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ABSTRACT

This report represents part of a total effort to initiate better management techniques for state-local educational planning. It involves a three-year cycle of assessment in grades 3, 6, and 9, to include information from teachers and principals as well as students. Chapter 1 provides a comprehensive report of the entire assessment program. It includes the stated purpose, the implementation procedure, type of instruments used and tabulated information related to interpreting score from objective-based test administered. Highlights of results from the science assessment are presented. Chapter 2 presents a comprehensive report of science achievement. A description of the test used is given. Ten objectives were cited and results for each objective are reported. Overall achievement is summarized as well as results according to family income, parental education level, and region. (Author/EB)

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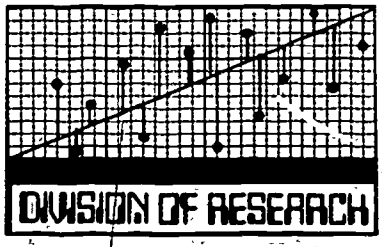
GRADE 3 SCIENCE



STATE ASSESSMENT OF EDUCATIONAL PROGRESS IN NORTH CAROLINA, 1973-74

DIVISION OF RESEARCH / NORTH CAROLINA DEPARTMENT OF PUBLIC INSTRUCTION / RALEIGH 27611

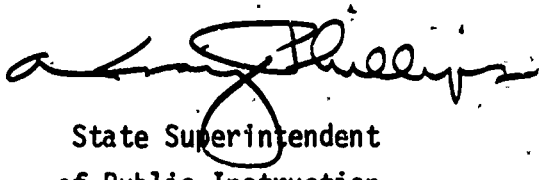
February, 1975

FOREWORD

As one of the ways to improve the quality of public education in the State, personnel in the State Department of Public Instruction conduct an annual assessment of educational performance. This assessment provides educational decision makers with accurate and objective information for planning and administering the State's public elementary and secondary schools.

This year, a series of reports will be released on the performance of third-grade students. The reports will include reading, mathematics, language arts, social studies, science, cultural arts, health, and physical education. Also, special surveys on teachers' and principals' opinions of education will be released. All of this information should also help the general public to be better informed about the status of their schools on a statewide basis.

Aware of the fact that patrons and educators at the local school level also wish to know more about the quality of education in their schools, the State Department of Public Instruction is initiating a program to assist local school personnel to conduct assessment programs. Constructive use of this information, as well as statewide data, will insure continuing progress in providing appropriate learning experiences for all children and youth in North Carolina.



State Superintendent
of Public Instruction

ACKNOWLEDGMENTS

In any major comprehensive effort such as the current Statewide Assessment of Education, it is impossible to recognize all individuals and groups who have made significant contributions. It is appropriate, however, to recognize a number of groups and agencies that have provided major services in this effort.

Were it not for the support of the members of the State Board of Education, funds and other resources would not have been allocated for the assessment program. The leadership provided by members of the Board is especially appreciated.

Special acknowledgments go to the personnel in the local school systems who cooperated and assisted with the assessment effort. The superintendents, the support staff, the principals, and the teachers proved to be accommodating and professionally dedicated in every respect. Their assistance was invaluable.

The Research Triangle Institute should be highly commended for assistance provided in several technical areas of the assessment.

The staff members from the Divisions of Reading, Language Arts, Mathematics, Science, Cultural Arts, Social Studies, and Health and Physical Education were vitally involved in the selection and development of tests for the assessment. Without their efforts, the comprehensiveness of the assessment would have been severely limited.

Finally, special appreciation is expressed to staff members in the Division of Research who successfully coordinated and completed this major assignment in a most efficient manner.

Wm. J. Brown Jr.

Director of The
Division of Research
Department of Public Instruction

H. T. Corder

Assistant Superintendent for
Research and Development
Department of Public Instruction

PREFACE

As part of his total effort to initiate better management techniques, the State Superintendent of Public Instruction indicated in 1970 that more and better information was needed for state-level planning. He initiated the State Assessment of Educational Progress in response to that need.

The assessment program was a collaborative effort from the beginning. Many levels of the education community contributed suggestions. Funds and services for the program were obtained from local, state, and federal sources. Cooperation among local and state components of the public school system and the nationally respected Research Triangle Institute was the backbone of the assessment. There was an open exchange of ideas, experiences, and services.

As a result of these cooperative relationships, the first State Assessment of Educational Progress took place in the spring of 1972 with minimal disruption to school programs. A statewide sample of sixth graders participated by completing exercises in reading, mathematics, language arts, career awareness, and several dimensions of student attitudes.

At the recommendation of the State Board of Education, the 1973 Legislature voted to fund the assessment program annually as part of the budget of the State Superintendent of Public Instruction. Concurrently, an advisory committee of legislators, businessmen, students, parents, and educators was formed to assist the State Board and the State Department of Public Instruction on aspects of statewide assessment and accountability.

A three-year cycle of assessment in grades three, six, and nine was established, beginning in 1974 with the State Assessment at the third grade. In the 1974 assessment, information was collected from teachers and principals as well as students. Student performance measures were taken in language arts, mathematics, cultural arts, reading, science, social studies, health, and physical education. Reports are now being prepared on the results.

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CHAPTER ONE: INTRODUCTION

Purpose of the Assessment

In order to improve educational planning and decision-making in North Carolina, the State Department of Public Instruction initiated a statewide assessment of educational progress. The information gathered through this assessment operation has three basic purposes:

1) To examine the state's present educational position: Knowing the educational status will enable educators to plan better programs for improving learning and teaching. Objective information will help decision-makers set program priorities with more assurance and allocate resources on the basis of need. An accurate description of the current status will increase general public knowledge and understanding about the public schools.

2) To measure educational progress over a period of years: As time passes, a charting of the educational progress in this state can be made. These benchmarks of educational quality could become the basis for educational accountability for the state.

3) To seek means of improving North Carolina's education: As more information is collected in the state assessments, variables which affect learning can be examined and those variables which show a positive influence on learning can be promoted.

In addition, the state assessment effort provides local units with technical assistance in planning similar local programs which aid the setting of local priorities. Goals may be set using meaningful state and regional norms which are made available from the statewide effort. Furthermore, assessment information collected in each school will assist teachers in planning better instructional programs for public school youngsters and help patrons and parents to better understand the educational needs and attainments of North Carolina children.

In a continuing attempt to develop and improve North Carolina's assessment program, the Legislature, adding its encouragement through program support, approved funds in 1973 as a part of the State Superintendent's program budget to underwrite the statewide assessment effort. This State Assessment at the third-grade level is the first stage in a proposed three-year assessment cycle. In 1974-75, assessment will occur in the sixth grade, and, in 1975-76, at the ninth-grade level.

Implementation of the Assessment

The Sample

Selecting third graders to participate in the assessment program was the responsibility of the Research Triangle Institute, assisted by the State Department of Public Instruction. The objective was to choose a representative sample of size sufficient to provide reliable estimates of test score averages for the state, the Coastal Plains, the Piedmont, and the Mountains. Independent samples of 2,500 students were considered appropriate for each of the areas described in the section entitled "Assessment Areas." The total third-grade enrollment of the eighteen schools containing 1970-71 state-supported kindergartens provided approximately 2,000 students for a special assessment follow-up.

A two-stage sampling procedure was designed to select the 12,500 students for the first five areas. In order to give each third-grade student in North Carolina an equal chance of being chosen, 618 schools were randomly selected with the probability of school selection based upon stratification according to the size of the third-grade enrollment.

Random selection of students within schools was controlled to preserve the proportion of ESEA Title I enrollment within the third-grade class.

Of the 93,752 third-grade students in North Carolina, the chance of selection for any child was ten out of seventy-four.

Pupil characteristics of the third-grade State Assessment sample are shown in Table 1.

TABLE 1

PUPIL CHARACTERISTICS OF THE THIRD-GRADE ASSESSMENT SAMPLE

Characteristic	State Assessment Sample
Sex	
. Male	51.3%
. Female	48.5%
Racial/Ethnic Membership	
. American Indian	1.2%
. Black	29.0%
. White	69.0%
Parental Education Level	
. Neither over eighth	5.9%
. One over eighth	25.9%
. One high school graduate	44.8%
. One over high school	23.5%
Family Income Estimate	
. Less than $3,000	15.4%
. $3,000 - $15,000	75.6%
. Over $15,000	8.1%
Any Kindergarten Experience	
. Yes	39.2%
. No	53.4%
. Unknown	6.8%

Field Procedures

An Assessment Coordinator was designated by the superintendent of each participating LEA to organize all assessment activities. The activities included: (1) selecting and coordinating the testing schedule, (2) distributing and collecting test packages and questionnaires, and (3) providing information and assistance to the test administrators and principals. With the approval of the superintendent, Assessment Coordinators also selected someone other than the student's classroom teacher to administer the tests. These administrators read aloud all items which did not test the student's ability to read. To insure standardization of test procedures, the Division of Research staff held workshops to acquaint coordinators and administrators with assessment procedures.

Assessment Areas

The 1973-74 State Assessment of Educational Progress consisted of five different assessment areas and an additional research package for the evaluation of hird graders who had previously attended state-supported kindergarten. In addition to student measures, all teachers (grades K-6) and principals of the 618 schools included in the student sample were asked to respond to questionnaires designed to reflect their opinions about the educational needs and priorities in North Carolina.

The subjects included in the six assessment areas and the type of testing involved are listed in Table 2.

TABLE 2

OVERVIEW OF 1973-74 ASSESSMENT AREAS, TESTING, AND SAMPLING

Assessment Area	Type of Testing	Number of Students Sampled
Reading, Math, Language Arts	Norm-Referenced (Iowa Tests of Basic Skills)	2,500
Reading, Math, Language Arts	Objective-Based	2,500
Health Physical Education	Objective-Based Motor Performance	2,500
Cultural Arts	Perception Survey	2,500
Science and Social Studies	Objective-Based	2,500
Third-Grade Kindergarten Follow-up	Norm-Referenced (Iowa Tests of Basic Skills) (Cognitive Abilities Test) (Self Observation Scale)	2,000

Types of Instruments

Reading, language arts, and mathematics were each assessed by both a norm-referenced test (Iowa Tests of Basic Skills) and an objective-based test developed at the state level. The difference in the kinds of information provided by the two types of measurements should be considered when interpreting test results.

Nationally standardized achievement tests, such as the Iowa Tests of Basic Skills, are designed to provide information about student performance in given subject areas in relation to the performance of other students who are representative of the nation as a whole. The national sample of students taking the ITBS is the "norm" or reference group to whose

performance we compare our state results. Thus, the ITBS provides information on the educational status of North Carolina third-grade students in relation to the performance of a national sample of "typical" third graders. Such standardized tests also assume a continuum of achievement skills based upon the scores of the national sample. North Carolina's third-grade results may be considered against this continuum.

Norm-referenced tests are designed to spread out developmental scores on a continuum of skills spanning several grade levels. However, they do not tell us specifically what our students have achieved or how they perform on a given set of educational tasks. Some items on the ITBS can admittedly be grouped into subject area objectives, but the test is not designed for diagnostic purposes.

Therefore, objective-based tests were developed for reading, language arts, mathematics, and several other areas in order to assess more specific knowledge of North Carolina's students. Program area specialists and researchers collaborated on this review and selection process. Questionnaires were developed, information gathered, standardized tests carefully reviewed, and objectives and items finally selected in accord with some of the major educational goals of North Carolina.

Objective-based tests, also known as criterion-referenced tests, are developed differently from norm-referenced tests. They facilitate assessing the extent to which students have learned some defined behavior domain or specific class of learner skills. These behavior domains are also referred to as objectives. Specific objectives considered important or crucial for later skills are selected for each subject area. Then, items selected to measure these objectives determine how well students have learned the knowledge or behavior described by the objectives. Objective-

based tests are thus diagnostic of specific learning, rather than more broadly comparative in nature - as are the norm-referenced tests. Strengths and weaknesses of a group of students for a given subject area are thus determined, and sometimes, though not necessarily, in relation to a norm group.

It is important in making educational program decisions to know specifically what students have learned as well as how they are generally performing in relation to other students. For this reason, the assessment of third graders included experimental objective-based tests for various subject areas. Norm-referenced and objective-based tests when combined should provide a more complete picture of the performance of North Carolina students.

In the 1973-74 State Assessment, other kinds of instruments besides norm-referneced and objective-based tests were also used to gauge student performance. For example, the physical education instrument was a motor performance test in which students participated in a variety of physical activities. That test was based neither on national norms nor on specific objectives.

In addition, tests were developed to measure student attitudes toward perceptions of subject matter (such as cultural arts). A survey of teachers' and principals' needs was taken. The assessment staff also acquired school and community information on variables known to be associated with achievement.

Interpreting Scores from Objective-Based Tests*

Generally objective-based tests results are interpreted by looking at the percentage of items achieved (or answered correctly) for a given objective. The desired level of achievement for an objective is a considered yet subjective decision on the part of educators. In some cases, 50 percent achievement of an objective at that grade level may be acceptable; in others, 100 percent may be considered necessary for acceptable performance. The level depends on both the purposes for assessing the objective and whether or not the objective has been previously taught. In the statewide survey objectives were selected that appeared to be commonly relevant to the curricular area throughout the state or that had some importance for state-level planning. Acceptable achievement levels may, therefore, vary with different subjects and objectives. This same process could be repeated at the regional or local level, and the final test may again have different objectives, depending on local priorities. A statewide sample of third-grade teachers reviewed the state selection of objectives for relevance and importance to their classes. They also examined the items and estimated the success they felt students would achieve on them. However, due to differences which exist across the state, a "desired" achievement level was not set for North Carolina.

*For a discussion on difficulties in interpreting norm-referenced test scores in light of North Carolina's difference from national norm-groups, see 1973-74 State Assessment reports on reading, language arts, and mathematics.

Another consideration is the number of items per objective. As mentioned earlier in the "Types of Instruments" section, objectives reflect specific areas or domains of student behaviors. Because only a limited number of items can be selected for a given group of behaviors (objectives), the results on these items should be carefully interpreted as "indicators" of general performance for the objective.

If there are only two items per objective, the possible achievement levels for the objective are necessarily 0 percent, 50 percent, and 100 percent achievement. Similarly with four items for the same objective, the possible achievement levels would be expanded to 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent. This increase in items enables a more specific reporting of results at both the student and group level. Further, we have a greater assurance that the students (or groups) have adequately learned the skills or behaviors stated in the objective if four items are used rather than two. However, no set rules can be given as some objectives can be stated with greater specificity than others and require fewer items for adequate measurement.

Generally statewide results will be reported by objectives and reflect the percentage of students who answer correctly a given number of items for the objective. For example, if an objective has three items, results will show what percentage of students answer <u>one</u>, <u>two</u>, <u>three</u>, or <u>no</u> items correctly. The number of items a student or group is expected to answer correctly is again a considered judgment based on the particular objective and the value or priority the user places on that objective.

Information at the item level also aids in interpretation as efforts are made to diagnose specific strengths and weaknesses. Thus, the objective-based test allows flexibility to curriculum specialists in assessing important developmental skills with greater accuracy. Certainly it adds a valuable perspective to those who plan programs to meet specific needs of North Carolina youngsters.

Comparisons within North Carolina

There are great variations within the boundaries of North Carolina. Particularly important is the variety which exists with the differing traditions and personalities of its Mountain, Piedmont, and Coastal Plains groups. The following table describes some of these differences:

TABLE 3

GENERAL ENVIRONMENTAL FACTORS WITHIN NORTH CAROLINA

Factor	Mountains	Piedmont	Coastal Plains	State
Population (1970)	760,760 (15%)	2,692,975 (54%)	1,628,323 (32%)	5,082,059
Growth (1960-1970)	11%	21.3%	7.7%	11.5%
Distribution of Non-White Population (1970)	41,459 (4%)	569,575 (51%)	515,444 (46%)	1,126,478
Percentage Non-White (1970)	5.4%	21.1%	31.6%	22.2%
Percentage Classified Rural (1970)	75.1%	45.9%	60.6%	55.0%
Percentage That Moved (1965-70)	40.5%	46.0%	49.2%	46.2%

These basic environmental factors indicate that a majority of the people - non-white and white - live in the Piedmont; the Mountains have the highest percentage of the people living in rural areas; and the Coastal Plains population has a greater proportion that is non-white. Perhaps the major point in these figures is the variety among these three major geographical divisions. As disclosed earlier, some of these same variables have been shown to be related to achievement.

Distribution of economic resources in these three regions also varies, as the following table shows:

TABLE 4

SOCIOECONOMIC FACTORS WITHIN NORTH CAROLINA

Factor	Mountains	Piedmont	Coastal Plains	State
Family Income	8,059	10,234	7,757	9,139
Family Income Female Head (1970)	5,017	5,620	4,104	5,017
Average Percentage Free School Lunch	35.2%	37.6%	64.7%	47.8%
Percentage Living Below Poverty	20.2%	15.1%	28.8%	20.3%
Percentage of all Families Below Poverty with Children Under 18	10.7%	8.9%	19.2%	12.3%
Percentage of all Children Under 18 From Poverty Families	20.5%	17.4%	34.4%	23.6%
Percentage of Children Under 18 Living with Both Parents	82.6%	80.1%	73.7%	78.3%

Because socioeconomic status is a strong predictor of academic success, regional differences in educational achievement are to be expected. Thus, any academic comparisons should be carefully tempered by these background differences.

Still another factor associated with academic achievement is the educational environment. Regional patterns are suggested in the table below:

TABLE 5

EDUCATIONAL FACTORS WITHIN NORTH CAROLINA

Factor	Mountains	Piedmont	Coastal Plains	State
Average of Median Years of Education - Adults Over 25	9.5	10.2	9.9	10.6
Adult Education Index	2.50	2.82	2.56	2.69
Percentage of High School Graduates of Those 16-21 Not in School	49.7%	48.7%	44.0%	46.7%
Taxing for Education Index	417	507	439	478

These environmental, socioeconomic, and educational factors are a major influence on a child's educational growth and development. Educators who consider regional comparisons must be aware of the differential effects that these factors contribute within regions. Certainly expectations are better determined with an awareness of the status of these variables, regardless of whether local, regional, or state comparisons are being made.

HIGHLIGHTS OF RESULTS FROM SCIENCE ASSESSMENT

General performance of North Carolina's third graders on the objective-based test reflected a high level of achievement and understanding of scientific principles. Eight of the 67 items classified as knowledge, comprehension, or application were each answered correctly by at least 85% of North Carolina's youngsters, and many other items gained impressive responses from the sampled pupils. However, some items were achieved at a low level.

Highest achievement was exhibited on knowledge items. Pupils achieved lower on items of comprehension and application. Objectives of life science were achieved at a high level. A lower level of achievement was shown for earth-space science and physical science.

In knowledge of life science, highest achievement was shown on items involving common characteristics of animals (88%), refrigerators prevent food spoilage (87%), oak trees grow from seeds (86%), and human babies come from the bodies of mothers (91%). Ninety-seven percent of the pupils knew that dinosaurs lived long ago and that web-footed animals live near the water. Physical science items that received high percentage correct responses (92% and 90%) involved the areas covered by eggs dropping from different heights and the recognition of items that cling to a magnet.

Little knowledge of the metric system was shown. Just 28% of the pupils knew that the width of a nickel is about two centimeters. Evidence of low achievement also appeared when only 35% of the pupils correctly answered that objects of different weights fall at the same speed. Fewer than one-third of the pupils (30%) knew that candles burn only a short time under an inverted beaker. Only 45% correctly responded that our year would be shorter if it took less time for the earth to go around the sun.

Strong beliefs and attitudes were displayed. Ninety percent of the students indicated the belief men have gone to the moon, and 88% reported the belief that a person will not fall off the earth. Ninety percent of the pupils expressed concern over pollution. Experience of the pupils included planting seeds and owning a pet for 93% and 95% respectively.

A surprisingly high percentage (52%) of the pupils believed that toads cause warts and even more of them (65%) believed that finding a four-leaf clover causes good luck. Preference for reading, music, and art over science was indicated by 81% of the pupils.

CHAPTER TWO: SCIENCE ACHIEVEMENT

Description of Test

Science achievement of 2,500 randomly selected third graders was tested in April, 1974, as a part of the 1973-74 State Assessment of Educational Progress. An 80-item instrument was developed by the Science Education Division of the North Carolina Department of Public Instruction for assessing the areas of Life Science, Physical Science, Earth-Space Science, and Scientific Processes. The objective-based test measured specific objectives in each of the above areas in the learning modes of knowledge, comprehension, and application.

This report will show the results of this test for the state (North Carolina) and region (Mountain, Piedmont, Coastal Plains). Results will also be presented by family income level and parental education level.

Sixty-seven of the 80 questions on the test were multiple choice. Each item was classified by Science Education Consultants of the Department of Public Instruction according to the science area and learning mode (e.g., Application - Physical Science) measured by the item. Classification of the items was verified by a selected group of third-grade teachers. Half of the items contained pictures, graphs, or charts to assist the youngster with the understanding of the question and/or to test his or her ability to recognize and analyze information from various sources.

Three items polled the students' attitudes and feelings toward pollution, science, and other school subjects. Another four items asked students about their superstitions and beliefs. To obtain

evidences of extended experiences, the last six items of the test asked students whether they had planted seeds, had a pet, visited a museum, looked through a microscope, seen a science movie, or performed a science experiment.

State Results by Objective

Objective 1: Knowledge-Life Science

Nine items were used to measure the objective. Ninety-three percent of pupils correctly responded to at least five of the nine items.

A very high percentage of pupils correctly responded to the items measuring this objective. The items of highest achievement involved the origin of a human baby and the picture recognition of common characteristics of animals. These items were answered correctly by 91% and 88% of pupils respectively. Lowest achievement involved essentials of animal survival and plant manufacture of its own food. These items were correctly answered by 67% and 59% of pupils respectively. Those incorrectly responding most often chose play as essential to animal survival and the grasshopper as a manufacturer of its own food. Seven of the nine items individually were answered by at least 80% of the pupils.

Knowledge of life science appears to be attained to a high degree among North Carolina's third graders. According to the results of this test, children in the state are receiving adequate instruction in the areas of life science tested for knowledge. However, extended experiences involving science experiments, science movies, microscopes, museums, and direct association with a variety of living things appear to be lacking.

Objective 2: Knowledge-Physical Science

Three items were used to measure the objective. Eighty-two percent of the pupils correctly responded to at least two of the three items.

Achievement was considered adequate on this objective. Ninety percent of the pupils chose the object that will cling to a magnet. Respondents answering incorrectly chose wood block more often than glass. Sixty-four percent responded that hot air will go up, while 70% knew that the sun supplies most of the earth's energy.

Objective 3: Knowledge-Earth-Space Science

Eleven items were used to measure the objective. Sixty-nine percent of the pupils correctly responded to at least six of the 11 items.

Objective achievement was considered adequate for third graders in knowledge of earth and space science, although item percentages varied widely. Only 35% of the pupils knew the time lapse between full moons, while 97% knew that dinosaurs lived long ago.

Other items reflecting high achievement involved rocks being brought from the moon (84%) and the rotation of the earth to cause day and night (71%).

An item of low achievement revealed that 42% of the pupils knew that the moon is nearer to the earth than the sun and other stars. Those who missed the item answered "stars" and "sun" in almost equal numbers as the celestial body nearest the earth.

Objective 4: Comprehension-Life Science

Seven items were used to measure the objective. Fifty-eight percent of the pupils correctly responded to at least four of the seven items.

Achievement of this objective was considered less than adequate. Three of the seven items individually were missed by more than 55% of the pupils. Although the validity of these items has been questioned, low achievement was evidenced by six of the seven items receiving less than 70% correct response.

Ambiguous drawings were considered partially responsible for the low achievement (15% and 20% respectively) of items involving plants attracted toward the sun and a "community" consisting of plants and animals. It is also possible that the pupils had little comprehension of the concept of "community" or that a child's first perception of a picture of a "community" emphasized "animals" as the subjects in the picture and "plants" as a natural part of animal surroundings. In any case, the overall evaluation of the objective was influenced little by the two items.

Other items receiving low percentages of correct responses (62%, 66%, and 67%) involved similarities of living things, a collection of animals living in a pond, and common living places of living things. One

item showed high achievement in the recognition of animal's feet that are adapted for living in or near water. The item was correctly answered by 97% of the pupils.

Objective 5: Comprehension-Physical Science

Four items were used to measure the objective. Fifty-one percent of the pupils correctly responded to at least three of the four items.

Less-than-adequate achievement was indicated by the responses to items measuring the comprehension of physical science. Highest achievement of 79% and 72% was shown on items about the transfer of energy: electricity being changed into heat and moving water causing work to be done. Fewer than half (47%) of the pupils knew that light travels faster than sound, and slightly more than half (51%) knew that a thermometer in a glass of water reads lower if ice cubes are added.

Objective 6: Comprehension-Earth-Space Science

Seven items were used to measure comprehension in earth science. Sixty-five percent of the pupils correctly responded to at least four of the items.

Achievement of the objective was considered less than adequate. However, the item percentages were less varied than for most of the other objectives. Item achievement of this objective ranged from 45% to 80%.

Low achievement items involved the duration of the earth's travel around the sun (45%), the best way to plant a crop on a hill (49%), the ultimate destination of eroded soil (52%), and the effects of pavement upon water flow (54%).

Pupils showed greater comprehension of earth science items dealing with the apparent absence of stars during the daytime (62%), the position of the sun and earth during the night (68%), and the appearance of the atmosphere prior to rain (80%).

Pupils seemed to score better on items dealing with phenomena observable in daily life than on items requiring direct training of the respondent. This supports a teaching methodology in which experiences of pupils are extended as a means of achieving better comprehension.

Objective 7: Application-Life Science

Three items were used to measure the ability of pupils to apply the concepts of life science. Sixty-six percent of the pupils correctly responded to at least two of the three items.

Objective achievement was considered less than adequate. One of the items received correct response from fewer than half of the pupils. The other two items were correctly answered by less than 70% of the pupils.

The lowest achievement, in which 49% correctly responded to the item, involved natural animal camouflage. Forty percent of the pupils incorrectly chose the response that the same number of green and brown worms would be found by birds on a green lawn. Similarities of animal shapes and the fading of grass shaded by fallen leaves were concepts sought in the other two items in which 67% and 68% correctly responded.

Improvement is needed in the measurement of the concepts in the application of life science. Pupils had difficulty with some of the items in which incorrect responses could be logically attractive. For example, if it is assumed that only a few brown and green worms are on

a green lawn, birds may ultimately find all of them. The brown ones would, of course, be more easily found.

Objective 8: Application-Physical Science

Twelve items were used to measure the objective. Seventy percent of the pupils correctly responded to at least seven of the 12 items.

Less-than-adequate achievement was indicated by the responses to the items measuring this objective. Thirty percent of the pupils correctly responded that candles burn for only a short time under an inverted beaker. Thirty-five percent knew that iron balls of different weights fall at the same speed, while 45% knew that a nail will act like a magnet inside a coil of wire connected to a battery.

Higher achievement was exhibited on items involving the shape of an egg after falling from a high place (92%), the mechanical advantage of an inclined plane (89%), and effect of increased temperature upon water evaporation (71%).

Performance on the application of physical science provided further evidence that pupils learn well from those experiences that are a part of their everyday life. Logical reasoning was also exhibited by pupils' responses to items concerned with application in physical science. Direct association of students with physical phenomena is one of the best ways to improve their use of scientific principles.

Objective 9: The Scientific Processes

Eleven items were used to measure the objective. Seventy-four percent of the pupils correctly responded to at least six of the 11 items.

Achievement was considered adequate on the objective, although performance involving the metric system exhibited low achievement. Twenty-eight percent responded that two centimeters is the approximate width of a nickel, while a larger percentage (32%) thought two meters to be the correct measure. Twenty-two percent admitted they did not know, and 17% thought nickels were two kilometers in width.

These responses probably reflect random markings of the item and an absence of instruction in the metric system. There is indication that instruction in the metric system needs to be introduced, since knowledge of the metric system is considered desirable.

Another item received a low percentage of correct responses. Forty-five percent of the pupils chose the option a dog is better than a cat as something very hard for a scientist to measure. The other pupils chose a cat is 16 inches long and a dog weighs 30 pounds in almost equal numbers (25% and 29%). Incorrect responses may be partially attributed to disagreement with the statement a dog is better than a cat or to the contention that there is considerable physical difficulty in measuring cats and dogs.

High achievement of scientific processes was exhibited on items involving recognizing similarities of objects (80%), bar graph interpretation (74%), and drawing conclusions from charted data (72%). Performance of North Carolina's third graders exceeded that of a national sample of third graders in the percentages correct on similar items used in a nationally standardized test.

Eighty-four percent of the pupils knew that a telescope is an instrument for studying stars. Ten percent thought a microscope to be the proper instrument for celestial study.

Laboratory experience with hypothesis testing and instruments seems to be needed to improve the pupils' concept of scientific processes.

Objective 10: Beliefs-Attitudes-Experiences

Usual objective measure is not applicable for this cluster of items. Items in this cluster have no "correct" answers; the answers reflect the affective makeup of the individual pupils.

Most of the pupils (60%) said they feel happy about science, but almost half (48%) indicated they prefer music and art to science. Only 19% chose science as a favorite over reading, arithmetic, music, and art. Ninety percent of the pupils indicated they feel sad about pollution.

Belief in superstition is prevalent among North Carolina's third graders. Handling a toad will cause warts was the belief of 52% of the pupils. Sixty-five percent held the belief that finding a four-leaf clover will bring good luck.

Ninety percent of the pupils believed that men have gone to the moon, and 88% knew that falling off the earth is a myth.

Young children tend to believe what they are told by adults and other children. The truths of science can become a part of the lives of children if teachers, parents, and associates will use discretion in their expression of beliefs, attitudes, and facts.

Experiences of North Carolina's third grades have included science experiments, movies, microscopes, museums, pets, and plants. Seventy-one percent of them have done a science experiment this year. Pets provided the most common experiences: 95% of the youngsters had owned a pet. Almost as many (93%) had planted seeds. Visiting a museum, looking

through a microscope, and seeing a movie about science in school this year added to the experiences of more than half the youngsters (60%, 63%, and 65% respectively).

Overall State Achievement

Total scores were computed for each child on the 67 items which had correct responses. The average score was 42.7 with standard deviation of 9.02. Two-thirds of the pupils scored between 34 and 52. Distribution of scores was impressively close to a normal distribution. Scores ranged from 15 to 63.

Results According to Family Income

Pupils of the third grade assessment are classified according to three annual family income categories, with "low" signifying under $3,000, "medium" $3,000 - $15,000, and "high" over $15,000.

A breakdown of science scores by family income is shown in Table 6 on the following page.

TABLE 6

RESULTS BY FAMILY INCOME

Family Income	Percentage of N. C. Sample in Each Family Income Group	Average Test Score (Items Correct)
Low (under $3,000)	15.7%	36.2
Medium ($3,000-$15,000)	76.6%	43.3
High (over $15,000)	7.7%	50.7

Almost all achievement items showed higher scores for pupils in higher levels of family income. However, three of the 67 items received larger percentages of correct responses for lower income groups. Items in which low income groups excelled involved using a lever to lift a heavy object; objects of different weights falling at the same speed, and measures difficult for scientists.

Items showing the largest differences between family income groups came from six of the nine achievement objectives. The knowledge of life science item involving the changes in the life of a frog showed a range of average achievement from 67% to 95% across levels of family income.

Two items of Knowledge-Earth Science showed percentage point differences of 34 and 37 between low family income and high family income pupils. These items involved the choice of a natural resource and the revolution of the earth around the sun.

Items dealing with scientific processes were closely associated with family income. The best description of an experiment was involved in an item which showed a wider range of average scores across family income groups than any other item of the test. Slightly more than one-third (35%) of low family income pupils correctly answered the item, while 88% of the pupils of the high income group marked the item correctly. Almost all (97%) of the high income group correctly answered the item identifying the instrument used to study the stars, while 69% of the pupils of the low income group gave correct responses.

Percentage point differences of 36 and 38 separated the extreme family income groups on the scientific process items on recognizing similarities of objects and drawing conclusions from charted data.

Comprehension-Life Science items involving common living places of living things and a collection of animals living in a pond showed percentage-point differences of 42 and 51 across levels of family income. High income pupils scored above 90% on each of these items.

Sensitivity to levels of family income was displayed in two items measuring comprehension of physical science. Items involving light travels faster than sound and a thermometer in a glass of water reads lower if ice cubes are added differed by 42 and 41 percentage points in the achievement between high family income and low family income pupils.

Items measuring comprehension of earth science requiring a concept of the duration of the earth's travel around the sun and the position of the sun and earth during the night were correctly answered by 32% and 48% of the low family income group. High family income pupils received corresponding percentages of 67% and 87%.

Forty percent of pupils from low income families knew that air-filled balloons fall slower than water-filled balloons, while 71% of the high family income pupils answered the question correctly. A similar item showing that objects of different weights and same size come to rest at different heights in water received percentage achievements of 53% and 87% from the two groups. These items were used to measure application of physical science concepts.

Belief that warts are caused by toads was much more prevalent among pupils of the lowest family income category. A much higher percentage of pupils from the high family income group (83%) had looked through a microscope than pupils from the low family income group (54%).

Results According to Parental Education Level

Four levels of parental education were determined by the combined education level of each parent as recorded by teachers on the Student Information Questionnaire. The levels were as follows: (1) both parents completed less than eighth grade; (2) at least one parent completed eighth grade but did not complete high school; (3) at least one parent finished high school; (4) at least one parent had some education beyond high school.

As shown in Table 7, which is found on the following page, parental education level is closely associated with scores of the science test. Almost all the items of the science test were more frequently correctly answered by Level 4 pupils, followed in order by Level 3, Level 2, and Level 1 pupils. Some exceptions will be noted, and the items showing the largest score differences among the groups will also be noted.

TABLE 7

RESULTS BY PARENTAL EDUCATION LEVEL

Parental Education Level	Percentage of N. C. Sample Having Parents in Given Education Level	Average Test Score (Items Correct)
1	6.1%	36.7
2	27.0%	39.6
3	43.7%	44.2
4	23.2%	49.0

Total science scores revealed average differences of 2.9, 4.6, and 4.8 between pupils in adjacent levels of parental education. Average scores for the four levels were 36.7, 39.6, 44.2, and 49.0 for Level 1, Level 2, Level 3, and Level 4 respectively.

Largest differences in achievement among parental education groupings involved four of the seven items measuring knowledge of earth science, one of the seven items measuring comprehension of life science, four of the 11 items measuring scientific processes, and two of the 12 items measuring application of physical science.

Knowledge of earth science appeared most sensitive to differences of achievement among levels of parental education. Items showing large percentage differences involved the earth's rotation to produce day and night, the correct order of the seasons, the nearest celestial body to the earth, and the earth's revolution about the sun. Percentage-point

differences between the highest and lowest levels of parental education ranged from 28 to 34 for the mentioned items. For example, the first mentioned item received 51% correct response from Level 1 pupils and 85% correct response from Level 4 pupils - a difference of 34 percentage points.

The Comprehension-Life Science item involving common living places of different animals was answered correctly by 50% of Level 1 pupils and 86% of Level 4 pupils. Scientific Processes items involving objects of similar shape, interpretation of graphs, the best description of an experiment, and the explanation of the effects of static electricity showed percentage-point differences of 37, 32, 42, and 32 between Level 4 and Level 1 pupils. Application-Physical Science items involving air-filled balloons fall slower than water-filled balloons and objects of different weights and same size come to rest at different heights in water showed percentage-point differences of 28 and 26 between Level 4 and Level 1 pupils.

The Application-Physical Science item involving objects of different weights fall at the same speed received a higher percentage of correct responses from Level 1 pupils than Level 4 pupils - a reversal of the general trend. Pupils whose parents had less than eighth grade education exceeded those with parents having education beyond high school by 17 percentage points on the item.

Pupils of parents with the highest levels of education tended more often to choose science as a favorite subject, show more concern over pollution, and believe in fact rather than superstition than pupils of parents with the lowest levels of education. Little difference was

evident among the groups regarding whether they had performed a science experiment this year, planted some seeds, or had a pet. However, the experiences of looking through a microscope, visiting a museum, or seeing a science movie were more prevalent among higher education groups.

Regional Results

North Carolina is divided into three geographic regions - Mountain, Piedmont, and Coastal Plains. Although the boundary lines are somewhat arbitrarily drawn, distinctive traits of each region are apparent, as described in the introduction of this report.

Regional breakdowns of the sample for the science test are an accurate reflection of the geographic breakdown of the population. Table 8 shows the number and percentage of sampled pupils within each region. Subsequent pages will describe the regional results on the science test.

TABLE 8

NUMBER AND PERCENTAGE OF SAMPLED STUDENTS IN EACH GEOGRAPHIC REGION

Region	Sampled Pupils
Mountain	335/14%
Piedmont	1264/53%
Coastal Plains	786/33%

Mountain

Overall performance in science was higher in the Mountain region than in the state as a whole. Mountain pupils averaged 44.7 items correct on the total test, compared to the state average of 42.7.

Although regional differences within items were slight, Mountain pupils exceeded the state by nine to ten percentage points on items dealing with a thermometer in a glass of water reads lower if ice cubes are added, the best way to plant a crop on a hill, and the fading of grass shaded by fallen leaves. Only two items showed Mountain performance below the state by more than one percentage point. That the width of a nickel is about two centimeters was known by 28% of the pupils in the state and 22% of the Mountain pupils. Thirty-one percent of the Mountain pupils knew that objects of different weights fall at the same speed, while 35% of the state pupils correctly responded to the item.

Mountain pupils showed a higher preference for science over reading, arithmetic, music, and art and more concern over pollution than pupils of the state. However, Mountain pupils showed less happiness about science than state pupils.

Belief in falling off the earth was less prevalent in the Mountains.

Seventy-seven percent of Mountain pupils had seen a movie about science in school this year, while only 65% of state pupils had done so. Experience with microscopes was much less prevalent in the mountains. Although 63% of North Carolina pupils had ever looked through a microscope, only 39% of the Mountain pupils had had the experience. Pet ownership and museum visitation were slightly more prevalent among Mountain pupils.

Piedmont

Piedmont pupils scored slightly above the state average on the total science test. Average score for Piedmont pupils was 43.2 items correct, as compared to 42.7 for the state.

Item percentage achievement on most items was almost identical for Piedmont and state pupils. Piedmont pupils were slightly above state percentages on items involving the closest celestial body to the earth and a collection of animals living in a pond.

Piedmont pupils showed a happier feeling about science than other pupils of the state. Less prevalent in the Piedmont was the belief that handling a toad will cause warts.

A higher percentage of pupils in the Piedmont than in the state indicated that they had seen a movie about science in school this year. Other science experiences of looking through a microscope and visiting a museum were also more prevalent in the Piedmont.

Coastal Plains

On the total science test, the state average was above the average for the Coastal Plains. Coastal Plains pupils averaged 41.1 items correct, while pupils of the state as a whole averaged 42.7.

Coastal Plains pupils scored three percentage points above the state on the item involving objects of different weights fall at the same speed. Responses to most of the other items indicated that one to five percent more state pupils correctly answered the items than did Coastal Plains pupils.

Largest differences of item percentages involved a thermometer in a glass of water reads lower if ice cubes are added and the best way to plant a crop on a hill. These items were correctly answered by 42% and 43% of Coastal Plains pupils and 51% and 49% of all North Carolina pupils.

Beliefs that handling a toad will cause warts and that a person can fall off the earth are more prevalent in the Coastal Plains than in the remainder of the state.

Fewer Coastal Plains pupils had seen a movie about science in school this year, looked through a microscope or visited a museum than in the state as a whole.

Comments Regarding Third-Grade Assessment Results

Assessment results reveal that third graders in North Carolina in general achieved at a high level in life science. They achieved at a somewhat lower level in physical and earth sciences. Theories for explaining this are varied. From personal observations and teacher comments, it seems that children at the third grade are very curious about living things and are motivated to investigate them and their actions. The fact that rural children have especially frequent contact with animals, plants, and nature in general may contribute to North Carolina students' achievement in life science. Teachers may also feel more confident in life science than in other areas of science.

Third-grade students also performed better on knowledge items than on comprehension or application items. Knowledge refers to being able to recall or name specifics about things or events; comprehension refers

to being able to relate knowledge to other things or events, or being able to see the full implication; application refers to being able to use abstractions in concrete situations. It appears logical for third graders to do better on knowledge items than on higher-level items, since recollection of facts requires a lower learning ability than do comprehension and application of facts or principles. It may also be that present instructional practices in the schools place greater emphasis on knowledge than upon application or comprehension.

One of the purposes of science is to cause students to question or disbelieve superstitions and myths unsupported by scientific proof. A rather large number of students expressed belief in stories such as toads causing warts and four-leaf clovers bringing good luck. This finding should encourage teachers to discuss superstitions in class in an effort to dispel unscientific beliefs.

The assessment findings suggest some need for change in the content of the science program or the method of science instruction. The Science Education Division of the Department of Public Instruction believes that science at the third grade can be improved by (1) placing more nearly equal emphasis on the broad areas of science--life science, physical science, and earth-space science, and (2) providing additional emphasis on conceptual learning and the investigative, student-oriented, hands-on method of instruction.

The assessment findings may also have implications for teacher-education personnel who are responsible for helping train future teachers and school administrators. Teacher-training institutions may need to develop criteria for potential teachers to assure that they are suffi-

ciently prepared to teach modern science in our schools.

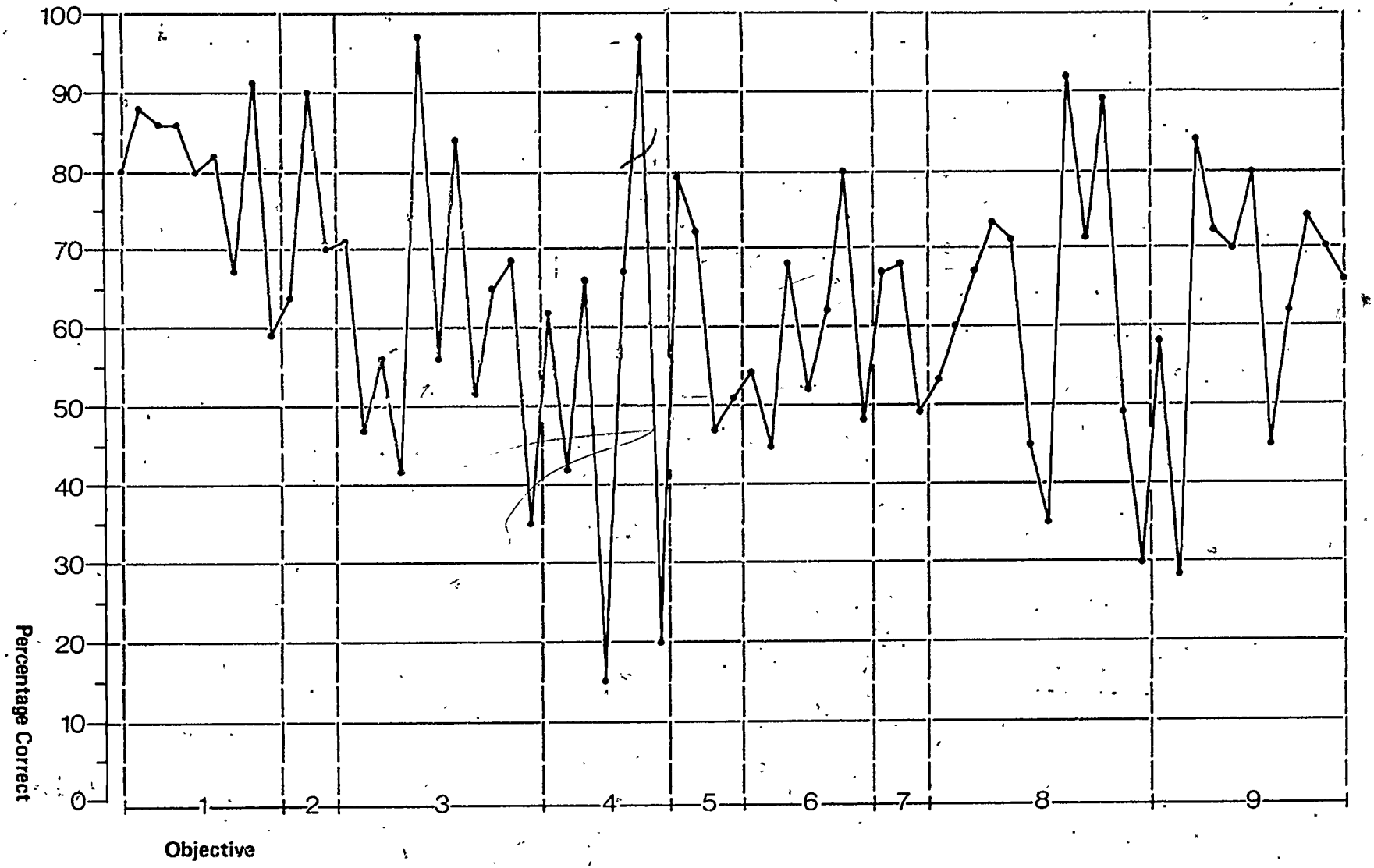
A close association is shown between the achievement of the child and his or her family income--the greater the income, the higher the achievement. The achievement of the child and the educational level(s) of his or her parents also are closely related--the greater the education level, the higher the achievement. Although these variables are proxy to many other conditions unfavorable to quality education, it is believed that increasing the parental education and family income would enhance educational achievement in science and other subjects. This should present a challenge for all of society.

Although the third graders performed well on process items and report having many worthwhile educational experiences(such as visiting museums and doing experiments in class),it is believed that added emphasis on such experiences for all students would enhance the science programs in our schools.

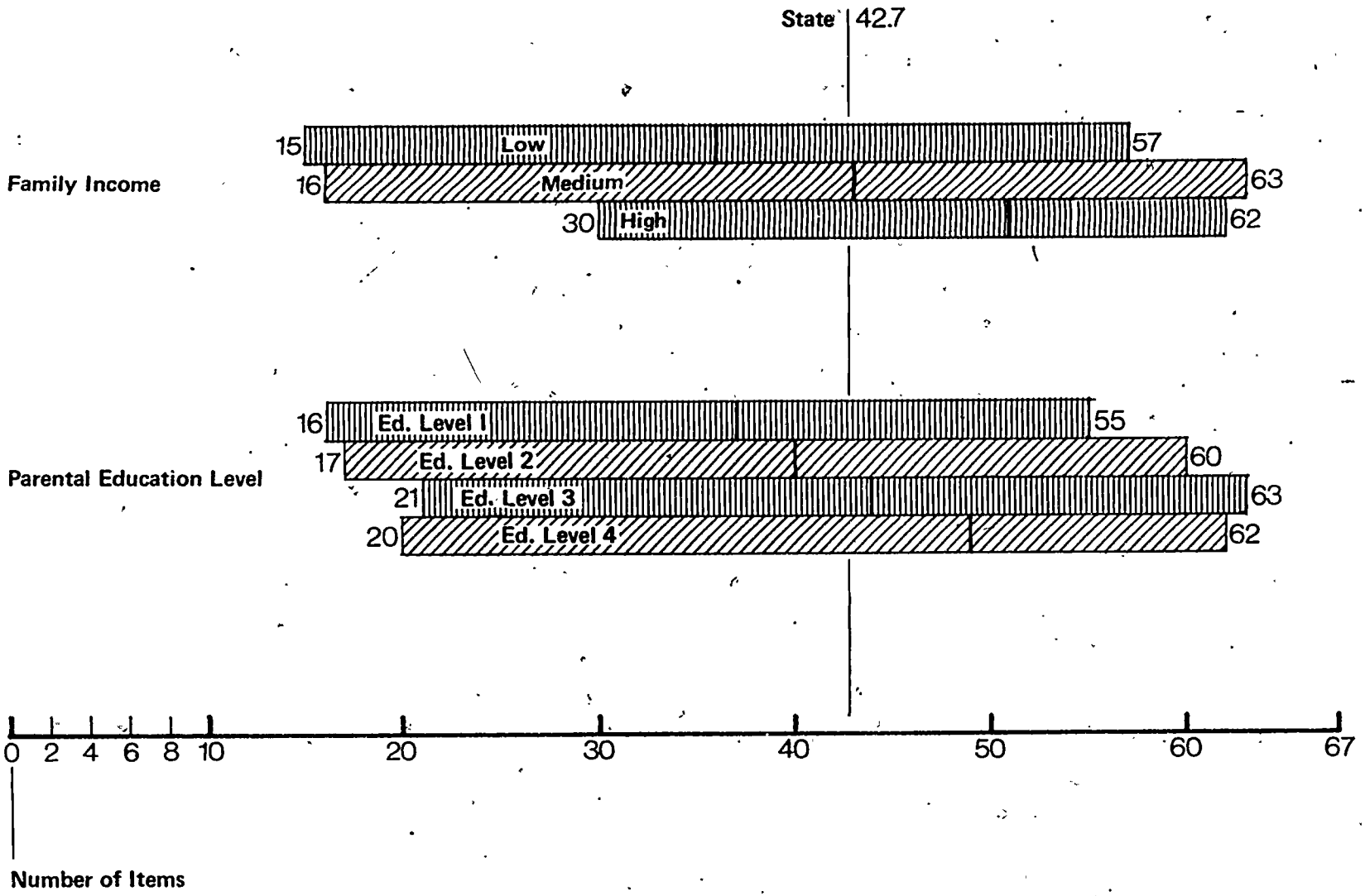
With national emphasis being placed on the use of the metric system of measurement, public schools and teacher training institutions are encouraged to include the study of the metric system in their programs.

APPENDIX

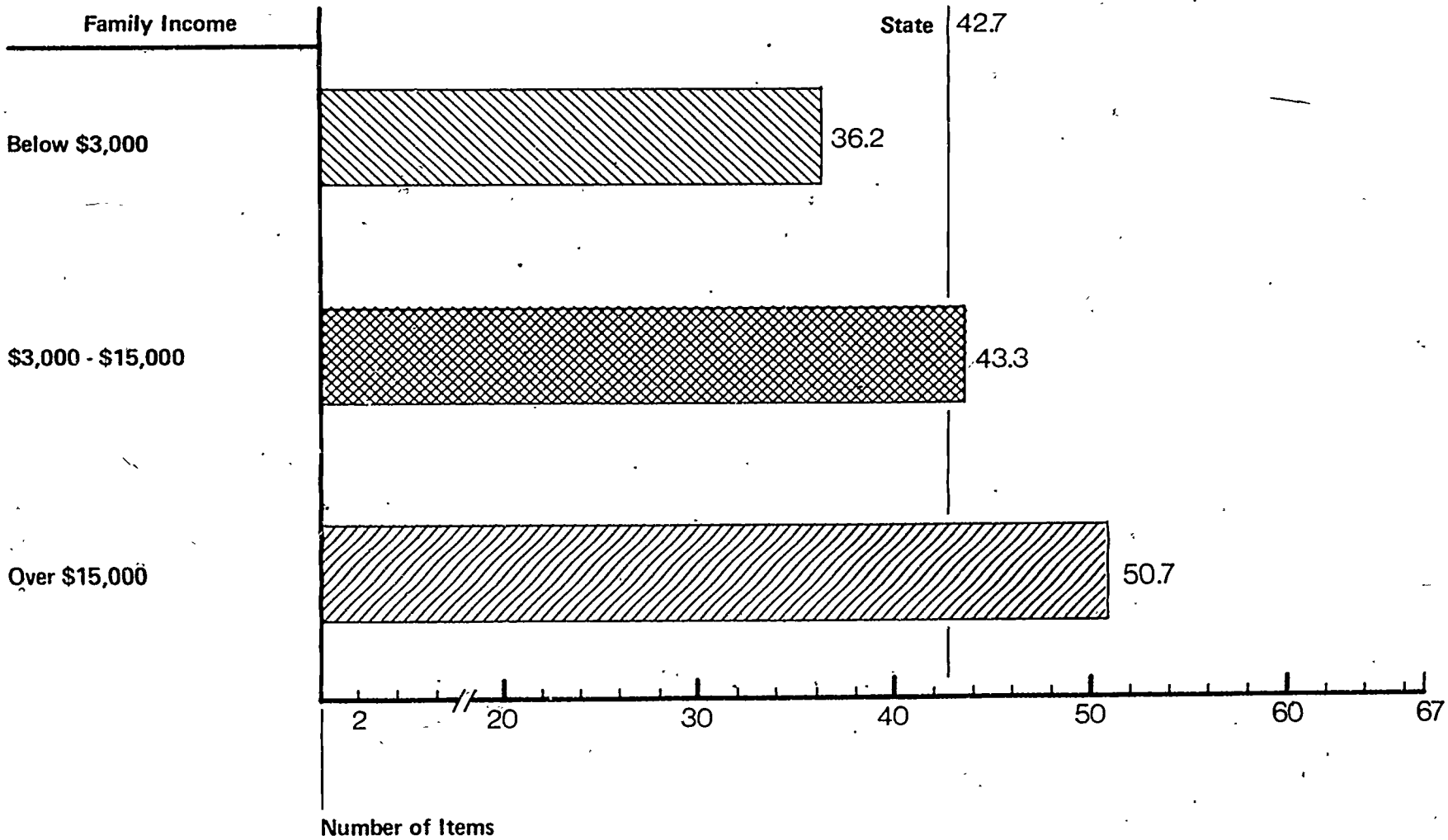
PERCENT OF N. C. STUDENTS RESPONDING CORRECTLY TO ITEMS ON OBJECTIVE BASED SCIENCE TEST



AVERAGE SCORES AND RANGES BY CLASSIFICATION VARIABLES FOR OBJECTIVE BASED SCIENCE TEST



AVERAGE NUMBER OF CORRECT RESPONSES ON OBJECTIVE BASED SCIENCE TEST BY FAMILY INCOME



AVERAGE NUMBER OF CORRECT RESPONSES ON OBJECTIVE BASED SCIENCE TEST BY PARENTAL EDUCATION LEVEL