flies									-	-
2. Types of aircraft									-	-
3. Aircraft instruments and their uses									-	-
4. Characteristics of jet propulsion						-			x	x
5. Characteristics of rockets and missiles						-			x	x
6. Aviation and weather								x	x	x
7. Problems of space flight						-			x	x

Causes of diseases and methods of control
Reproduction
Fire, its prevention and control
Military uses of atomic energy
Radioisotopes
How an airplane flies
Types of aircraft
Aircraft instruments and their uses

There are no items that may or may not be included in the science instruction for prospective elementary school teachers, depending upon the teachers selected.

All the items on the checklist are included in the science instruction given to prospective elementary school teachers.

The instructors at School H stated that they also included and stressed in their instruction the following items, which they believe are important in the preparation of prospective elementary school teachers:

Heredity
Cell structure
Chemical and physical nature of protoplasm

The names of the instructors of the science courses at School H are included in the alphabetical list of respondents given in Appendix J. Information concerning their preparation and experience is also given in Appendix J.

Summary

In Chapter IV the general procedures for gathering data are described. A summary is given of the visit to each school. Data for each school are summarized in Tables IV to XI. Chapter V will be devoted to a general summary and interpretations of the findings.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

Detailed data for each of the eight institutions included in the study are given in Chapter IV. From these data certain summary findings may be drawn.

A summary of the total responses at the eight institutions to the checklist is presented in Table XII. A study of this table reveals that:

1. The number of items taught and stressed at the eight institutions varies from 57 to 97 items.

2. The number of items taught, but which may or may not be stressed depending upon the teacher selected, varies from 0 to 28 items.

3. The number of items taught but not stressed varies from 10 to 40 items.

4. The number of items which may or may not be included varies from 0 to 14 with only 2 institutions indicating any items in this category.

5. The number of items not included varies from 0 to 4 items, with three institutions showing no items not included in the required or recommended courses.

Data relative to the items taught, regardless of stress, are summarized in Table XIII.

A study of Table XIII reveals that from 85 per cent to 100 per cent

TABLE XII

SUMMARY OF RESPONSES TO THE CHECKLIST

CATEGORY	SCHOOLS A	B	C	D	E	F	G	H
Taught and stressed	66	67	81	57	97	60	82	94
Taught and stressed or taught but not stressed depending upon teacher selected	19	7	0	15	0	28	13	2
Included but not stressed	11	37	29	40	15	10	16	16
May or may not be included, depending upon teacher selected	14	0	0	0	0	10	0	0
Not included	2	1	2	0	0	4	1	0
TOTAL	112	112	112	112	112	112	112	112

TABLE XIII

SUMMARY OF ITEMS TAUGHT REGARDLESS OF STRESS

	SCHOOLS A	B	C	D	E	F	G	H
Taught and stressed	66	67	81	57	97	60	82	94
Taught - may or may not be stressed	19	7	0	15	0	28	13	2
Taught and not stressed	11	37	29	40	15	10	16	16
TOTAL	96	111	110	112	112	98	111	112
PER CENT	85	99	98	100	100	87	99	100

of the items included in the checklist are taught in the required or recommended courses at the eight institutions included in the study with all but two of the institutions including 110 (98 percent) or more of the 112 items. The institutions do differ in the amount of stress given the various topics. The degree of stress also varies when several instructors are used to teach the same course.

Data relative to items which "may or may not be taught" or which "are not taught" are summarized in Table XIV.

TABLE XIV

SUMMARY OF RESPONSES TO ITEMS WHICH "MAY OR MAY NOT BE" OR "ARE NOT" INCLUDED

	SCHOOLS							
	A	B	C	D	E	F	G	H
May or may not be taught	14	0	0	0	0	10	0	0
Not taught	2	1	2	0	0	4	1	0
TOTAL	16	1	2	0	0	14	1	0
PER CENT	15	1	2	0	0	13	1	0

A study of Table XIV reveals that in 6 of the 8 institutions there are no items which "may or may not be" included and only 0 to 2 items definitely not included.

In the two remaining institutions from 10 to 14 items may or may not be included in the required or recommended courses and 2 to 4 items are definitely not included.

A summary of the institutional responses to the 112 individual items of the checklist is given in Table XV. A study of this summary table reveals:

1. All 35 items in Section I, A Knowledge, Understanding, and Appreciation of the Earth and the Universe, are included in the required or recommended courses at each of the eight institutions studied but the degree of stress varies.

2. Of the 28 items in Section II, A Knowledge, Understanding, and Appreciation of Living Things, 15 are taught in all 8 schools; 13 are taught in 4 schools and "may or may not be taught" or "are not taught" in the remaining 4.

TABLE XV

SUMMARY OF RESPONSES AT THE EIGHT INSTITUTIONS INCLUDED IN THE STUDY

COURSE CONTENT	SCHOOLS A	B	C	D	E	F	G	H
I. A knowledge, understanding, and appreciation of the earth and the universe								
A. Knowledge and understanding of the relationship of the earth and the heavenly bodies								
1. The sun and the sun's family	x	x	x	x	x	x	x	x
2. Nature of the planets, their relative size, and their distance from the sun	x	x	x	x	x	-x	x	x
3. Nature of comets, meteors, and planetoids	x	-	-	-	x	-x	-	x
4. Nature of stars, their size, movement, and distance from earth	x	-	x	-	-	-x	-	x
5. The moon, its size and movements, causes of tides, eclipses, and why the moon appears to change its shape	x	x	x	-	x	x	x	x
6. Causes of day and night and the seasons of the year	x	x	x	x	x	x	x	x
7. The vastness and orderliness of the universe	x	x	x	-	x	x	-x	x
8. Man-made satellites	-	x	x	x	x	-	-	x
9. Gravitation, gravity, and inertia	x	x	x	x	x	x	x	x
10. Constellations and galaxies	x	-	-	-	-	-x	-	x
11. Solar energy and cosmic rays	-x	x	-	-	-	-x	-x	x
12. Theories of the formation of the earth	-	-x	-	-	x	-x	-x	x
B. Knowledge and understanding of the earth's structure and its surface								
1. The shape, size, and composition of the earth	x	x	x	x	x	x	x	x
2. Kinds of rock and their formation	x	x	x	x	x	x	x	x
3. The causes of mountains, earthquakes, volcanoes, hot springs, and geysers	x	x	x	-	x	x	x	x
4. Formation of soil	x	x	x	-	x	x	x	x
5. History of the earth - the geological time chart	x	-x	x	-	x	-x	-	x
6. Forces that have changed and are still changing the surface of the earth	x	x	x	-	x	x	x	x
7. The continents	x	x	x	x	x	x	x	x
8. The polar regions	x	x	x	x	-	x	x	x

TABLE XV (Continued)

COURSE CONTENT	SCHOOLS A	B	C	D	E	F	G	H
9. Oceans, lakes, and streams	x	x	x	x	x	x	x	x
10. Theories concerning the earth's interior	-x	-x	-	-	-	-x	x	x
C. Knowledge and understanding of the composition and characteristics of air and the causes of weather								
1. Composition, characteristics, and pressure of the atmosphere	x	x	x	x	x	x	x	x
2. The water cycle	x	x	x	x	x	x	x	x
3. Forms of precipitation and their causes	x	x	x	x	x	x	x	x
4. Cloud formation	x	x	x	-	x	-x	x	x
5. Causes of winds and the wind belts of the world	x	x	x	x	x	-x	x	x
6. Causes of hurricanes, tornadoes, and thunderstorms	x	x	x	-	x	-x	x	x
7. Weather forecasting and instruments used	x	x	-	-	x	x	-x	x
8. Climates of the earth	x	-	x	x	x	x	x	x
D. Knowledge and understanding of how natural resources can be conserved and why they need to be conserved								
1. Vanishing natural resources	x	x	x	x	x	-x	x	x
2. Dependence on natural resources	x	x	x	-x	x	-x	x	x
3. Conservation of the soil by preventing erosion and maintaining soil fertility	x	x	x	-	x	-	x	x
4. Conservation of coal, oil, gas, and minerals stored in the ground	x	x	x	-	-	-	x	x
5. Conservation of water supplies	x	x	x	-	x	-x	x	x
II. A knowledge, understanding, and appreciation of living things								
A. Understanding the growth and development of plants and animals								
1. Prehistoric life and evolution of living things	x	-x	x	-x	x	-x	-	x
2. The variety of living things and their classification	x	-x	x	x	x	x	-x	x
3. Conditions necessary for life	x	x	x	x	x	x	x	x
4. Interrelationship of living things and balance of nature	-x	x	x	x	x	x	x	x
5. Protective adaptation	-x	x	x	-	x	-x	x	x
6. Reproduction of plants and animals	-x	x	-	x	x	x	x	x
7. Growth of plants and animals	x	x	-	x	x	x	x	x
8. Obtaining and storing of food by plants and animals	x	x	-	x	x	x	x	x
9. Man's influence on living things and his dependence upon them	-x	x	x	-x	x	-x	x	x

TABLE XV (Continued)

COURSE CONTENT	SCHOOLS A	B	C	D	E	F	G	H
10. Normal habitats of plants and animals	?	x	x	x	x	x	-x	x
B. Understanding how the seasons of the year affect living things								
1. Hibernation of animals	?	x	-	-x	x	?	-	x
2. Survival of insects	?	x	no	-x	-	?	x	x
3. Migration of some animals	?	x	-	-x	-	-	-	x
4. Seasonal changes in plants and animals	-x	x	-	-x	x	-	-x	x
5. Human adaptations to seasonal changes and to climate	-x	x	x	-x	-	x	x	x
C. Knowledge of some of the behaviors and habits of animals								
1. Hermit animals	no	-	no	-	-	no	no	-
2. Communal life among animals	?	-	x	-	x	?	-	-
3. Home building of animals	?	-	x	-	x	no	-	-
4. Animals protecting themselves and caring for their young	?	-	x	-x	x	?	x	-
D. Understanding the human body and how it works								
1. Kinds of food and their uses in the human body	x	x	x	x	x	x	x	-
2. The systems of the body and their functions	x	x	x	x	x	-x	x	-
3. Effect of alcohol, tobacco, and narcotics upon the human body	?	-	-	-	-	?	x	-
4. Causes of diseases and methods of control	-x	-	x	-	x	?	x	-
5. Reproduction	x	-x	-	x	x	-x	x	-
E. Understanding how living things can be conserved and why they need to be conserved								
1. Economic importance of living things	x	x	x	-	x	?	-x	x
2. Conservation of wild life	x	x	x	-x	x	no	-x	x
3. Conservation of and need for forests	x	x	x	x	x	?	x	x
4. Man's part in maintaining the balance of life in nature	x	x	x	-x	x	-x	x	x
III. Knowledge, understanding, and appreciation of matter and energy								
A. Knowledge of the composition of things								
1. The nature of atoms, molecules, elements, mixtures, and compounds	x	x	x	-x	x	x	x	x
2. Composition of matter	x	x	x	-x	x	x	x	x
3. Physical and chemical change	x	x	x	x	x	x	x	x
4. Chemistry in man's everyday life	-x	x	x	-x	x	-x	x	x

TABLE XV (Continued)

COURSE CONTENT	SCHOOLS A	B	C	D	E	F	G	H
B. Understanding the characteristics of heat and how it is used								
1. Heat as a form of energy	x	x	x	x	x	x	x	x
2. Sources of heat and its measurement	x	-	x	x	x	x	x	x
3. Effect of heat upon matter	x	-	-	x	x	x	x	x
4. Producing and using heat	x	-	-	x	x	x	x	x
5. Methods of heat transference	x	-	-	x	x	x	x	x
6. Refrigeration and air conditioning	-x	-	-	x	x	-x	x	-x
7. Fire, its prevention and control	?	x	-	-	x	x	x	-
C. Understanding atomic energy and knowledge of some of its uses								
1. The structure of the atom	x	x	x	x	x	x	x	x
2. Forces within atoms	x	-	x	-	x	x	x	x
3. The fission process	x	-	x	-	x	-x	x	x
4. The fusion process	x	-	x	-	x	-x	x	x
5. Military uses of atomic energy	-	-	-	-	-	-x	-x	-
6. Non-military uses of atomic energy	x	-	-	-	x	-x	-x	-
7. Radioisotopes	x	-	-	-	x	x	x	-
8. Radioactive "fall out"	-	-x	x	-	x	?	-x	-x
D. Gaining a knowledge of machines and how they work								
1. What work is and how it is measured	x	x	x	x	x	x	x	x
2. Simple machines such as the lever, the pulley, the wheel and axle, the inclined plane, the screw, and how they work	x	x	x	x	x	x	x	x
3. Complex machines such as the steam engine, gasoline engine, diesel engine, power turbines, and how they work	-	-	-	x	x	x	-	x
4. Friction	-	x	x	x	x	x	x	x
E. Knowledge of some of the characteristics and uses of magnetism and electricity								
1. Natural magnets and man-made magnets	x	x	x	x	x	x	x	x
2. Characteristics of magnets	x	x	x	x	x	x	x	x
3. The theory of magnetism	x	x	x	x	x	x	x	x
4. Static electricity	x	x	x	x	x	x	x	x
5. Generating electricity	x	x	x	x	x	x	x	x
6. Measuring electricity	-	-	-	x	-	-x	x	x

TABLE XV (Continued)

COURSE CONTENT	SCHOOLS A	B	C	D	E	F	G	H
7. Electrical circuits	x	x	x	x	-	x	x	x
8. Uses of electricity	-	-	x	x	-	x	x	x
F. Understanding what sound is and knowledge of some of its uses								
1. Causes of sound	-x	x	x	x	x	x	x	x
2. Characteristics of sound	-x	x	x	x	x	x	x	x
3. Using sound to produce music	?	-	-	x	x	x	-	x
4. How we speak and how we hear	-x	-	x	x	x	x	x	x
G. Understanding the characteristics of light and knowledge of how light can be used								
1. Characteristics of light	-x	-	x	x	x	x	x	x
2. Reflection and refraction of light	-x	x	x	x	x	x	x	x
3. How we see objects	x	-	x	x	x	x	x	x
4. Uses of light in motion pictures, microscopes, telescopes, and cameras	?	-	-	-x	x	x	x	x
5. Formation of colors	-x	-	x	x	x	x	x	x
6. Providing proper lighting in our homes	-x	-	-	-	x	-	x	x
7. Correcting eye defects with lenses	-x	-	-	-	x	-x	-x	x
H. Knowledge and understanding of aviation								
1. How an airplane flies	-	x	x	-	x	x	x	-
2. Types of aircraft	no	no	x	-	x	no	x	-
3. Aircraft instruments and their uses	?	-	-	-	x	-	-	-
4. Characteristics of jet propulsion	-	-	x	x	x	-	-	x
5. Characteristics of rockets and missiles	-	-	x	x	x	-	-	x
6. Aviation and weather	?	-	x	-	x	-	x	x
7. Problems of space flight	?	-	x	-	x	?	-	x

3. Of the 49 items in Section III, A Knowledge, Understanding, and Appreciation of Matter and Energy, 41 are taught in all 8 schools; 8 are taught in 5 schools and "may or may not be" or "are not taught" in the 3 remaining institutions.

4. Of the 112 items on the checklist, 92 are included in the courses required or recommended at all 8 schools, and 21 may or may not be taught depending upon the institution attended and the instructor selected. These 21 items are:

Normal habitats of plants and animals
Hibernation of animals
Survival of insects (not included at all in 1 school)
Migration of some animals
Hermit animals (not included at all in 4 schools)
Communal life of animals
Home building of animals (not included at all in 1 school)
Animals protecting themselves and caring for their young
Effect of alcohol, tobacco, and narcotics upon the human body
Causes of diseases and methods of control
Economic importance of living things
Conservation of wild life (not included at all in 1 school)
Conservation of and need for forests
Fire, its prevention and control
Radioactive "fall out"
Uses of light in motion pictures, microscopes, telescopes, and cameras
Using sound to produce music
Types of aircraft (not included at all in 3 schools)
Aircraft instruments and their uses
Aviation and weather
Problems of space flight

A study of the suggestions for additional topics to be included in the recommended or required courses (Table XVI) reveals little agreement among the institutions. Two institutions made no suggestions for additional topics. The greatest number of additions (10) was suggested by School F, which also was one of the two schools which included less than 90 per cent of the items on the checklist in its required or recommended courses. School A, which also included less than 90 per cent of the checklist items

TABLE XVI

ADDITIONAL TOPICS SUGGESTED BY THE RESPONDENTS

TOPIC	SCHOOLS							
	A	B	C	D	E	F	G	H
Cell and its structure		x						x
Cell concept and theory							x	
Cellular metabolism		x						
Chemical and physical nature of protoplasm								x
Chemistry of protoplasm						x		
Earth's magnetic field							x	
Effect of climate on plants and animals							x	
Fluid dynamics						x		
Fluids and fluid pressures	x							
Food cycle			n		n	x		
Function of endocrine glands	x		o		o			
Genetics		x				x		
Heredity	x		n		n			x
Kinetic and potential energy			e		e	x		
Limitation of population rise						x		
Map construction				x				
Map reading				x				
Maps and how to use them							x	
Mechanical advantages							x	
Mitosis and meiosis		x						
Motors				x				
Mountains, plains, plateaus	x						x	
Nebulae						x		
Newton's Laws of Motion						x		
Nitrogen cycle						x		
Pressure gradients							x	
Vector quantities						x		
Weights and measures	x							
World distribution of plants	x							

in its required or recommended courses suggested 6 additions. School G made 7 suggestions; School B, 4; School D, 3; School H, 3; and Schools C and E, none. Only 4 of the 29 suggestions for additions were made by more than one school.

Conclusions

From the data discussed in Chapter IV and presented in Summary Tables XII, XIII, XIV, and XV, the following conclusions for the study may

be drawn:

1. The program of science preparation for elementary school teachers in the eight institutions included in the study is compatible with the preparation recommended by authorities, since all of the schools include in their required or recommended courses from 85 per cent to 100 per cent of the items recommended. Only 2 of the schools include less than 98 per cent of the recommended items.

2. There is little difference among the institutions, regardless of size, type of organization, and course names or descriptions, since 92 of the 112 recommended items are common to the required or recommended courses at all 8 institutions.

3. The stress given to any selected item depends upon the instructor selected. The stress varies in any one institution when several teachers teach a given course. The stress also varies among the institutions.

4. According to the results of the interview checklists, the area of greatest strength in the science preparation of elementary school teachers is Section I, A Knowledge, Understanding, and Appreciation of the Earth and the Universe. The area of least preparation is Section II, A Knowledge, Understanding and Appreciation of Living Things.

Recommendations

1. The eight institutions included in the study should continue to examine their programs of science preparation for elementary teachers and to compare and contrast their course content with the content recommended by authorities.

2. Continuous study should be made of the degree of stress given various items. This is especially important when several instructors are

involved with the same course.

3. Checks should be made to determine the "over-lap" among courses and the resulting stress or lack of stress on any given item.

4. Further study should be made of the items suggested as additions to the checklist and the desirability and feasibility of their inclusion should be determined.

5. Consideration should be given to the idea of specialized science courses for elementary school teachers, based on the recommendations of authorities. These courses might replace the general science survey courses.

6. Consideration should be given to the idea of the place and function of a "special elementary school science methods course" as recommended by some authorities.

7. Follow-up studies should be made of graduates who have recently completed the programs described in the study to determine how effective these graduates find their science preparation and to secure their recommendations for modifications or additions.

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APPENDIX A

QUALIFICATIONS OF THE AUTHORITIES

GLENN O. BLOUGH is Professor of Education and Supervisor of Curriculum Development at the University of Maryland. He received his B.A., M.A., and LL.D. degrees from the University of Michigan. A previous Assistant Professor of Science Education at State Teachers College, Greeley, Colorado, he has also taught at the University of Chicago, State Teachers College, Upsilanti, Michigan, and served as a specialist in science with the United States Department of Health, Education and Welfare in Washington from 1947 through 1955. Mr. Blough is the co-author of ELEMENTARY-SCHOOL SCIENCE AND HOW TO TEACH IT.

R. WILL BURNETT is Professor of Science Education at the University of Illinois. He also serves as Science Editor for the World Book Encyclopedia. Mr. Burnett received his B.A. degree from the University of Kansas, his M.A. degree from Columbia University, and his Ph.D. from Columbia University. He has served as Research Associate Instructor, Teachers College, Columbia; Professor of Education at Stanford; Professor of Biological Science and Education and Chairman of the Division of Natural Science at San Francisco College; Professor of Science Education at the University of Illinois. Mr. Burnett is the author of TEACHING SCIENCE IN THE ELEMENTARY SCHOOL.

GERALD S. CRAIG is Professor Emeritus of Natural Sciences, Teachers College, Columbia University. He is the president of the National Council of Supervisors of Elementary Science and the president of the National Association of Research in Science Teaching. Mr. Craig received the first Science Education Recognition Award in 1956. He received his B.S. degree from Baylor University (Texas), his M.A. and Ph.D. degrees from Columbia University. He has served as Consultant in Elementary Science, Horace Mann School, Teachers College, Columbia; Professor of Natural Sciences, Columbia University. Mr. Craig developed natural science field centers in Alabama, Conneticut, New Hampshire, and Puerto Rico. He is president of Science Education, Incorporated, was a member of the Thirty-First and Forty-Sixth Yearbook Committees, is a member of the National Society for the Study of Education. He contributed to the Thirty-Sixth Yearbook and has contributed to numerous articles for the elementary schools, teacher education, and field studies in science. He is the author of SCIENCE FOR THE ELEMENTARY SCHOOL TEACHER.

CLARK HUBLER is Professor of Science Education at Wheelock College in Boston, Massachusetts. He received his B.A. degree from Western Washington College of Education, his M.A. and Ed.D. degrees from Teachers College, Columbia University. He taught for twelve years in elementary and junior high schools in the state of Washington; was a science consultant at the Horace Mann-Lincoln School at Teachers College, Columbia University for two years; was Assistant Professor at the Teachers College of Connecticut for

two years. He has also taught in summer sessions at Harvard, the University of Delaware, Bowling Green, and Washington State University. He received the seventh Science Education Recognition Award in 1957. Mr. Hubler is a Fellow in the American Association for the Advancement of Science. He is listed in American Men of Science. He is the author of WORKING WITH CHILDREN IN SCIENCE.

ALBERT J. HUGGETT is the late Associate Professor of Education, School of Science and Art, Michigan State College. He was listed in Who's Who in American Education, was a leader of American Men of Science. Some of his publications include Professional Problems of Teachers, Growth and Learning in the Elementary School; Psychological Foundations of Instruction and Practice in the Elementary School. He was co-author of ELEMENTARY-SCHOOL SCIENCE AND HOW TO TEACH IT.

JUNE E. LEWIS is Professor of Science at New York State University. She is a member of a research project in Bandung, Indonisia, sponsored by the Ford Foundation. She received her B.A. degree in Science and English from Western State Teachers College, Columbia, Missouri, and her Ed.D. from Harvard University. She is co-author of a science book in the Craig Series, and also co-author of THE TEACHING OF SCIENCE IN THE ELEMENTARY SCHOOL.

JOHN GABRIEL NAVARRA is chairman of the Department of Science at Jersey City State College. A previous Associate Professor of Science at East Carolina College, he has also served as visiting professor at the University of Virginia; Teachers College, Columbia University; and the University of Southern California. He has conducted numerous science workshops and served as science consultant to various school systems. He has taught science courses on television. President of the Council for Elementary Science, International, Dr. Navarra is editor of the Classroom Science Bulletin, assistant editor of the American Biology Teacher, and author of Development of Scientific Concepts in a Young Child. He co-authored Experimenting in Science, and SCIENCE TODAY FOR THE ELEMENTARY-SCHOOL TEACHER.

IRENE C. POTTER is Elementary Science Coordinator at Glens Falls, New York. She received her B.A. degree from Colby College, Waterville, Maine, and her M.A. degree from Columbia University, New York. She developed the Glens Falls Elementary School Science Syllabus for local use. Every state, and many foreign countries, have requested copies for their use. She is co-author of THE TEACHING OF SCIENCE IN THE ELEMENTARY SCHOOL.

JOSEPH ZAFFORONI is Associate Professor of Science, Teachers College, University of Nebraska. He has served as elementary teacher and principal in public schools at Ellensburg, Washington; demonstration teacher at Ernest Horn Laboratory School, Colorado State College; Assistant Professor and Elementary Science Consultant at Eastern Washington College of Education. He has also taught at summer sessions at Johns Hopkins University, University of Toledo, and the University of Arizona. He is former president and current director of the Council for Elementary Science, International. Besides writing for professional journals, he has served as science consultant for the American Library Association. He is co-author of the book, SCIENCE TODAY FOR THE ELEMENTARY-SCHOOL TEACHER.

APPENDIX B

BOOKS SURVEYED FOR TABLE I

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APPENDIX C

PRELIMINARY CHECKLIST

TITLE OF COURSE _____ CREDIT HOURS _____

In this course, we attempt to develop:

	INCLUDED AND STRESSED	INCLUDED BUT NOT STRESSED	NOT INCLUDED
I. A knowledge, understanding, and appreciation of the earth and the universe			
A. Knowledge and understanding of the relationship of the earth and the heavenly bodies			
1. The sun and the sun's family			
2. Nature of the planets, their relative size, and their distance from the sun			
3. The nature of comets, meteors, and planetoids			
4. The nature of stars, their size, movement, and distance from the earth			
5. The moon, its size and movements, causes of tides, eclipses, and why the moon appears to change its shape			
6. Causes of day and night and the seasons of the year			
7. The vastness and orderliness of the universe			
8. Man-made satellites			
9. Gravitation and gravity			
10. Constellations and galaxies			
11. Others (list and check)			
B. Knowledge and understanding of the earth's structure and its surface			
1. The shape, size, and composition of the earth			
2. The kinds of rock and their formation			
3. The causes of mountains, earthquakes, volcanoes, hot springs, and geysers			

	INCLUDED AND STRESSED	INCLUDED BUT NOT STRESSED	NOT INCLUDED
4. Formation of soil			
5. History of the earth			
6. Forces that have changed and are still changing the surface of the earth			
7. The continents			
8. Oceans, lakes, and streams			
9. The nature of the earth's interior			
10. Others (list and check)			
C. Knowledge and understanding of the composition and characteristics of air and the causes of weather			
1. Composition, characteristics, and pressure of the atmosphere			
2. The water cycle			
3. Forms of precipitation and their causes			
4. Causes of winds and the wind belts of the world			
5. Causes of hurricanes, tornadoes, and thunderstorms			
6. Weather forecasting			
7. Climates of the earth			
8. Others (list and check)			
D. Knowledge and understanding of how natural resources can be conserved and why they need to be conserved			
1. Vanishing natural resources			
2. Dependence on natural resources			
3. Conservation of the soil by preventing erosion and maintaining soil fertility			
4. Conservation of coal, oil, gas, and minerals stored in the ground			
5. Conservation of water supplies			
6. Others (list and check)			

	INCLUDED AND STRESSED	INCLUDED BUT NOT STRESSED	NOT INCLUDED

II. A knowledge, understanding, and appreciation of living things

A. Understanding the growth and development of plants and animals

1. Prehistoric life
2. The variety of living things and their classification
3. Conditions necessary for life
4. Struggle for existance and the balance of nature
5. Protective adaptation
6. Reproduction of plants and animals
7. Growth of plants and animals
8. Obtaining and storing of food by plants and animals
9. Man's influence on living things and his dependence upon them
10. Plants and animals live in characteristic communities
11. Others (list and check)

B. Understanding how the seasons of the year affect living things

1. Hibernation of animals
2. Survival of insects
3. Migration of some animals
4. Seasonal changes in plants and animals
5. Others (list and check)

C. Knowledge of some of the behaviors and habits of animals

1. Hermit animals
2. Communal life among animals
3. Home building among animals
4. Animals protecting themselves and caring for their young

	INCLUDED AND STRESSED	INCLUDED BUT NOT STRESSED	NOT INCLUDED

5. Others (list and check)

D. Understanding the human body and how it works
   1. Kinds of food and their uses in the human body
   2. The systems of the body and their functions
   3. Effect of alcohol, tobacco, and narcotics upon the human body
   4. Causes of diseases and methods of control
   5. Reproduction
   6. Others (list and check)

E. Understanding how living things can be conserved and why they need to be conserved
   1. Economic importance of living things
   2. Conservation of wild life
   3. Conservation of and need for forests
   4. Others (list and check)

III. A knowledge, understanding, and appreciation of matter and energy
   A. Knowledge of the composition of things
      1. The nature of atoms, molecules, elements, and compounds
      2. Composition of matter
      3. Physical and chemical change
      4. Chemistry in man's everyday life
      5. Others (list and check)

   B. Understanding the characteristics of heat and how it is used

	INCLUDED AND STRESSED	INCLUDED BUT NOT STRESSED	NOT INCLUDED
1. Heat as a form of energy			
2. Sources of heat and its measurement			
3. Effect of heat upon matter			
4. Producing and using heat			
5. Eliminating heat			
6. Fire, its prevention and control			
7. Others (list and check)			
C. Understanding atomic energy and knowledge of some of its uses			
1. The structure of the atom			
2. Forces within atoms			
3. The fission process			
4. The fusion process			
5. Military uses of atomic energy			
6. Nonmilitary uses of atomic energy			
7. Radioisotopes			
8. Others (list and check)			
D. Gaining a knowledge of machines and how they work			
1. Simple machines such as the lever, the pulley, the wheel and axle, the inclined plane, the screw, and how they work			
2. Complex machines such as the steam engine, gasoline engine, diesel engine, power turbines, and how they work			
3. Friction			
4. Others (list and check)			
E. Knowledge of some of the characteristics and uses of magnetism and electricity			

	INCLUDED AND STRESSED	INCLUDED BUT NOT STRESSED	NOT INCLUDED
1. Natural magnets and man-made magnets			
2. Characteristics of magnets			
3. The theory of magnetism			
4. Static electricity			
5. Generating electricity			
6. Uses of electricity			
7. Others (list and check)			
F. Understanding what sound is and knowledge of some of its uses			
1. Causes of sound			
2. Characteristics of sound			
3. Using sound to produce music			
4. How we speak and how we hear			
5. Others (list and check)			
G. Understanding the characteristics of light and knowledge of how light can be used			
1. Characteristics of light			
2. Reflection and refraction of light			
3. How we see objects			
4. Uses of light in motion pictures, microscopes, telescopes, and cameras			
5. Formation of colors			
6. Providing proper lighting in our homes			
7. Correcting eye defects with lenses			
8. Others (list and check)			
H. Knowledge and understanding of aviation			
1. How an airplane flies			
2. Types of aircraft			

	INCLUDED AND STRESSED	INCLUDED BUT NOT STRESSED	NOT INCLUDED
3. Aircraft instruments and their uses			
4. Characteristics of jet propulsion			
5. Characteristics of rockets and missiles			
6. Aviation and weather			
7. Others (list and check)			

APPENDIX D

(date)

(inside address)

I am making a study of "The Science Requirements for Elementary School Teachers" in Oklahoma colleges that prepare elementary teachers. I plan to use the enclosed interview checklist in these colleges to determine the science course content that is now being offered to students who are preparing to teach in the elementary grades, and to compare this course content with recommendations of authorities.

Would you please examine this entire checklist, and make corrections or additions that would improve the instrument by either making the statements clearer or the checklist more complete? If, in your opinion, no corrections or additions are necessary, I would appreciate your statement concerning this. Also, please fill out the enclosed Personal Data Sheet, and return all the material in the enclosed envelope.

Your contribution is vital to the satisfactory completion of this study, which is being made in the interest of improving teacher education. Your cooperation in replying promptly will be sincerely appreciated.

Sincerely yours,

Jack Kisner

PERSONAL DATA SHEET

NAME _____

ADDRESS _____

_____

PROFESSIONAL DEGREES:

B.A. or B.S.	_____	MAJOR	_____	MINOR	_____
M.A. or M.S.	_____	MAJOR	_____	MINOR	_____
Ph.D. or Ed.D.	_____	MAJOR	_____	MINOR	_____

COLLEGE HOURS IN SCIENCE:

Subject	Hours	Subject	Hours
Astronomy	_____	General Physical Science	_____
Biology	_____	Physics	_____
Botany	_____	Physiology	_____
Chemistry	_____	Zoology	_____
Geography	_____	Others (list)	_____
Geology	_____	_____	
Meteorology	_____	_____	

EXPERIENCE, Years Teaching:

Elementary School Science _____

High School Science _____

College Science _____

Supervisor of Science Teachers _____

Administration _____

PRESENT PROFESSIONAL RESPONSIBILITY:

_____

_____

PUBLICATIONS:

_____

APPENDIX E

NAMES OF CONSULTANT GROUP

James A. Adams
Northeastern State College
Tahlequah, Oklahoma

George L. Dunagan
Nelagoney Public Schools
Pawhuska, Oklahoma

Edward A. Gallaway
Northeastern State College
Tahlequah, Oklahoma

C. H. Goben, Jr.
Tahlequah Public Schools
Tahlequah, Oklahoma

H. R. Goff
Tulsa Public Schools
Tulsa, Oklahoma

Wynniebell Graver
Tulsa Public Schools
Tulsa, Oklahoma

Leah Alice Graves
Tulsa Public Schools
Tulsa, Oklahoma

Louis B. Hanson
Coweta Public Schools
Coweta, Oklahoma

Mildred Henderson
Tulsa Public Schools
Tulsa, Oklahoma

Carl Henson
Kansas Public Schools
Kansas, Oklahoma

Dennis R. Horn
Tulsa Public Schools
Tulsa, Oklahoma

Clyde L. Jones
Tulsa Public Schools
Tulsa, Oklahoma

Katherine Jones
Tulsa Public Schools
Tulsa, Oklahoma

Walter W. Lambert
Tulsa Public Schools
Tulsa, Oklahoma

Edward A. Lenthold
Muskogee Public Schools
Muskogee, Oklahoma

Maurice Love
Muskogee Public Schools
Muskogee, Oklahoma

Pat McCafferty
Tulsa Public Schools
Tulsa, Oklahoma

C. L. Robberson
Ada Public Schools
Ada, Oklahoma

Berry Don Robertson
Tahlequah Public Schools
Tahlequah, Oklahoma

S. Gleason Smith
Tulsa Public Schools
Tulsa, Oklahoma

Marjorie Wilson Swan
Pryor Public Schools
Pryor, Oklahoma

M. B. Traw
Westville Public Schools
Westville, Oklahoma

Betty Whisenhunt
Tahlequah Public Schools
Tahlequah, Oklahoma

Charles W. Wood
Preston Public Schools
Preston, Oklahoma

J. Clinton Young
Kansas Public Schools
Kansas, Oklahoma

APPENDIX F

PART II

Content of Science Courses

Title of Course

Credit Hours

In this course, we attempt to develop:

	Included And Stressed	Included But Not Stressed	Not Included
I. A knowledge, understanding, and appreciation of the earth and the universe			
A. Knowledge and understanding of the relationship of the earth and the heavenly bodies			
1. The sun and the sun's family			
2. Nature of the planets, their relative size, and their distance from the sun			
3. Nature of comets, meteors, and planetoids			
4. Nature of stars, their size, movement, and distance from earth			
5. The moon, its size and movements, causes of tides, eclipses, and why the moon appears to change its shape			
6. Causes of day and night and the seasons of the year			
7. The vastness and orderliness of the universe			
8. Man-made satellites			
9. Gravitation, gravity, and inertia			
10. Constellations and galaxies			
11. Solar energy and cosmic rays			
12. Theories of the formation of the earth			
13. Others (list and check)			
B. Knowledge and understanding of the earth's surface and its structure			
1. The shape, size, and composition of the earth			
2. Kinds of rock and their formation			

	Included And Stressed	Included But Not Stressed	Not Included
3. The causes of mountains, earthquakes, volcanoes, hot springs, and geysers			
4. Formation of soil			
5. History of the earth - the geological time chart			
6. Forces that have changed and are still changing the surface of the earth			
7. The continents			
8. The polar regions			
9. Oceans, lakes, and streams			
10. Theories concerning the earth's interior			
11. Others (list and check)			
C. Knowledge and understanding of the composition and characteristics of air and the causes of weather			
1. Composition, characteristics, and pressure of the atmosphere			
2. The water cycle			
3. Forms of precipitation and their causes			
4. Cloud formations			
5. Causes of winds and the wind belts of the world			
6. Causes of hurricanes, tornadoes, and thunderstorms			
7. Weather forecasting and instruments used			
8. Climates of the earth			
9. Others (list and check)			
D. Knowledge and understanding of how natural resources can be conserved and why they need to be conserved			
1. Vanishing natural resources			
2. Dependence on natural resources			
3. Conservation of the soil by preventing erosion and maintaining soil fertility			

	Included And Stressed	Included But Not Stressed	Not Included
4. Conservation of coal, oil, gas, and minerals stored in the ground			
5. Conservation of water supplies			
6. Others (list and check)			
II. A knowledge, understanding, and appreciation of living things			
A. Understanding the growth and development of plants and animals			
1. Prehistoric life and evolution of living things			
2. The variety of living things and their classification			
3. Conditions necessary for life			
4. Interrelationship of living things and balance of nature			
5. Protective adaptation			
6. Reproduction of plants and animals			
7. Growth of plants and animals			
8. Obtaining and storing of food by plants and animals			
9. Man's influence on living things and his dependence upon them			
10. Normal habitats of plants and animals			
11. Others (list and check)			
B. Understanding how the seasons of the year affect living things			
1. Hibernation of animals			
2. Survival of insects			
3. Migration of some animals			
4. Seasonal changes in plants and animals			
5. Human adaptations to seasonal changes and to climate			
6. Others (list and check)			

	Included And Stressed	Included But Not Stressed	Not Included
C. Knowledge of some of the behaviors and habits of animals			
1. Hermit animals			
2. Communal life among animals			
3. Home building of animals			
4. Animals protecting themselves and caring for their young			
5. Others (list and check)			
D. Understanding the human body and how it works			
1. Kinds of food and their uses in the human body			
2. The systems of the body and their functions			
3. Effect of alcohol, tobacco, and narcotics upon the human body			
4. Causes of diseases and methods of control			
5. Reproduction			
6. Others (list and check)			
E. Understanding how living things can be conserved and why they need to be conserved			
1. Economic importance of living things			
2. Conservation of wild life			
3. Conservation of and need for forests			
4. Man's part in maintaining the balance of life in nature			
5. Others (list and check)			
III. A knowledge, understanding, and appreciation of matter and energy			
A. Knowledge of the composition of things			
1. The nature of atoms, molecules, elements, mixtures, and compounds			

	Included And Stressed	Included But Not Stressed	Not Included
2. Composition of matter			
3. Physical and chemical change			
4. Chemistry in man's everyday life			
5. Others (list and check)			
B. Understanding the characteristics of heat and how it is used			
1. Heat as a form of energy			
2. Sources of heat and its measurement			
3. Effect of heat upon matter			
4. Producing and using heat			
5. Methods of heat transference			
6. Refrigeration and air conditioning			
7. Fire, its prevention and control			
8. Others (list and check)			
C. Understanding atomic energy and knowledge of some of its uses			
1. The structure of the atom			
2. Forces within atoms			
3. The fission process			
4. The fusion process			
5. Military uses of atomic energy			
6. Non-military uses of atomic energy			
7. Radioisotopes			
8. Radioactive "fall out"			
9. Others (list and check)			
D. Gaining a knowledge of machines and how they work			
1. What work is and how it is measured			
2. Simple machines such as the lever, the pulley, the			

	Included And Stressed	Included But Not Stressed	Not Included
wheel and axle, the inclined plane, the screw, and how they work			
3. Complex machines such as the steam engine, gasoline engine, diesel engine, power turbines, and how they work			
4. Friction			
5. Others (list and check)			
E. Knowledge of some of the characteristics and uses of magnetism and electricity			
1. Natural magnets and man-made magnets			
2. Characteristics of magnets			
3. The theory of magnetism			
4. Static electricity			
5. Generating electricity			
6. Measuring electricity			
7. Electrical circuits			
8. Uses of electricity			
9. Others (list and check)			
F. Understanding what sound is and knowledge of some of its uses			
1. Causes of sound			
2. Characteristics of sound			
3. Using sound to produce music			
4. How we speak and how we hear			
5. Others (list and check)			
G. Understanding the characteristics of light and knowledge of how light can be used			
1. Characteristics of light			

	Included And Stressed	Included But Not Stressed	Not Included
2. Reflection and refraction of light			
3. How we see objects			
4. Uses of light in motion pictures, microscopes, telescopes, and cameras			
5. Formation of colors			
6. Providing proper lighting in our homes			
7. Correcting eye defects with lenses			
8. Others (list and check)			
H. Knowledge and understanding of aviation			
1. How an airplane flies			
2. Types of aircraft			
3. Aircraft instruments and their uses			
4. Characteristics of jet propulsion			
5. Characteristics of rockets and missiles			
6. Aviation and weather			
7. Problems of space flight			
8. Others (list and check)			

APPENDIX G

(date)

(inside address)

Enclosed are several copies of the Interview Checklist we discussed in our telephone conversation yesterday.

Part I, "Kinds of Science Courses Required or Recommended," can be filled out by any member of your staff who is acquainted with the science requirements of your college, for the preparation of elementary school teachers.

Please give a copy of Part II, "Content of Science Courses," to each member of your staff who teaches a science course that is required or recommended for the standard elementary certificate. Please ask each instructor to check, in the appropriate space, the extent to which he includes the items of this checklist in the science courses he teaches to those students who are preparing to be elementary school teachers. If an instructor teaches more than one science course to students who are preparing to be elementary school teachers, he should use a separate checklist for each course.

I will be at your college Friday, February 9, at 9 am for discussions with the instructors to whom you have given the checklist.

I certainly appreciate your help in distributing this material.

Sincerely yours,

Jack Kisner

encl.

INTERVIEW CHECKLIST

PART I

Kinds of Science Courses Required or Recommended

I. Are general survey courses in science required or recommended for students who are preparing to teach in the elementary grades?

Yes ___ No ___

II. If general survey courses in science <u>are</u> required or recommended for students who are preparing to teach in the elementary grades, please complete the following:

Course	Number of Hours
A. General Physical Science	_____
B. General Biological Science	_____
C. _____	_____
D. _____	_____
E. _____	_____

In the above courses, are the following areas included?

Area	Yes	No
1. Astronomy	___	___
2. Botany	___	___
3. Chemistry	___	___
4. Geography	___	___
5. Geology	___	___
6. Meteorology	___	___
7. Physics	___	___
8. Physiology	___	___
9. Zoology	___	___

Comments:

III. If general survey courses in science are not required or recommended, are any specific courses in science required or recommended for students who are preparing to teach in the elementary grades?

Yes ___ No ___ If any specific courses in science are required or recommended, please complete the following:

Course	Number of Hours
A. Astronomy	_____
B. Biology	_____
C. Botany	_____
D. Chemistry	_____
E. Geography	_____
F. Geology	_____
G. Meteorology	_____
H. Physics	_____
I. Physiology	_____
J. Zoology	_____
K. _____	_____

Comments:

IV. If general survey courses in science are not required or recommended for students who are preparing to teach in the elementary grades, what

areas of science are required and what courses are recommended within these areas? Please complete the following:

Area	Minimum Hours	Recommended Courses
A. Biological Science	____	_____
		_____
		_____
B. Earth Science	____	_____
		_____
		_____
C. Physical Science	____	_____
		_____
		_____

Comments:

V. Are the introductory courses in science that are offered to students who are preparing to teach in the elementary grades different from the introductory courses in science offered to students who are preparing for other professions? Yes ___ No ___

Comments:

VI. Is a science methods course offered for students who are preparing to teach in the elementary grades? Yes ___ No ___

Is this methods course required or recommended for certification of elementary teachers? Required ___ Recommended ___

Comments:

(date)

(inside address)

The attached Interview Checklist is for use in a study I am making. This study pertains to:

1) Eight Oklahoma institutions of higher education that prepare elementary school teachers.

2) The science courses each of these institutions require or recommend for persons preparing to teach in the elementary grades.

3) The science methods courses each of these institutions require or recommend for persons preparing to teach in the elementary grades.

Current interest in science and in science teaching has given impetus to this study.

Will you please study the attached checklist and mark, in the appropriate space, the extent to which you include the items of the checklist in the science course or science methods course you teach? If your course includes items which are not on the checklist, will you please write them in under "additions," and check, in the appropriate space, to what extent they are included in your course?

If you teach more than one science course or science methods course for persons preparing to teach in the elementary grades, will you please use a separate checklist for each course you teach?

I have made arrangements with the chairman of your department concerning the date I plan to come to your campus to discuss the checklist with you. I will appreciate your filling out this checklist and allowing me an interview. I will also appreciate your completing the attached Personal Data Sheet.

Sincerely yours,

Jack Kisner

encl.

PERSONAL DATA SHEET

NAME _____

ADDRESS _____

_____

PROFESSIONAL Degrees:

B.A. or B.S. _____ Major _____ Minor _____

M.A. or M.S. _____ Major _____ Minor _____

Ph.D. or Ed.D. _____ Major _____ Minor _____

EXPERIENCE, Years Teaching:

Elementary School Science _____

High School Science _____

College Science _____

Supervisor of Science Teachers _____

Administration _____

PRESENT PROFESSIONAL RESPONSIBILITY:

_____

_____

APPENDIX H

(date)

(inside address)

Within the past few years persons connected with and interested in teacher education have evidenced a concern for the problem of preparing teachers to teach science in the elementary schools. The Oklahoma State Department of Education and the Frontiers of Science Foundation of Oklahoma, Incorporated have realized the importance of this problem and are encouraging studies of this particular nature.

I am making a study which will attempt to ascertain the kind of science course preparation provided for teachers who will teach science in the elementary grades, and to compare this preparation with the recommendations of authorities in the field. The study is to be conducted in eight selected institutions in Oklahoma having teacher education programs. Your cooperation is solicited in making such a study.

I would like to receive permission to visit your campus and to interview some of the teachers about the teacher preparation program. A structured interview in the form of a checklist for expediency and simplicity of response will be used.

The results of the study will be summarized, and the information will be available to each institution as soon as the study is completed.

Sincerely yours,

Jack Kisner

APPENDIX I

CATALOG DESCRIPTION OF COURSES

School A

104 - General Biology

Designed especially for students who do not plan further work in the field of biology; an introductory course in the physiological processes of plants and animals. No credit in major. Not open to students with credit in either botany or zoology.

104 - General Physical Science

A lecture-demonstration course designed to assist the student to interpret his physical enviornment. A study of important topics in astronomy, chemistry, geology, and physics. No major credit. Not open to students with previous college credit in either astronomy, chemistry, physics or geology.

NE353 - Geography for Elementary Teachers

Materials and methods for geography in the elementary grades. A study leading to the understanding of the world as the home of man; relationships of such factors as the earth as a globe, climate, land forms, water bodies, minerals, and cultural patterns of the world.

402 - Science for the Elementary Teacher

Further treatment of fundamentals of biological and physical science with particular emphasis on taxonomy, electronics, electricity, and magnetism. Prerequisites: Biology 104, General Physical Science 104, and Mathematics 113, or their equivalents.

School B

Biology 114, 124. Biological Science. 4 (3-2)

Problems which must be solved by the individual organism, plant or animal. Cellular organization and differentiation, photosynthesis, nutrition, respiration, circulation, excretion, coordination, locomotion, growth, reproduction, and genetics. Heredity, plant and animal classification, ecology, evolution, parasitism and disease.

Geology 214. General Geology. 4 (4-0)

Geological principles and earth history. For non-majors. Not open to students who have taken 114.

Geography 210. World Regional Geography. 3 (3-0) or 4 (3-2)

Prerequisite: sophomore standing. Continental survey of world's physical and cultural features. Not open to geography majors.

Education 4K2. Science in the Elementary School Curriculum. 2 (2-0)

To be taken as part of Block A in the senior year. Deals with the purposes, selection, and organization of content, teaching and learning procedures, and evaluation of outcomes in elementary school science.

School C

Science 314. Science for the Elementary Teacher. 4 hours

A combination lecture, laboratory, and experience-centered course to develop the background necessary for the prospective elementary teacher in science content, methods of science teaching, and the preparation of simple equipment. The development of science concepts and units of study in areas appropriate to the elementary school. Prerequisite, senior college standing.

Science 324. Science for the Elementary Teacher. 4 hours

A continuation of Science 314. Prerequisite, Science 314.

Geography 103. Elements of Human Geography. 3 hours

A study leading to an understanding of the world as the home of man; relationships of such factors as the earth as a globe, climate, land forms, water bodies, minerals, and cultural patterns of the world.

School D

Botany 4. Biology for Teachers. 5 hours

Open for credit only to students in the Teacher Certification Program.

Physics 4. Science for Teachers. 5 hours

Prerequisite, elementary algebra, plane geometry. Open for credit only to students in the Teacher Certification Program.

Geography 61. Geography for Elementary Teachers. 3 hours

Education 244. Science in Elementary Schools. 2 hours

Prerequisite, eight hours of education.

School E

104 - General Biology

The outstanding discoveries and generalizations in the field of biology which have a bearing on the trends of thought and the course of civilization. Lecture-demonstration. This course does not apply on major or minor in biology.

104 - General Physical Science

A lecture-demonstration course designed to assist the student to interpret his physical environment. A study of important topics in astronomy, chemistry, geology, and physics. The course does not apply on major or minor in physics or chemistry, and is not designed to be taken by students who will complete courses in these fields.

103 - Elements of Human Geography

A study leading to the understanding of the world as the home of man; relationship of such factors as the earth as a globe, climate, land forms, water bodies, minerals, and cultural patterns of the world.

362 - Methods and Materials in Elementary Sciences

Purposes, selection of content, teaching methods and procedures, and evaluation of outcomes in elementary school science. Prerequisite, Education 202.

School F

104a - General Biology

The outstanding discoveries and generalizations in the field of biology, with particular attention to the cell and heredity. Lecture and laboratory.

104 - General Physical Science

A lecture-demonstration course designed to assist students to interpret their physical environment. A study of important topics in astronomy, chemistry, geology, and physics. Not acceptable as credit for physics majors or minors and not designed for teaching certificates in the sciences.

103 - Elements of Human Geography

A study leading to the understanding of the world as the home of

man; relationship of such factors as the earth as a globe, climate, land forms, water bodies, minerals, and the cultural patterns of the world.

362 - Methods and Materials in Elementary Science

Methods of presenting nature subjects in elementary grades; a study of plants and animals in the environment of the child.

School G

Biology 104 - General Biology. 4 hours

The outstanding discoveries and generalizations in the field of biology which have a bearing on trends of thought and the course of civilization. Lecture-demonstration. This course does not apply on major or minor in biology.

Physical Science 104 - General Physical Science. 4 hours

A lecture-demonstration course designed to assist the student to interpret his physical environment. A study of important topics in astronomy, chemistry, geology, and physics. This course does not apply on major or minor in physics or chemistry, and is not designed to be taken by students who will complete courses in these fields.

Geography 103 - Elements of Human Geography. 3 hours

A study leading to the understanding of the world as the home of man; relationship of such factors as the earth as a globe, climate, land forms, water bodies, minerals, and cultural patterns of the world.

Education 362 - Methods and Materials in Elementary Natural Science. 2 hours

Prerequisite, Education 203, Psychology 342. A survey of elementary science curriculum content and teaching materials; exploration and evaluation of organizational programs; laboratory experiences in developing more effective teaching methods to meet the increasing demands for greater scope and better understanding of elementary science.

School H

Biology 104. General Biology. 4 hours

A general education course for non-major students, illustrating the basic principles of biology and relating them to other fields of knowledge.

Physical Science 104. General Physical Science. 4 hours

A lecture-demonstration course designed to assist the student in interpreting his physical environment; important topics in astronomy, chemistry, geology, and physics.

Geography 103. Elements of Human Geography. 3 hours

A survey of the physical elements of geography with emphasis on space relations; land forms; world distribution of population; wealth and climate; climate regions; resource map readings and interpretations.

Education 362. Methods and Materials in Elementary Natural Science. 2 hours

Methods of presenting nature subjects in the elementary grades; a study of plants and animals in the environment of the child.

APPENDIX J

COLLEGE SCIENCE INSTRUCTORS INTERVIEWED FOR THIS STUDY

Helen Aingworth

Ray C. Baird

Martha Bard

Lewis Barker

C. W. Bridges, Jr.

Nathan C. Brooks

Elmer R. Brown

Paul Buck

John Bulman

J. J. Burnett

William G. Carter

Donald D. Collier

Clifford J. Dennis

Nason Neill Duncan

John O. Eichling

Charles Wayne Ellinger

Floyd W. Frazier

Edward A. Galloway

Charles Gardner

Robert V. Garner

George T. Guess

F. L. Hambrick

Gordon M. Harrell

Vivla V. Johnson

Harold E. Laughlin

R. H. Loomis

E. H. Marchant

W. Ware Marsden

Doyle McCoy

Teruo Morishige

John W. Morris

John D. Naff

William T. Perfound

Earl A. Reynolds

Frank Rinehart

Alex R. Ross

Anne R. Semple

Daniel A. Shorter

Wayne H. Silver

Ray L. Six

Don Stafford

Hobart Stocking

Emil R. Strake

Ralph F. Strete

John Stroup

Ernest Sturch, Jr.

W. H. Tanner

Raymond John Taylor

Carl R. Thomas

Arnold Dean Walker

Clarence Yoesting

PREPARATION AND TEACHING EXPERIENCE
OF RESPONDENTS

School A

IN-STRUCTOR	BACHELOR'S DEGREE		MASTER'S DEGREE		DOCTOR'S DEGREE		YEARS OF SCIENCE TEACHING EXPERIENCE		
	MAJOR	MINOR	MAJOR	MINOR	MAJOR	MINOR	ELEM.	H.S.	COLLEGE
A	Geology	Social Studies	Earth Science					9	29
B	History	Geography	Education		Education	Geography		13	5
C	Physics Chemistry	Mathematics	Physics	Chemistry					2
D	Chemistry	Biology	School Administration	Natural Science			1	17	4
E	Zoology	Chemistry	Zoology	Botany	Zoology	Botany			12
F	Education	Biology	Zoology	Botany				3	15
G	Zoology	Botany	Parasitology	Bacteriology	Para-sitology	Proto-zoology			15

School B

IN-STRUCTOR	BACHELOR'S DEGREE		MASTER'S DEGREE		DOCTOR'S DEGREE		YEARS OF SCIENCE TEACHING EXPERIENCE		
	MAJOR	MINOR	MAJOR	MINOR	MAJOR	MINOR	ELEM.	H.S.	COLLEGE
A	Physics	Chemistry	School Administration	Psychology	Elementary Education	Guidance	4	6	8
B	Geology	Civil Engineering	Greek Theology	Chinese Culture					43
C	Geology	Mathematics	Geology						12
D	Geology	Physics	Geology	Physics					12
E	Zoology	German	Zoology	Botany	Zoology	Botany			4
F	Chemistry		Geology		Geology				14

School C

IN-STRUCTOR	BACHELOR'S DEGREE		MASTER'S DEGREE		DOCTOR'S DEGREE		YEARS OF SCIENCE TEACHING EXPERIENCE		
	MAJOR	MINOR	MAJOR	MINOR	MAJOR	MINOR	ELEM.	H.S.	COLLEGE
A	History	Government	History	Government				2	1
B	Chemistry	Physics Geology	Chemistry		Education	Science Education			13

School D

IN-STRUCTOR	BACHELOR'S DEGREE MAJOR	BACHELOR'S DEGREE MINOR	MASTER'S DEGREE MAJOR	MASTER'S DEGREE MINOR	DOCTOR'S DEGREE MAJOR	DOCTOR'S DEGREE MINOR	YEARS OF SCIENCE TEACHING EXPERIENCE ELEM.	H.S.	COLLEGE
A	Geography	History	Education		Geography	Economics	2	4	24
B	Mathematics	Physics	Mathematics	Physics					5
C	Botany	Zoology	Botany	Zoology	Botany	Zoology			36
D	Biology	Chemistry	Botany						1
E	Botany	Zoology	Botany	Zoology	Botany	Zoology			2
F	Zoology Chemistry	Physics Mathematics	Secondary Education	Zoology	Curriculum	Science Education		6	1

School E

IN-STRUCTOR	BACHELOR'S DEGREE MAJOR	BACHELOR'S DEGREE MINOR	MASTER'S DEGREE MAJOR	MASTER'S DEGREE MINOR	DOCTOR'S DEGREE MAJOR	DOCTOR'S DEGREE MINOR	YEARS OF SCIENCE TEACHING EXPERIENCE ELEM.	H.S.	COLLEGE
A	Biology	Mathematics	Natural Science					9	1
B	Mathematics	Physics	Physics	Mathematics					4
C	English	Social Studies	Geology	Geography				1	23
D	Chemistry	Physics	Education	Mathematics	Education		5	15	5

School F

IN-STRUCTOR	BACHELOR'S DEGREE		MASTER'S DEGREE		DOCTOR'S DEGREE		YEARS OF SCIENCE TEACHING EXPERIENCE		
	MAJOR	MINOR	MAJOR	MINOR	MAJOR	MINOR	ELEM.	H.S.	COLLEGE
A	Mathematics	Business	School Administration		School Administration	Sociology			20
B	Social Studies	Science	Education		Geography	History		8	15
C	History	Geography	Geography	History				12	1
D	Engineering	Mathematics	Physics	Mathematics					4
E	Natural Science	Social Studies	Education	Zoology				21	1
F	Physics	Mathematics							1
G	Home Economics	Science	Home Economics	Chemistry	Education	Physiology		26	8
H	Biology	Education	Botany					2	
I	Field Crops	Soils	Field Crops	Genetics	Genetics	Botany			1

School G

IN-STRUCTOR	BACHELOR'S DEGREE		MASTER'S DEGREE		DOCTOR'S DEGREE		YEARS OF SCIENCE TEACHING EXPERIENCE		
	MAJOR	MINOR	MAJOR	MINOR	MAJOR	MINOR	ELEM.	H.S.	COLLEGE
A	Zoology	Botany	Entomology	Zoology	Entomology	Zoology			11
B	Biology	Mathe-matics	Botany	Zoology	Botany	Zoology		7	12
C	Natural Science		Botany						3
D	Natural Science		Physics					1	1
E	Mathe-matics	Physics	Natural Science	Chemistry				2	1
F	Geography	History	Geography					5	1
G	History	Geography	Geography	Education			4	3	15
H	Chemistry	Biology	Education		Elementary Education		4	5	12

School H

IN-STRUCTOR	BACHELOR'S DEGREE		MASTER'S DEGREE		DOCTOR'S DEGREE		YEARS OF SCIENCE TEACHING EXPERIENCE		
	MAJOR	MINOR	MAJOR	MINOR	MAJOR	MINOR	ELEM.	H.S.	COLLEGE
A	Zoology	Chemistry	Vertebrate Zoology	Paleontology					1
B	Chemistry	Physics	Chemistry	Mathematics					3
C	Chemistry	Mathe-matics	Natural Science					3	3
D	Chemistry	Physics	Chemistry	Mathematics	Chemistry	Physics			6
E	Physics	Chemistry	Natural Science					9	3
F	Education	Science	Geography						4
G	Education	History	English	Psychology	Education		20	2	2
H	Education	Biology	Botany		Botany	Horticul-ture			15
I	Biology	Chemistry	Plant Ecology	Animal Ecology			5	6	1

VITA

Andrew Jackson Kisner

Candidate for the Degree of

Doctor of Education

Thesis: SCIENCE CONTENT PREPARATION OF PROSPECTIVE ELEMENTARY SCHOOL TEACHERS IN EIGHT OKLAHOMA INSTITUTIONS OF HIGHER EDUCATION

Major Field: Education

Minor Field: Higher Education

Biographical:

Personal data: Born at Tahlequah, Oklahoma, October 22, 1912. Son of William H. and Alice V. Kisner.

Education: Attended grade school at Tahlequah, Oklahoma; graduated from Central High School, Tahlequah, Oklahoma in 1929; received the Bachelor of Science degree from Northeastern State College in 1932, with a major in biological science and minors in chemistry, physics, and mathematics; received the Master of Education degree from the University of Oklahoma in 1939, with a major in Public School Administration; completed requirements for the degree of Doctor of Education in May, 1963.

Professional experience: Taught science and mathematics in Roland, Oklahoma, public schools, 1932-1935 (High School Principal in 1933 and Superintendent in 1934); in Webbers Falls, Oklahoma, public schools, 1935 to 1942 (High School Principal, 1935 to 1937 and Superintendent, 1937 to 1942). Instructor of navigation and principles of flight, Randolph Field, Texas, 1942 to 1946. Elementary School Principal in Tahlequah, Oklahoma, public schools in 1948. Instructor of Education and Director of Audio-Visual Department, Northeastern State College, 1949 to 1956. Assistant Professor, Department of Education, and Director of Placement Services, Northeastern State College, 1956 to 1963.

Professional Organizations: Oklahoma Education Association; National Education Association; Kappa Mu Epsilon.