1971

Relationships among pupil self concept, attitude toward school, and achievement on selected science exercises from the National Assessment of Educational Progress

David Jon Alvord
_Iowa State University_

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Relationships among pupil self concept, attitude toward school, and achievement on selected science exercises from the National Assessment of Educational Progress

by

David Jon Alvord

A Dissertation Submitted to the Graduate Faculty in Partial Fulfillment of The Requirements for the Degree of DOCTOR OF PHILOSOPHY

Major Subject: Education (Educational Administration)

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For the Graduate College

Iowa State University of Science and Technology Ames, Iowa

1971
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INTRODUCTION AND RATIONALE

Throughout the history of American education, educators and laymen alike have expressed a concern for stimulating the development of both cognitive and affective behavior in pupils. Evidence of this can be seen by analyzing goals of American public education as expressed by a number of prominent groups. Representative of these kinds of statements are the goals delineated by the Educational Policies Commission in 1944 (1, pp. 225-226).

1. to develop salable skills and those understandings and attitudes that make the worker an intelligent and productive participant in economic life...;
2. to develop and maintain good health and physical fitness;
3. to understand the rights and duties of the citizens of a democratic society, and to be diligent and competent in the performance of their obligations as members of the community and citizens of the state and nation;
4. to understand the significance of the family for the individual and society and the conditions conducive to successful family life;
5. to know how to purchase and use goods and services intelligently;
6. to understand the methods of science, the influence of science on human life, and the main scientific facts concerning the nature of the world and of man;
7. opportunities to develop their capacities to appreciate beauty in literature, art, music, and nature;
8. to be able to use their leisure time well and to budget it wisely, balancing activities that yield satisfactions to the individual with those that are socially useful;
9. to develop respect for other persons, to grow in their insight into ethical values and principles, and to be able to live and work cooperatively with others; and
10. to grow in their ability to think rationally, to express their thoughts clearly, and to read and listen with understanding.
While the concern for developing both cognitive and affective behavior in pupils has been demonstrated by groups such as the Educational Policies Commission and others, the relationship between the two domains remains a fertile area for research.

In support of the need for further research, Krathwohl et al. (2, p. 20) raise a question concerning the long supported assumption that growth in the affective domain is directly related to growth in the cognitive domain.

The authors of this work hold the view that under some conditions the development of cognitive behavior may actually destroy certain desired affective behaviors and that, instead of a positive relation between growth in cognitive and affective behavior, it is conceivable that there may be an inverse relation between growth in the two domains.

In support of the view expressed by Krathwohl et al. (2), Neale (3, p. 636), studying the relationship between affective and cognitive development, drew the following conclusion:

In short, positive or negative attitudes toward mathematics appear to have only a slight causal influence on how much mathematics is learned, remembered, and used.

Mager, as quoted by Neale (3, p. 633), further supports the need for additional study.

Favorable attitudes toward school subjects, says Mager, maximize the possibility that a student will willingly learn more about the subject, remember what he has learned, and use what he has learned.
Unfortunately, this widespread belief has not yet been well verified by scientific study. Nor do we know much about the effects of present programs upon such attitudes toward learning.

Speaking about the cognitive and affective domains, Krathwohl et al. (2, p. 20) state:

Clearly there is a need for conclusive experimentation and research on the relations between the two domains.

Studies of self concept as it relates to cognitive performance have shown a positive relationship between self concept and cognitive ability. This is evidenced by the following brief review.

Lecky (4) studied the importance of self concept in relation to academic achievement and found substantial evidence to indicate a definite relationship between the two factors. Lumpkin (5) also found significant relationships between pupil self concept and achievement in reading. Other studies indicating a positive relationship between self concept and achievement have been conducted by Bruck (6), Binder (7), Brookover et al. (8), Caplin (9), Jones and Grieneeks (10), and Brookover et al. (11).

A review of the literature by Caplin (12), however, substantiates a need for further investigation of the relationship between self concept and achievement, especially at the elementary and junior high levels (12, p. 13).

The literature shows that most of the studies have been conducted at the high school or college level: the elementary school has seen relatively few investigations of the problem.
Although a few major studies have been conducted with respect to the relationship between cognitive and affective development, it appears that research findings are quite varied. This conclusion is supported by a number of statements from researchers concerned with such a relationship. For example, Piaget and Inhelder (13, p. 158) state:

There is no behavior pattern, however intellectual, which does not involve affective factors as motives... Behavior is therefore of a piece. ... The two aspects, affective and cognitive, are at the same time inseparable and irreducible.

Contrary to these findings Krathwohl et al. (2, p. 7) comment that:

...much of the research on the relations between cognitive achievement and attitudes and values shows them to be statistically independent.

It becomes obvious in the face of such divergency that additional research in this area is necessary to further promote the understanding of the relationship between cognitive and affective behavior.

Statement of the Problem

The major problem of this research was to investigate the relationships among science achievement, attitude toward school, and self concept. Specifically, the study focused on three grade levels: fourth, seventh, and twelfth. These grade levels were selected for compatibility with National Assessment of Educational Progress (NAEP) science exercises.

Development of Hypotheses

The working hypotheses formulated for testing were developed on the basis of the general research hypothesis which has been logically deduced
from the research rationale. Specifically, the research hypothesis was as follows: There are no significant relationships among pupil performance on selected cognitive measures and pupil performance on affective measures of attitude toward school and self concept.

In accordance with the statement of the problem, the research undertaken examined relationships between science achievement and self concept and between science achievement and attitude toward school. Hypotheses one and seven were developed for this purpose. Additional hypotheses were also considered. These dealt with examining the relationship between subscale scores on the two affective measures and scores on the cognitive measure. Hypotheses two and eight were formulated to test these relationships. Finally, hypotheses three through six and nine through twelve, dealing with the factors of sex, race, and education level of parents, were investigated.

In developing the hypotheses the following questions served as criteria:

1) Is there a relationship between achievement and self concept? What is the direction of this relationship?
2) Is there a relationship between achievement and attitude toward school? What is the direction of this relationship?
3) Is there one major component within attitude toward school and within self concept which is more directly related to achievement than the other components?
4) Does the degree of relationship within groups compared on cognitive and affective measures differ with regard to
grade level, sex, race, and parent's educational level?

Based upon these criteria several hypotheses were developed and tested at the 0.05 significance level.

1. The correlation between pupil achievement on selected science measures and measures of pupil self concept is not significantly different than zero.

2. The correlation between science achievement and each of the subscales on the self concept measure is not significantly different than zero.

3. The correlation between science achievement and self concept is not significantly different for girls than for boys.

4. The correlation between science achievement and self concept is not significantly different for black pupils than for non-black pupils.

5. The correlation between science achievement and self concept does not differ significantly when pupils are categorized with respect to the educational level of the parent.

6. The correlation between science achievement and self concept does not differ significantly when pupils are categorized with respect to grade level.

7. The correlation between pupil achievement on selected science measures and measures of pupil attitude toward school is not significantly different than zero.

8. The correlation between science achievement and each of the subscales on the attitude toward school measure is not significantly different than zero.
9. The correlation between science achievement and attitude toward school is not significantly different for girls than for boys.

10. The correlation between science achievement and attitude toward school is not significantly different for black pupils than for non-black pupils.

11. The correlation between science achievement and attitude toward school does not differ significantly when pupils are categorized with respect to the educational level of the parent.

12. The correlation between science achievement and attitude toward school does not differ significantly when pupils are categorized with respect to grade level.

Assumptions

Assumptions relating to the research under investigation are as follows:

1) Each of the seven measures used in carrying out the research will measure what it purports to measure.

2) Science achievement, attitude toward school, and self concept can be identified and measured.

3) Sampling procedures used will yield a sample which is representative of pupils in Iowa and from which generalizations to other pupils in Iowa can be made.

Definition of Terms

Following is a list of terms germane to the investigation. Subsequent use of the terms defined below relate to the definitions which follow.
**affective** - refers to pupil behavior involved primarily with expressions of attitudes, interests, values, and appreciations.

**cognitive** - refers to pupil behavior involved primarily in intellectual functions dealing with evaluation, synthesis, application, comprehension, and recall of knowledge.

**pupils** - refers to girls and boys enrolled in Iowa public schools in grades twelve, seven, and four.

**race** - refers to two classifications, black and non-black.

**National Assessment of Educational Progress (NAEP)** - refers to a program directed by the Education Commission of the States. The program is designed to measure the level of knowledge and skills of the general public and to make available data on the progress of education in the United States.

**attitude toward school** - is defined as the degree of positive or negative feeling a pupil associates with school as measured by his score on the School Sentiment Index.

**science achievement** - is defined as the degree of success associated with a pupil's performance on selected science exercises released through the National Assessment of Educational Progress.

**public school** - is defined as any school operating an educational program supported directly and primarily by public taxation.

**parent's educational level** - refers to the level of education completed by the parent or legal guardian with the most formal education.

**self concept** - is defined as the degree of positive or negative feeling associated with an individual pupil's attitude toward himself as measured by his score on the Self Appraisal Inventory.
Delimitations

Pupils represented in the sample were selected at random from a stratified population of all twelfth, seventh, and fourth grade pupils in Iowa public schools.

Data on which findings are based were limited to that gathered through the use of the following instruments: 1) School Sentiment Index for Intermediate Grades; 2) School Sentiment Index for Secondary Grades; 3) NAEP Science Achievement Exercises for Grade Four; 4) NAEP Science Achievement Exercises for Grade Seven; 5) NAEP Science Achievement Exercises for Grade Twelve; 6) Self Appraisal Inventory for Intermediate Grades; and 7) Self Appraisal Inventory for Secondary Grades.

Conclusions and recommendations made in the final chapter relate only to twelfth, seventh, and fourth grade pupils in Iowa public schools.

Sources of Data

This investigation was made possible through the researcher's position as a consultant in the Planning, Research, and Evaluation Division of the Iowa Department of Public Instruction. The data were gathered from 83 Iowa school districts to meet state requirements for participation in Title III of the Elementary, Secondary Education Act of 1965. Title III requires that states secure pupil information on a statewide basis in affective as well as cognitive areas. The major focus of the data collection for Title III was to assess the present status of pupils with regard to desired goals and objectives in both cognitive and affective areas.
REVIEW OF LITERATURE

A review of related literature was undertaken in three areas germane to the present investigation: 1) attitude as it relates to achievement; 2) self concept as it relates to achievement; and 3) National Assessment of Educational Progress as it relates to science achievement. The discussion within the review was confined to a limited number of major studies; however, the scope of the review did include an analysis of literature not discussed within this chapter.

Attitude as it Relates to Achievement

A major study of attitude as it relates to achievement was conducted by Anttonen (14). The study involved 607 pupils from suburban schools near St. Paul, Minnesota. Pretests were administered to pupils in the fifth and sixth grades to determine attitude toward arithmetic. The same pupils were retested in grades eleven and twelve with the original instrument in a modified form. In addition to the attitude measures employed, three measures of arithmetic achievement were also used. The arithmetic sub section of the Iowa Tests of Basic Skills (ITBS) was used as a criterion measure for fifth and sixth grade pupils, and at the secondary level, the Quantitative Thinking subscore of the Iowa Tests of Educational Development (ITED) was used as a measure of achievement. Grade point averages were also calculated for mathematics courses taken by those in the sample.

The study sought to answer two basic questions:
1) Is attitude in mathematics related to mathematics achievement?
2) Is there stability of attitude toward mathematics from elementary to secondary school level?
Examination of the relationships between attitude and achievement scores at elementary and secondary levels was done through intercorrelations using Pearson product-moment correlation coefficients.

Arithmetic total scores on ITBS were not included as variables in the intercorrelations, as scores on this measure were expressed in grade equivalent units.

In examining intercorrelations between elementary and secondary mathematics attitude scores and achievement, Anttonen (14) found an overall low positive correlation (.305 \( p > .01 \)). He also found a low positive correlation between elementary attitude scores and Quantitative Thinking scores \( (r=.218, p > .01) \), and between elementary attitude scores and grade point average \( (r=.311, p > .01) \).

Higher correlations were found between secondary attitude scores and Quantitative Thinking scores \( (r=.379, p > .01) \) and between secondary attitude scores and grade point average \( (r=.432, p > .01) \).

The relationship between attitude and achievement was also investigated with regard to grade level and sex. For both grade levels and sexes a low positive correlation was found between elementary and secondary math attitude scores.

In general, Anttonen (14) found consistently low correlations between elementary attitude and achievement measures and only somewhat higher correlations between secondary attitude measures and achievement.

Since low correlations between elementary attitude scores and both elementary and secondary achievement scores were reflected by Anttonen's (14) study, it would appear that a considerable degree of the variation
between cognitive and affective performance is not explained by achievement and attitude alone. Thus, the inclusion of an additional measure would most likely increase the chances of explaining more of this variation.

As self concept has been shown in a number of studies [Wattenberg and Clifford (15), Bodwin (16), and Kurtz and Swenson (17)] to be related to cognitive performance, it would appear that research including this factor would strengthen present knowledge of the relationships between cognitive and affective performance.

In a study recently conducted by Neale et al. (18, p. 232), the following comment was made with regard to the relationship between attitude toward school and achievement.

> Despite a widely held belief that favorable attitudes toward school and school subjects contribute to learning, no substantial body of empirical knowledge has been developed to document such a belief.

On the basis of the above statement, the authors were concerned with investigating three major factors:

1) the correlation between attitudes toward school subjects and school achievement;

2) the role of attitudes in predicting achievement; and

3) the changes in attitudes over time.

The study included a population of 105 boys and 110 girls attending classes in elementary schools near St. Paul, Minnesota. Tests were administered to pupils in eight classrooms during the first week of school. The instruments administered to subjects included:
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1) attitudinal measures of the semantic differential type
   (composed of four subscale scores including social studies,
   science, arithmetic, reading, and an overall composite
   score);

2) Lorge-Thorndike Intelligence Test (Level III); and

3) Science Research Associates Achievement Series.

Analyses employed included the computation of intercorrelations
among variables. Correlation coefficients were computed to predict post-
test achievement scores from pretest intelligence quotients, pretest
achievement, and pretest attitude scores. Separate multiple correlations
were calculated by sex for social studies, science, arithmetic, reading,
and composite achievement scores. A two-way analysis of variance was
also employed to ascertain attitude changes of boys and girls measured on
pre- and posttests. Significance levels used were 0.05 and 0.01 respec-
tively.

Findings of the study by category of purpose are summarized by the
following excerpts (18, pp. 234-235):

Relationship between attitude toward school subjects
and school achievement

1) For boys, attitude and achievement were signifi-
cantly correlated (p>.01) for social studies
(.28), arithmetic (.23, .27), and reading (.27,
.23). For science, attitudes and achievement
correlations bordered on significance (.15, p>.05;
.20, p>.01). Composite attitude and achievement
scores correlated (.24 and .27, p>.05).

2) For girls, attitudes and achievement were signifi-
cantly correlated only for reading (.20, p>.05;
.35, p>.01). In the case of pretest scores this
relationship was sufficient to make the correla-
tion between composite attitude and achievement
significant (.20, p>.05).
Attitude change over time

1) ...separate correlations were computed for each measure of attitude between scores at the beginning and at the end of the year. These correlations ranged from .29 to .56; all were significantly different from zero ($p < .01$).

2) ...girls' attitudes toward school were generally more favorable than boys. In two cases, the "boy subjects" of arithmetic and science, no significant differences were found. In addition, attitudes measured at the end of the year were consistently less positive than attitudes at the beginning of the year regardless of sex. Differences were significant for every stimulus except arithmetic.

A careful analysis of the research reported by Neale et al. (18) indicates a number of concerns regarding methods and procedures employed.

The research reports that attitude measures were administered to subjects during the first week of school. The validity of comparisons made between measures of attitude toward school during the first week of school and measures of attitude toward school at the end of the school year is questionable. Since pupils have spent the summer away from school, their responses may not reflect their true attitude toward school after having been exposed to the school environment for only one week.

The present research employed measures to reduce the area of weakness suggested above. In addition, a number of subscales not investigated by Neale et al. (18) will be a part of the present study. In this manner, it will be possible to investigate attitude toward school in light of factors other than subject matter areas.
Self Concept as it Relates to Achievement

A major study of the relationship between self concept and academic achievement was conducted by Brookover et al. (19). Among hypotheses tested, the following are of importance to the present research (19, pp. 47-48):

1) Self concept of academic ability is associated with academic achievement at each grade level;

2) Changes in self concept of academic ability are associated with parallel changes in academic achievement; and

3) Self concept of academic ability is a necessary but not a sufficient condition for the occurrence of high academic achievement.

Subjects in the study included 307 girls and 255 boys, a total N of 562. The pupils represented a longitudinal sample which was studied over a five year period. Pupils were tested during the fall in seventh grade and during the fall of each succeeding school year through grade twelve.

The first hypothesis was tested using the Pearson product-moment correlation technique. Findings indicated positive correlations between self concept of ability (SCA) and grade point average (GPA) in all grades, and correlations were significant beyond the 0.01 level. In grades seven through eleven the strength of the correlations was greater for boys than for girls. A decrease in the strength of correlations from eleventh to twelfth grade was indicated in the combined correlation coefficient. However, most of this decrease was due to the reduced size of the correlation coefficient for boys. In summary, the relationship between cognitive and affective measures tended to be positive and relatively stable for both boys and girls with the one exception for boys which indicated a decrease from eleventh to twelfth grade.
In testing the hypothesis that change in self concept of academic ability is associated with a parallel change in academic achievement, measures of self concept of academic ability and grade point averages were obtained over one and two year periods. To control for regression effects, only pupils in the middle two stanines on both variables were included in testing the hypothesis.

Tests of the hypothesis were made in two ways. First, Chi Square tests were made to determine whether observed scores were significantly greater than expected scores. In all but three instances, from grade eight to grade nine, from grade nine to grade ten, and from grade eleven to grade twelve, observed scores were significantly greater than expected scores at the 0.05 significance level. It was also observed that changes were greater over two year time periods than for one year time periods.

An additional test of the same hypothesis was made by reviewing monotonic trends. In three of four tests the cognitive measure of grade point average was found to fit the hypothesized descending monotonic trend which was calculated from the affective measure of self concept of ability patterns. Based on these two tests of the hypothesis, it was concluded that changes in self concept of ability were associated with parallel changes in grade point average.

The third hypothesis stated that self concept of academic ability is a necessary but not a sufficient condition for the occurrence of academic achievement. To test this hypothesis, Brookover et al. (19) grouped pupils in the longitudinal population accordingly into two categories of self concept, high and low, and into two categories of grade point average, high and low. Two sets of stanines were used for the
analysis. Findings regarding the third hypothesis are summarized below (19, p. 95):

In summary, only rarely did a student have a low self concept of academic ability in the fall and high academic grades at the end of the semester. On the other hand, a large proportion of students who scored high on SCA had comparatively low GPA scores. The necessary but not sufficient relationship of SCA to GPA is therefore supported by this analysis.

In reviewing the research methodology, it appears that the concept of randomness with reference to selection of subjects was weakened. Evidence of this appears in the criteria used to select pupils eligible to be drawn as members of the sample population. Pupils excluded from the population from which the sample was drawn included: 1) those for whom questionnaire data were not available for the complete five year period; 2) pupils who were not promoted regularly from grades four through twelve; and 3) pupils who were classified as non-Caucasian.

In addition, the self concept of ability measure was administered to pupils during the fall of each succeeding school year from 1961 to 1965. On the basis of the author's own admission, there is a strong probability that measures of self concept of ability taken during the first part of the school year could differ significantly from measures taken later in the year.

Brookover et al. (19, pp. 45-46), in discussing objectives and hypotheses of the research, make the following statements:

The major objective of the longitudinal research was predicated upon the proposition that students' self concept of academic ability results from their
perceptions of the evaluations significant others hold of their ability.

...the relationship of perceived evaluations of significant others to self concept is conceptualized as a necessary and sufficient condition, i.e., if the student's significant others change in their evaluations of the student's ability, this change will be reflected in the student's self-evaluation of ability. A change in the former will be reflected in a change in the latter.

With the basis for the longitudinal study resting upon the proposition previously expressed, it would seem that obtaining measures of self concept of ability in the fall would seriously limit the input of evaluations from significant others in the school setting. Therefore, if, as the authors contend, significant others change in their evaluations of a pupil's ability, this change will be reflected in the pupil's self concept of ability. It follows, then, if measures of pupil self concept of ability are secured early in the school year and prior to major formal evaluations from teachers, the probability of gaining an accurate measure of a pupil's self concept of ability is seriously decreased.

An investigation by Bledsoe and Garrison (20) was conducted to examine the relationships among self concept, academic achievement, and other selected variables. The population from which the sample was drawn included 18 schools in Clarke County, Georgia. From these 18 schools, four schools believed to constitute a representative cross section were drawn. All pupils in grades four and six, present in these schools on a specific day, were tested.

The investigation was guided by the following hypotheses (20, p. 3):

1) The self concepts of fourth grade boys are similar to those of sixth grade boys.
2) The self concepts of fourth grade girls are similar to those of sixth grade girls.

3) The self concepts of fourth grade boys are similar to those of fourth grade girls.

4) The self concepts of sixth grade boys are similar to those of sixth grade girls.

5) There is no significant relationship between measures of the self concept and measures of academic achievement among fourth and sixth grade pupils.

6) The correlations between self concepts and achievement variables of fourth grade boys are not significantly different from the correlations of these variables for fourth grade girls.

7) The correlations between self concepts and achievement variables of sixth grade boys are not significantly different from the correlations of these variables for sixth grade girls.

In testing hypotheses one and two, it was concluded that although self concepts of both boys and girls were lower for fourth grade than for sixth grade, differences within sexes were not significant and, therefore, these hypotheses could not be rejected. Upon investigation of differences between sexes in self concept scores, Bledsoe and Garrison (20) found that both fourth and sixth grade boys had significantly lower self concepts than their counterparts. Therefore, hypotheses three and four, relating to differences between sexes, were rejected.

The hypotheses of no significant relationship between measures of self concept and measures of academic achievement were tested using Pearson product-moment correlation techniques. Findings for fourth grade boys indicated a correlation between self concept and selected achievement variables which was significantly greater than zero for reading vocabulary, reading comprehension, arithmetic reasoning, arithmetic fundamentals,
English, and total achievement battery scores. Spelling was the only achievement variable for which the correlation with self concept was not significantly greater than zero. On the other hand, for fourth grade girls, the only achievement variable found to be significantly related to self concept was reading comprehension.

Findings for sixth grade pupils were quite similar to findings for fourth grade pupils in terms of differences between sexes. For example, all variables of achievement for boys were found to be significantly related to self concept. For girls, at this level, none of the achievement variables were found to be significantly correlated with self concept.

In administering tests to pupils, Bledsoe and Garrison (20, pp. 46-48) reported that:

The classroom teacher of the groups remained in the classroom and assisted in passing out and collecting the tests and in helping pupils faced with special problems connected with taking the tests.

The fact that a pupil's teacher was present in the same room when he was responding to questions relating to his self concept throws some suspicion on the validity of responses given by the pupil. Since the teacher was present at the time of testing, a strong probability exists that a pupil could be influenced in his response to a particular item. This possible source of invalidity can be controlled by simply having the tests administered to pupils in the absence of classroom teachers and building administrators. Such a precaution was taken in the present research.

Caplin (9) studied 180 subjects in grades four, five, and six from five elementary schools in New Jersey. Subjects were matched within grade
levels on sex, intelligence, and socio-economic level. Four hypotheses were investigated and two of the four are germane to the present research.

It was hypothesized that there was a significant positive relationship between self concept and academic achievement. In addition, it was hypothesized that there was a significant positive relationship between level of aspiration and academic achievement.

Data were gathered using a fifty-item self-report instrument to measure self concept and level of aspiration. Composite scores on the **Iowa Tests of Basic Skills** (ITBS) were also secured. Scores on the two measures were treated with correlation procedures and findings indicated a significant correlation at or beyond the 0.001 level of significance for each of three relationships. The first relationship was between composite scores on ITBS and overall self concept scores. The correlation coefficient reported for this relationship was .52. The other two relationships were between ITBS composite scores and scores on the school-related subsection of the self concept measure and between ITBS composite scores and scores on the personal/social subsection of the self concept measure. Correlation coefficients reported were .58 and .45 respectively.

Caplin (9) also found composite scores on ITBS and level of aspiration scores to be significantly correlated beyond the 0.001 level of significance and reported a correlation coefficient of .61.

Subjects included in Caplin's (9) sample were drawn from a population reported to represent a lower socio-economic group. While this is not a serious limitation, it does not allow generalizations to be made to
other socio-economic groups. This, however, will be possible in the present research since a range of socio-economic levels will be represented.

Perhaps the most serious limitation of Caplin's (9) research occurs in his measurement of self concept. Caplin (9, p. 30) reports that classroom teachers administered the self concept measure to subjects.

When the instrument in this study was administered, the confidential nature of all replies was stressed by the teachers.

...the teacher also read the sentences aloud to the class, and answered any questions privately that the pupils had in relation to the meaning of any item.

The basic assumption apparently made by Caplin (9) was that the presence of the teacher during the administration of the instrument and his subsequent interaction with pupils in explaining items in the instrument did not significantly influence the subjects' responses. The validity of this assumption is questionable in light of previous findings concerning influences of teacher behavior on pupil behavior.

In addition, no mention is made by Caplin (9) as to whether subjects responded anonymously. It would appear if anonymity were not maintained that a further source of invalidity in measuring self concept might exist.

Since there is a probability that both teacher administration of instruments and non-anonymity of subjects could act to influence measures of self concept, procedures used in the present research controlled for these possible sources of invalidity.
National Assessment of Educational Progress

National Assessment of Educational Progress (NAEP) had its official beginning in 1964 with the establishment of the Exploratory Committee for Assessing the Progress of Education (ECAPE). The committee was appointed by Francis Keppel, then Commissioner of Education. The basic purpose in establishing ECAPE was to determine the feasibility of assessing the educational progress of Americans.

Ten areas were included in the plan developed by ECAPE. These areas were: reading; science; mathematics; social studies; citizenship; art; literature; career and occupational development; handwriting; and music. Three of the ten areas, science, reading, and mathematics, were to be assessed every three years, while the other seven areas were to be assessed only every six years.

Exercises included in the assessment were based on objectives formulated for each of the ten subject matter areas (21, Appendix A, p. 2).

The educational objectives for all ten subject matter areas were developed with the intention that they must be: 1) Considered important by scholars in the area; 2) Accepted as an educational task by schools; and 3) Regarded as desirable by thoughtful lay citizens.

The development of each set of objectives involved participation by numerous groups across the nation. The science objectives were developed under contract by Educational Testing Service (ETS) and were validated by eleven panels of educators and citizens.

The four major objectives defined for science were (21, Appendix A, p. 2):
1) Know fundamental facts and principles of science;
2) Possess the abilities and skills needed to engage in the process of science;
3) Understand the investigative nature of science; and
4) Have attitudes about the appreciations of scientists, science, and the consequences that stem from adequate understandings.

Based upon these four major objectives, science exercises were subsequently developed by ETS (21, Appendix A, p. 3).

Exercise writers were told to develop exercises:
1) that sample some important knowledge, skill, or attitude;
2) in whatever form or mode seemed most appropriate to the assessment of a particular objective; and
3) that call for knowledge and skills of varying difficulty, some of which almost everyone has acquired, some of which only about half have acquired, and some which only the most able are expected to do.

The sampling procedures for National Assessment were developed by Research Triangle Institute. The sample was stratified on the basis of geographic region, size of community, type of community, age, race, parent's educational level, and sex. Four age levels were selected for inclusion in the sample: nine-year-olds; thirteen-year-olds; seventeen-year-olds; and young adults between the ages of 26 and 35. Approximately 28,000 people in each of the three younger age groups and about 10,000 young adults were tested.

Results of the NAEP in the area of science, based on data released thus far, have been aptly summarized by Williamson (22, pp. 44-48).
The Assessment program does reveal the gradual general development of science concepts by 9, 13, 17 year olds, and young adults. In general, there is gradual progression in the understanding of concepts for 9, 13, and 17 year olds, but a leveling-off for adults.

The data gathered from the science exercises show what different age groups know and can do, their information and misinformation. The overlap exercises (ages 9-17) reveal about what one would expect. The general drop between 17 year olds and young adults reveals that from these exercises the curve of forgetting is quite steep and there exists a low degree of permanence in science taught, especially factual information. This is especially true of exercises in the physical sciences using quantitative measures.

1. 9 year olds (most 95-75%; many 75-35%; and few 34-4%)

While science at this age level is about equally distributed between the biological and physical sciences, the Assessment exercises are distributed 21 biological and 39 physical. Nine of the 21 biological were answered by a majority of the students and only 14 of those in the physical sciences area. Twenty-five were correctly answered (biological and physical) by most children and only three (all physical) by a few children.

2. 13 year olds (most 95-75%; many 74-35%; few 34-4%)

Assessment exercises were distributed as follows: 17 in biological sciences and 29 in the physical sciences. Eight of the biological questions were answered correctly by most of the pupils (approximately half) while only six of the questions in physical sciences were answered correctly by most of the students.

3. 17 year olds (most 95-75%; many 74-35%; few 34-4%)

Fifty-two exercises were included in the Assessment at this age level... 14 exercises were from the biological sciences and 34 from the physical sciences. In this age group two
of the biology exercises were correctly answered by most of the students, and six from the physical sciences.

4. Adults (most 95-75%; many 74-35%; few 34-4%)

Fifty exercises were included in the Assessment... 25 exercises are from the biological sciences and 25 from the physical sciences. Only eight exercises were answered by most of the participants (five biological and three physical). The remainder of the exercises were about equal in difficulty. Adults tended to do poorly on factual information exercises and excelled on those related to experience.

When NAEP science exercises are viewed within the framework of the taxonomy developed by Krathwohl et al. (2), the limitation of the assessment's comprehensiveness becomes obvious. From a careful review of the basic objectives prepared to guide the development of science exercises, it seems apparent that the emphasis for NAEP was primarily directed toward assessing cognitive behavior. Hence, affective aspects of science as well as other subject matter areas included in the assessment appear to have been deemphasized and an overemphasis placed on cognitive aspects. A similar view is expressed by Findley (23, p. 9).

One issue that is inevitably raised by such an assessment is whether the emphasis on measurable cognitive outcomes does not in itself give these outcomes an emphasis out of proportion in the total program of the schools.

The apparent lack of emphasis on investigating a broader scope of affective behavior as it relates to cognitive behavior may be remedied somewhat by certain aspects of the present study. Two major areas of the affective domain, self concept and attitude toward school, were
investigated. In addition, relationships between science achievement and the two affective measures were also examined. In this respect the research to be undertaken should provide a more complete understanding, as it is concerned with the additional dimension of affective behavior. This should also provide further implications for schools, since a number of the subscales which compose the two affective measures relate to institutional variables, such as school environment, organizational structure, and mode of instruction. These variables can then be examined in relation to cognitive behavior.

In addition, the present research will provide baseline data for a comprehensive overview of pupil progress in science in Iowa public schools. Findings then will be more useful in making generalizations about Iowa's progress than would otherwise be possible if only data from two Iowa schools were available, as is presently the case.

In summary, results of the NAEP indicate a consistent growth in the development of science skills and knowledge. Trends, however, indicate that this growth levels off after grade twelve. Pupils were found to possess a greater amount of factual information, while adults tended to excel in general knowledge.

Summary

In light of the preceding review of related literature, there appear to be consistent low positive correlations between attitude and achievement. Most correlation coefficients ranged from .20 to .40. The coefficients were generally higher for girls than for boys. In addition,
relationships between attitude and achievement were slightly higher for pupils at the secondary level than at the elementary level.

Studies designed to measure pupil attitude toward school have generally been rather limited in terms of sample size. In addition, attitude measurement has, for the most part, centered on measuring attitudes toward school in general and toward specific subject matter areas. The present research is less restricted in terms of sample size and in terms of the scope of attitudinal areas of investigation.

Although positive relationships between attitude and achievement have been found in a number of studies, conclusive evidence concerning the nature of this relationship, implies Krathwohl et al. (2), has not yet been accumulated.

Studies of self concept, on the other hand, have generally been limited to the secondary school levels. Relatively little investigation, notes Caplin (12), has been undertaken at the junior high and elementary school levels. Furthermore, these studies, too, have been rather limited in terms of sample size, thus restricting the extent of external validity. Additionally, few studies which have investigated self concepts have also studied attitude and achievement and interrelationships which might exist.

The literature indicates the existence of positive correlations between self concept and achievement. This relationship tends to remain relatively stable as pupils progress in school. Boys generally possess lower self concepts than girls, while few differences exist within sexes.

Rarely were pupils with low self concepts high achievers, although many pupils with high self concepts were found to be low achievers.
Evidence also seemed to indicate a tendency for changes in self concept to accompany changes in achievement.

Although a number of studies have indicated positive relationships between achievement and attitude toward school and between achievement and self concept, relatively little information directly applicable to school settings has been derived from a knowledge of such a relationship. This is primarily because there are numerous factors which are thought to compose attitude toward school and self concept.

A strength of the present research lies in the separate analysis of relationships between achievement and attitude toward school and between achievement and self concept through comparisons of subscales scores on attitude toward school and self concept with achievement. This permits an investigation into a number of factors composing attitude toward school and self concept to determine which correlate most highly with achievement. Information of this type would then allow local schools to focus their emphasis for improving pupil attitudes and self concepts by dealing with those factors shown to be most directly related to attitude and self concept.
METHODS AND PROCEDURES

Instrumentation

In consideration of appropriate affective instruments to employ in the research, a review of pertinent literature was completed. The two attitudinal areas under investigation were attitude toward school and self concept. Since the term self concept is generally defined in the literature as a person's attitude toward self, it is thus appropriately treated as an attitudinal measure along with attitude toward school.

There are a number of factors of importance when consideration is given to the selection of appropriate instrumentation designed to measure attitude and attitude-related characteristics.

Oppenheim (24) suggests five factors of concern in the development of attitude or attitude-related scales; unidimensionability, linearity and equal or equal appearing intervals, reliability, validity, and reproducibility. For these five factors the following definitions are offered (24):

1) Unidimensionability refers to a scale measuring one thing at a time as exclusive of other factors as possible.
2) Linearity and equal or equal appearing intervals refers to scales following a straight-line concept with a scoring system based on interchangeable units.
3) Reliability refers to scales measuring in a consistent manner.
4) Validity refers to scales measuring what they purport to measure.
5) Reproducibility refers to the quality or the degree of preciseness that can be obtained in placing an attitude on a continuum.
in relatively the same position each time the attitude is measured.

With these factors in mind, Oppenheim (24) discusses the three major types of attitudinal measures developed by Likert, Guttman, and Thurstone. In discussing these types of measures, Oppenheim (24) indicates a number of advantages and disadvantages for each.

Of the Likert-type scales, Oppenheim (24) states if the chief concern of the researcher is to study attitude-patterning the Likert procedure is quite relevant. The Likert-type scales, according to Oppenheim (24), correlate well with Thurstone-type scales. The major emphasis in developing attitudinal measures of the Likert variety is that of unidimensionability. The Likert scales call for the development of an attitudinal continuum, generally ranging from strongly agree to strongly disagree and responses are weighted most often from 5 to 1. Unlike the Thurstone scales, the items within Likert-type scales have no definite scaled values, but instead are equally weighted.

In summary, Oppenheim (24, p. 141) states that:

...the Likert scales tend to perform very well when it comes to a reliable, rough ordering of people with regard to a particular attitude. Apart from their relative ease of construction, these scales have two other advantages: first, they provide more precise information about the respondent's degree of agreement and disagreement... Second, it becomes possible to include items whose manifest content is not obviously related to the attitude in question so that the subtle and deeper ramifications of an attitude can be explored.

Thurstone scales, relates Oppenheim (24), concentrate on dealing with the problem of equal or equal appearing intervals. Such scales are
devised by comparing pairs of attitude statements using panels of judges and subsequently deriving a scale value for each item within the attitude measuring instrument. Oppenheim (24) points out that such a method, called the paired-comparisons technique, becomes extremely difficult when more than 15 or 20 items are involved.

The third major type of attitudinal scale, the Guttman scale, also referred to as scalogram analysis, is chiefly concerned with unidimensionality and reproducibility. The procedure of scalogram analysis, states Oppenheim (24), is designed to depict how subjects' responses deviate from an ideal scale pattern. Guttman scales, indicates Oppenheim (24), are very useful when research is designed to examine small changes or shifts in attitude.

It would appear from an analysis of Oppenheim's (24) treatment of the three major types of attitudinal scales and from other related readings that the Likert-type attitudinal scales seem most appropriate for this research and also tend to be as reliable and as valid as other types of attitudinal scales. The difficulty in making a determination as to which of the several types of attitudinal scales most fully satisfies the five factors of unidimensionability, linearity and equal or equal appearing intervals, reliability, validity, and reproducibility earlier discussed is supported by the following statement from Oppenheim (24, p. 123):

It follows that, for the present, it is impossible to say which method is best. Each has important desirable features, but each of them is also open to criticism. For our own inquiry, the best method is the one which is most appropriate to our particular problem.
Examination of measuring instruments

The three instruments employed in the research represent a type of measurement which differs from traditional norm-referenced approaches. They are designed to assess relative levels of pupil performance and degrees of positive attitudes toward school and self.

The NAEP science exercises were designed so that one-third of the items for a given grade level represented the educational performance level of the low achievers, one-third represented the performance level of the middle achievers and one-third the level of the high achievers. The emphasis on measurement was not to produce variant scores as is the traditional approach when standardized norm-referenced measures are used, but instead was to determine what pupils could do.

The affective measures also were developed with the intent of assessing relative levels of pupil attitude toward school and self rather than to determine pupil status in reference to a norm group.

Both cognitive as well as affective measures used in the research were selected for their appropriateness in assessing the present status of pupils with respect to certain desired characteristics. The advantages of a criterion-referenced approach to measurement are discussed by Popham (25, pp. 2-3):

Through the years educators have been inclined to use standardized achievement tests for determining the learners' current abilities. Recent advances in measurement circles, however, suggest the thorough inappropriateness of using typical standardized tests for such assessments. The unsuitability of such tests rests upon a basic distinction between norm-referenced and criterion-referenced approaches to measurement. A standardized test is, generally, a norm-referenced test and is designed primarily to
identify an individual's status with respect to a norm group, that is, other individuals who have completed the same test. Because of the necessity to produce variant scores, scores which permit comparisons among individuals, standardized tests are often unable to represent the complete range of learner behavior which we need to know about.

Criterion-referenced tests, on the other hand, are designed to measure a learner's status with respect to a specified performance standard and, as such, are more suitable for purposes of needs assessment.

In view of previously discussed considerations of various types of attitude scales, a Likert-type scale was selected to carry out the present research. The Self Appraisal Inventory, designed to measure self concepts, and the School Sentiment Index, designed to measure attitudes toward school, were subsequently chosen as appropriate Likert-type measures. The subscales contained within each of the two measures should allow for a number of meaningful and practical applications to local school situations. In addition, these same measures are being used in a number of other states in measuring attitudes and self concepts of pupils. Therefore, use of these measures allows for valid comparisons among states.

Field tests were run on 3,000–4,000 pupils by developers of the two measures, but at the time of this writing no information concerning the measures' reliability was available. On the basis of this, it was decided to determine the reliability of the measures by using a technique which would yield inter-item correlation coefficients for items within each subscale of the two measures. The results of this analysis is examined in Chapter IV.
The NAEP measures were analyzed using Flanagan Discrimination Indices. Results of this analysis are also examined in Chapter IV.

Instrumentation employed in the research can be categorized into three areas: self concept measures, attitude toward school measures, and science achievement measures. A discussion of each follows.

**Self concept measures**

Under an 18 state compact, Instructional Objectives Exchange (IOX), under the direction of W. James Popham at the University of California at Los Angeles, was contracted to develop an instrument which could be used to assess self concepts of groups of pupils.

The approach used by IOX to develop these measures was predominantly a criterion-referenced measurement approach in which objectives are clearly stated and measures are devised to assess the attainment of objectives. Separate measures were devised for intermediate and secondary grade levels to control for differences in reading abilities.

The intermediate grade level measure, Self Appraisal Inventory Intermediate Level (Appendix A), consists of 80 statements to which pupils responded either true or false. The inventory is composed of four separate subscales: general, family, peer group, and scholastic. Therefore, scores on any of the four subscale measures can be obtained as a single measure or subscale scores can be combined for a composite self concept score.

The secondary grade level measure, Self Appraisal Inventory Secondary Level (Appendix B), also consists of 80 statements. Pupils indicate their responses to the statements according to the following scale: a) strongly
agree; b) agree; c) disagree; and d) strongly disagree. The subscale composition is identical to the intermediate level instrument.

**Attitude toward school measures**

The attitude toward school instruments were also developed by IOX. The approach used to develop these measures was similar to that used to develop the two self concept measures.

Two separate measures were developed, one to assess attitude toward school of intermediate grade pupils and the other to assess attitude toward school of secondary school pupils. The intermediate measure, School Sentiment Index Intermediate Level (Appendix C), consists of 75 items to which pupils respond either true or false. Subscales which compose the measure include teachers, learning, school social structure, peer group, and general.

The secondary measure, School Sentiment Index Secondary Level (Appendix D), is composed of 83 items to which pupils respond by marking one of the following four responses: a) strongly agree; b) agree; c) disagree; and d) strongly disagree. Subscales which compose this measure are identical to those for the School Sentiment Index Intermediate Level.

**NAEP science measures**

The three NAEP measures (Appendices E-G) are composed of science items that have been released by NAEP. These items are representative of the total package of science items used by NAEP. All items released thus far were included except those involving the manipulation of apparatus.

For grade four a total of 58 exercises were used, 44 were used for grade seven, and 50 for grade twelve.
Pupils responded to each item by circling one of three, four, five, or six responses. Each question included an "I don't know" response to reduce the likelihood of guessing.

**Administration of Instruments**

Administration of instruments to pupils was standardized by taping all instructions. All questions as well as responses on the NAEP instrument were taped and played to pupils in groups of approximately 12. Pupils responded by marking answers directly in the exercise booklets. This was done to control for possible transformation errors.

The four affective instruments, School Sentiment Index Intermediate Level, School Sentiment Index Secondary Level, Self Appraisal Inventory Intermediate Level, and Self Appraisal Inventory Secondary Level, were administered prior to the NAEP science exercises to control for any negative feelings which may have been induced by pupils' inability to respond to science items.

Directions for the affective measures were given on tape but items within the measures were read silently by pupils to instill a greater feeling of confidentiality of responses.

A pilot study was conducted to identify problems in administration which might have resulted from use of the taped measures or from the format of the exercise booklets. Thirty pupils from a total of three grade levels, four, seven, and twelve, were administered the measures in three two-hour sessions. At the end of each exercise session, pupils were engaged in discussion to assess their reactions to such factors as pacing.
of the questions, clarity of instructions, marking of responses, and length of sessions.

In compiling pupil reactions from each of three discussion sessions, and auditing exercise booklets, no problems related to the measures or methods used to administer the measures were noted.

Exercises were administered to pupils in April by specially trained proctors. Testing sessions were held outside pupils' regular classrooms and in the absence of classroom teachers and building administrators. Pupils also responded anonymously to each of the three measures.

Sample Design

The population for this sample consisted of all full-time pupils enrolled in the public schools of Iowa in grades four, seven, and twelve. The population excluded special education students and private school students attending public schools on a shared-time basis.

To test hypotheses of the research, a stratified, multi-stage, cluster sample of pupils was selected.

In designing the sample, three zones were delineated, an urban zone, a suburban zone, and the remainder of the state.

The urban zone consisted of school districts within the seven Iowa cities having a population of 50,000 or more. These were Cedar Rapids, Council Bluffs, Davenport, Des Moines, Dubuque, Sioux City, and Waterloo. Within this zone, each city was sampled independently. Thus, for sampling purposes, each constituted a separate stratum.

The suburban zone consisted generally of the school districts located within the metropolitan areas associated with the seven cities in
the urban zone except that only the western halves of Pottawattamie and Woodbury counties were included in the suburban zones for Council Bluffs and Sioux City. Within this zone, a sample of schools was selected. The entire zone constituted a single stratum.

The remainder of the state was divided into five geographical areas formed by combining adjacent Area Vocational School Districts as follows:

1) Northeast, consisting of districts I, II, and VII;
2) Northwest, consisting of districts III, IV, V, XII, and Cherokee county currently not assigned to any district;
3) Central, consisting of districts VI and XI;
4) Southwest and Southern, consisting of districts XIII, XIV, and XV; and
5) Southeast, consisting of districts IX, X, and XVI.

A sample of schools was selected independently from each geographic area, each area constituting a separate stratum. Thus, for sampling purposes, 13 strata were defined. (Appendix H)

According to data supplied by the Iowa State Department of Public Instruction, the total enrollment of black pupils in both public and non-public schools during the 1969-70 school year was 10,196. A total of 8,607 or 84.4 percent of these pupils were concentrated in the seven largest cities. Consequently, it was decided to limit the comparisons between black and non-black pupils to these cities.

The plan was to select a basic sample from all pupils in Iowa public schools excluding the black pupils in these seven cities and to select a special sample (at a much higher rate) from the group excluded from the basic sample. Comparisons would then be made between the special sample
of black pupils and that portion of the basic sample taken from the same seven cities. Later, this plan was modified by dropping Dubuque and Council Bluffs from the special sample. Dubuque had almost no black pupils and Council Bluffs had very few.

In consultation with A. J. Netusil, Professor of Educational Statistics, Iowa State University; R. D. Hickman, Professor of Statistics, Iowa State University; and H. D. Baker, Professor of Statistics, Iowa State University; the sampling rates were established. The sampling rates, for the special sample, were set at each grade level to yield a total of approximately 100 pupils. These rates were 1 out of 4, 1 out of 5.5, and 1 out of 7 for grades twelve, seven, and four respectively. The data used to set the rates were slightly out-of-date and did not give the black enrollment by grade level; consequently, the actual numbers of names drawn in the special sample were 89 for grade twelve, 108 for grade seven, and 116 for grade four.

The sampling rates, for the basic sample, were set at each grade level to yield a total of about 1,000 pupils. The rates were set at 1 out of 46, 1 out of 48, and 1 out of 49 in grades twelve, seven, and four respectively. These rates were based on data from the 1969-70 school year.

Within a stratum, the sample was selected in stages. The number of stages depended upon the stratum and the amount of information available. At the most, four stages were used. First, school districts were selected within stratum (except in the seven largest districts where each district constituted a stratum). This was done by ordering the districts by size in terms of total 1969-70 enrollment figures and selecting a sample in a
systematic manner, thus assuring a representation of districts of different sizes. Within a sample school district, a particular building or attendance center was selected; within the sample building or attendance center, a particular section, class or homeroom was drawn; and, finally, within the section, individual pupils were selected. At each stage, down to the last one, selection was made with probability proportional to size in terms of enrollment or estimated enrollment. At the final stage (pupils within class) selection was made at random with equal probability.

This procedure provided a sample with roughly equal numbers of pupils in each sample group yet with the probability of selection being the same for each pupil in the universe regardless of the size of a pupil's high school district, class, or homeroom. Pupils were selected in clusters not only to conserve field costs by reducing the number of school districts to be visited by test proctors but also because the testing procedures were better suited to group administration.

The criterion earlier established by NAEP procedures called for limiting the size of groups to 12. Since the group sizes could not be controlled completely while still maintaining uniform overall sampling rates, the expected group size was set at 10 in anticipation that few groups would exceed 12 when the sample was drawn. Thus, in order to obtain 1,000 pupils, 100 groups were needed at each grade level. In grade twelve, five groups exceeded the criterion of 12 pupils; four containing 13 each, and one containing 17 (the latter being in a school district having an unusually high twelfth grade enrollment relative to the total enrollment in the district). In grades seven and four, no group
exceeded 13 pupils. Grade seven had four groups of 13 each, and grade
four had five groups of 13 each.

Test proctors were provided with lists of the names of pupils com-
prising each sample group. Substitute names were also provided to help
reduce attrition rates where pupils might be absent or otherwise unable
to participate on the scheduled testing date. Generally, two male and
two female names were provided with instructions to substitute within sex.
When substitutes were exhausted within a given sex, no further substitu-
tion was made.

Treatment of Data

All pupil responses were punched onto IBM cards and each card was
verified and edited for valid responses. Cards were then read onto tape
for processing.

Data were treated using correlation techniques and t tests.

Estimation

Since in the basic sample every pupil had the same chance of being
selected, the sample was self-weighting. That is, estimates of popula-
tion means for the population represented by this sample can be obtained
directly from the corresponding sample means without having to apply any
weighting factors. Estimates of population totals can be obtained by
multiplying the sample totals by the inverse of the sampling fraction.
The same is true for the special sample of black pupils selected from the
five largest cities. However, since the sampling rates for the special
sample differ considerably from the corresponding rates for the basic
sample, estimates of population parameters for the combined universe
represented by these samples (all public school pupils in Iowa in grades
twelve, seven, or four) require weighting, let:\[f_1 = \text{inverse of sampling fraction, basic sample (46 for grade twelve, 48 for grade seven, and 49 for grade four).}\]
\[y_1 = \text{sample total, basic sample.}\]
\[n_1 = \text{number of pupils tested, basic sample.}\]
\[f_2 = \text{inverse of sampling fraction, special sample of black pupils (4 for grade twelve, 5.5 for grade seven, and 7 for grade four).}\]
\[y_2 = \text{sample total, special sample.}\]
\[n_2 = \text{number of pupils tested, special sample.}\]

Then estimates of sub-population means ($\hat{Y}_1$, $\hat{Y}_2$) are obtained by:

1) $\hat{Y}_1 = \frac{y_1}{n_1}$

2) $\hat{Y}_2 = \frac{y_2}{n_2}$

Estimates of sub-population totals ($\hat{Y}_1$, $\hat{Y}_2$) are obtained by:

2) $\hat{Y}_1 = f_1y_1$

3) $\hat{Y}_2 = f_2y_2$

Estimates of totals for the entire universe of all public school pupils in the selected grade level are obtained by adding the estimates of the totals for the two sub-universes. Thus:

3) $\hat{Y} = \hat{Y}_1 + \hat{Y}_2 = f_1y_1 + f_2y_2$.

The researcher is indebted to H. D. Baker and R. D. Hickman for the development of these equations.
Finally, estimates of means for the entire universe are obtained by dividing the estimated total for the $y$ characteristic by the corresponding estimated number of pupils in the universe. Thus:

$$\frac{\sum y}{N} = \frac{\sum y}{\sum n}$$

where $N = f_1 n_1 + f_2 n_2$. 
FINDINGS

The findings reported in this chapter are organized as follows:
1) overview; 2) description of sample; 3) measuring instruments; 4) science achievement and self concept; and 5) science achievement and attitude.

Overview

Tables 1 through 7 are used to describe the sample, while Tables 24 through 30, Appendices I and J, relate to measuring instruments. Decisions concerning the null hypotheses tested in this research are presented in Tables 8 through 23. Tables 8 through 15 present findings associated with the relationship between science achievement and self concept. Tables 16 through 23 summarize findings associated with the relationship between science achievement and attitude toward school.

Tabled values of t, r, and Zr, used in calculations, are reported in Popham (25).

The formula for computing correlation coefficients is also reported in Popham (25, p. 88).

Confidence intervals were calculated using the formula for confidence intervals suggested by Popham (25, p. 92). When confidence intervals are established, overlap between intervals representing different classifications indicates that significant differences do not exist. If, however, confidence intervals do not overlap, significant differences are said to exist.

To test for significant differences between means, the separate variance t test, reported in Popham (25, p. 145), was used. In cases where calculated t values exceed the averaged tabled values of t for n1-1 and
\( n_2 - 1 \) degrees of freedom at the .05 significance level, significant differences are said to exist.

Description of Sample

Percentage breakdowns for the sample population by sex, race, grade level, and parent education level are reported in Table 1.

Table 1. Percent of sample by sex, race, grade level, and parent education level

<table>
<thead>
<tr>
<th>Sex</th>
<th>N</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>1619</td>
<td>51.2</td>
</tr>
<tr>
<td>Girls</td>
<td>1543</td>
<td>48.8</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>279</td>
<td>8.8</td>
</tr>
<tr>
<td>Non-black</td>
<td>2883</td>
<td>91.2</td>
</tr>
<tr>
<td>Grade level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1105</td>
<td>34.9</td>
</tr>
<tr>
<td>7</td>
<td>1099</td>
<td>34.8</td>
</tr>
<tr>
<td>12</td>
<td>958</td>
<td>30.3</td>
</tr>
<tr>
<td>Parent education level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 8th grade</td>
<td>43</td>
<td>1.4</td>
</tr>
<tr>
<td>More than 8th grade but less than high school</td>
<td>319</td>
<td>10.1</td>
</tr>
<tr>
<td>High school graduate</td>
<td>1350</td>
<td>42.7</td>
</tr>
<tr>
<td>Beyond high school</td>
<td>1450</td>
<td>45.8</td>
</tr>
</tbody>
</table>
It can be noted that some discrepancy exists between expected sample size reported in Chapter III and actual sample totals given in Table 1. This is due primarily to three factors: 1) sampling rates were set based upon figures reported for the beginning of the school year; 2) pupil information loss due to inappropriate pupil responses; and 3) pupil information loss due to pupil absences from test sessions.

Table 2 exhibits science achievement means and standard deviations for grades four, seven, and twelve. Means and standard deviations for science achievement scores are given when pupils are classified according to parent education level, race, and sex.

In Table 3, means and standard deviations for attitude toward school scores are given by grade levels (and within grade levels when pupils are categorized by parent education level, race, and sex). Means and standard deviations for attitude toward school subscale scores are also given for pupils within each of the three grade levels investigated.

Table 4 lists self concept means and standard deviations for pupils in grades four, seven, and twelve. These are also given within grade levels when pupils are categorized by parent education level, race, and sex. Additionally, means and standard deviations for self concept subscale scores are given for all three grade levels.

Tables 5 through 7 contain t values for comparisons of means. Table 5 indicates t values for comparisons of science achievement means within grade levels by parent education level, race, and sex. Table 6 presents t values for comparisons of self concept means within grade levels by
parent education level, race, and sex. Table 7 reveals t values for com­
parisons of attitude toward school means within grade levels by parent 
education level, race, and sex.

Measuring Instruments

A representative sample of results for the inter-item correlations 
within each of the subscales in the School Sentiment Index and the Self 
Appraisal Inventory is given in Appendix I. In general, the correlation 
coefficients indicate low positive correlations. This, however, is not 
surprising since items composing criterion-referenced measures are not 
selected on the basis of their correlation with other test items designed 
to measure a particular characteristic, but instead are selected because 
of their correlation with the criterion measure. Therefore, items within 
the same subscales, although correlated with the criterion measure, may 
not be highly correlated with other items in the subscale. This phenome­
on is characteristic of criterion-referenced measures (26, pp. 245-246).

Should the items in the final test correlate highly 
with one another? According to the criterion-oriented 
approach, the answer is "no." This conclusion follows 
from the logic of multiple correlation.

...of a number of variables each correlate posi­
tively with a criterion, the multiple correlation is 
higher when the predictors correlate as little as pos­
sible with one another. The maximum multiple correla­
tion would be obtained when the predictors had zero 
correlations with one another.

The same logic would hold for a linear combination 
of items. When items have low correlations with one 
another and each correlates positively with the cri­
terion, each item adds information to that provided 
by the other items...

Table 2. Means and standard deviations for science achievement when pupils are categorized by parent education level, race, and sex

<table>
<thead>
<tr>
<th>Parent education level</th>
<th>Grade level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>$\bar{X}$</td>
</tr>
<tr>
<td>Less than 8th grade</td>
<td>36.30</td>
</tr>
<tr>
<td>More than 8th grade but</td>
<td></td>
</tr>
<tr>
<td>less than high school</td>
<td>37.18</td>
</tr>
<tr>
<td>High school graduate</td>
<td>40.57</td>
</tr>
<tr>
<td>Beyond high school</td>
<td>41.92</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Race</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Non-black</td>
<td>40.76</td>
</tr>
<tr>
<td>Black</td>
<td>31.71</td>
</tr>
</tbody>
</table>

<table>
<thead>
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<th>Sex</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Boy</td>
<td>41.50</td>
</tr>
<tr>
<td>Girl</td>
<td>39.65</td>
</tr>
</tbody>
</table>
Table 3. Means and standard deviations for attitude toward school by parent education level, race, sex, and attitude toward school subscale scores

<table>
<thead>
<tr>
<th>Parent education level</th>
<th>Grade level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>( \bar{X} )</td>
</tr>
<tr>
<td>Less than 8th grade</td>
<td>56.92</td>
</tr>
<tr>
<td>More than 8th grade but less than high school</td>
<td>54.69</td>
</tr>
<tr>
<td>High school graduate</td>
<td>54.82</td>
</tr>
<tr>
<td>Beyond high school</td>
<td>56.66</td>
</tr>
<tr>
<td>Race</td>
<td></td>
</tr>
<tr>
<td>Non-black</td>
<td>55.42</td>
</tr>
<tr>
<td>Black</td>
<td>51.13</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Boy</td>
<td>53.86</td>
</tr>
<tr>
<td>Girl</td>
<td>56.97</td>
</tr>
<tr>
<td>Subscales</td>
<td></td>
</tr>
<tr>
<td>Teacher</td>
<td>26.02</td>
</tr>
<tr>
<td>Learning</td>
<td>3.66</td>
</tr>
<tr>
<td>School</td>
<td>11.55</td>
</tr>
<tr>
<td>Peer</td>
<td>7.31</td>
</tr>
<tr>
<td>General</td>
<td>6.81</td>
</tr>
</tbody>
</table>
Table 4. Means and standard deviations for self concept by parent education level, race, sex, and self concept subscale scores

<table>
<thead>
<tr>
<th>Parent education level</th>
<th>Grade level</th>
<th>Race</th>
<th>Sex</th>
<th>Subscales</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
<td>7</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$\bar{X}$</td>
<td>S.D.</td>
<td>$\bar{X}$</td>
<td>S.D.</td>
</tr>
<tr>
<td>Less than 8th grade</td>
<td>51.77</td>
<td>10.38</td>
<td>48.23</td>
<td>10.63</td>
</tr>
<tr>
<td>More than 8th grade but</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>less than high school</td>
<td>52.23</td>
<td>12.52</td>
<td>52.15</td>
<td>12.74</td>
</tr>
<tr>
<td>High school graduate</td>
<td>53.18</td>
<td>12.67</td>
<td>54.31</td>
<td>12.56</td>
</tr>
<tr>
<td>Beyond high school</td>
<td>56.66</td>
<td>12.62</td>
<td>55.88</td>
<td>12.15</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-black</td>
<td>54.36</td>
<td>13.03</td>
<td>54.63</td>
<td>12.41</td>
</tr>
<tr>
<td>Black</td>
<td>51.91</td>
<td>12.15</td>
<td>54.74</td>
<td>12.05</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boy</td>
<td>53.63</td>
<td>12.68</td>
<td>53.90</td>
<td>12.42</td>
</tr>
<tr>
<td>Girl</td>
<td>55.08</td>
<td>13.35</td>
<td>55.39</td>
<td>12.34</td>
</tr>
<tr>
<td>Subscales</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peer</td>
<td>12.49</td>
<td>4.04</td>
<td>13.33</td>
<td>4.00</td>
</tr>
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<td>Family</td>
<td>14.84</td>
<td>3.49</td>
<td>15.20</td>
<td>3.91</td>
</tr>
<tr>
<td>School</td>
<td>13.89</td>
<td>4.12</td>
<td>12.85</td>
<td>4.38</td>
</tr>
<tr>
<td>General</td>
<td>13.10</td>
<td>3.65</td>
<td>13.26</td>
<td>3.54</td>
</tr>
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</table>
Table 5. t values for comparisons of science achievement means within grade levels by parent education level, race, and sex

<table>
<thead>
<tr>
<th>Grade level</th>
<th>Parent education level 1 vs 2</th>
<th>Parent education level 1 vs 3</th>
<th>Parent education level 2 vs 3</th>
<th>Parent education level 2 vs 4</th>
<th>Parent education level 3 vs 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>.3546</td>
<td>1.7981</td>
<td>2.3717*</td>
<td>3.8885**</td>
<td>5.5244**</td>
</tr>
<tr>
<td>7</td>
<td>1.3802</td>
<td>1.8769</td>
<td>2.9164**</td>
<td>1.7209</td>
<td>5.3895**</td>
</tr>
<tr>
<td>12</td>
<td>1.4735</td>
<td>2.1524*</td>
<td>3.4248**</td>
<td>1.9125</td>
<td>5.5979**</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Race</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 vs 2</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sex</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 vs 2</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>12</td>
</tr>
</tbody>
</table>

*significant at .05
**significant at .01
Table 6. *t* values for comparisons of self concept means within grade levels by parent education level, race, and sex

<table>
<thead>
<tr>
<th>Grade level</th>
<th>1 vs 3</th>
<th>1 vs 4</th>
<th>2 vs 3</th>
<th>2 vs 4</th>
<th>3 vs 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>.5556</td>
<td>1.9436</td>
<td>.6499</td>
<td>3.1113**</td>
<td>3.9092**</td>
</tr>
<tr>
<td>7</td>
<td>1.7859</td>
<td>2.2398*</td>
<td>1.6266</td>
<td>2.7507**</td>
<td>1.9442</td>
</tr>
<tr>
<td>12</td>
<td>2.1675*</td>
<td>2.9016**</td>
<td>.3086</td>
<td>1.1807</td>
<td>2.1051*</td>
</tr>
</tbody>
</table>

**Race**

<table>
<thead>
<tr>
<th>Grade level</th>
<th>1 vs 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>1.6074</td>
</tr>
<tr>
<td>7</td>
<td>.0725</td>
</tr>
<tr>
<td>12</td>
<td>.0962</td>
</tr>
</tbody>
</table>

**Sex**

<table>
<thead>
<tr>
<th>Grade level</th>
<th>1 vs 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>1.8328</td>
</tr>
<tr>
<td>7</td>
<td>1.9954*</td>
</tr>
<tr>
<td>12</td>
<td>2.0315*</td>
</tr>
</tbody>
</table>

*significant at .05  
**significant at .01
Table 7. t values for comparisons of attitude toward school means within grade levels by parent education level, race, and sex

<table>
<thead>
<tr>
<th>Grade level</th>
<th>1 vs 2</th>
<th>1 vs 3</th>
<th>Parent education level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 vs 4</td>
<td>2 vs 3</td>
<td>2 vs 4</td>
</tr>
<tr>
<td>4</td>
<td>.9558</td>
<td>1.0039</td>
<td>.1259</td>
</tr>
<tr>
<td>7</td>
<td>1.0900</td>
<td>1.2384</td>
<td>1.1833</td>
</tr>
<tr>
<td>12</td>
<td>.8838</td>
<td>1.4642</td>
<td>1.0596</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Race</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 vs 2</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sex</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 vs 2</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>12</td>
</tr>
</tbody>
</table>

*Significant at .05
**Significant at .01
Analysis of the NAEP science achievement instruments was completed by using Flanagan Discrimination Indices (Appendix J). This is a measure of how well individual items discriminate between high achieving and low achieving pupils. The technique takes into account the proportion of pupils in the high achievement group who answer items correctly in relation to the proportion in the low achievement group who answer correctly. When more high achieving pupils than low achieving pupils answer an item correctly, then the item is said to discriminate (27). Discrimination indices given are based upon analyses of 288 fourth grade pupils, 277 seventh grade pupils, and 133 twelfth grade pupils.

In examining discrimination indices for the NAEP instruments, the manner in which items were selected for inclusion within the instruments should be taken into consideration. The fact that some of the items included in the NAEP science achievement instruments were designed for the performance level of pupils in the low achievement range of a particular age group may account for some of the lower discrimination indices.

Science Achievement and Self Concept

Hypothesis 1: The correlation between pupil achievement on selected science measures and measures of pupil self concept is not significantly different than zero.

An analysis of Table 8 reveals the existence of significant positive correlations between science achievement and self concept. This relationship is evident at each of three grade levels studied. It can also be noted that the correlation decreases from grade four to grade seven.
and from grade seven to grade twelve. The decision was made to reject the null hypothesis based upon evidence supplied in Table 8.

Table 8. Correlation of science achievement with self concept

<table>
<thead>
<tr>
<th>Grade level</th>
<th>$r$</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>.2792**</td>
<td>1105</td>
</tr>
<tr>
<td>7</td>
<td>.1759**</td>
<td>1099</td>
</tr>
<tr>
<td>12</td>
<td>.1576**</td>
<td>958</td>
</tr>
</tbody>
</table>

**significant at or beyond .01

Hypothesis 2: The correlation between science achievement and each of the subscales on the self concept measure is not significantly different than zero.

Table 9 contains a summary of the results related to the second hypothesis. At the fourth grade level all subscales were significantly correlated with science achievement at and beyond the .01 level. For seventh grade, the school, family, and general subscales were significantly correlated with science achievement. For grade twelve, the only subscale correlated with science achievement was the school subscale which is designed to indicate the schools' influence on self concept. The highest correlations at each grade level were those between the school subscale and science achievement, while the lowest were between the peer subscales and science achievement.

Based upon generally consistent significant correlations between self concept subscale scores and science achievement scores for two of three
grade levels investigated, the decision was made to reject the null hypothesis.

Table 9. Correlation of science achievement with self concept subscales

<table>
<thead>
<tr>
<th>Grade level</th>
<th>N</th>
<th>Peer</th>
<th>Family</th>
<th>School</th>
<th>General</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>1105</td>
<td>.1846**</td>
<td>.2609**</td>
<td>.3239**</td>
<td>.1738**</td>
</tr>
<tr>
<td>7</td>
<td>1099</td>
<td>.0085</td>
<td>.1211**</td>
<td>.3311**</td>
<td>.0643*</td>
</tr>
<tr>
<td>12</td>
<td>958</td>
<td>.0061</td>
<td>.0032</td>
<td>.3823**</td>
<td>.0613</td>
</tr>
</tbody>
</table>

*significant at .05  
**significant at or beyond .01

Hypothesis 3: The correlation between science achievement and self concept is not significantly different for girls than for boys.

Confidence intervals were established for boys and girls at each of three grade levels and are reported in Table 10. For grade four, the correlation between science achievement and self concept for boys and girls was not significantly different. However, for both grades seven and twelve, significant differences were reported and, therefore, the decision was made to reject the null hypothesis.

It can be noted that the correlation between achievement and self concept for both girls and boys is highest at grade four and lowest at grade twelve.
Table 10. Ninety-five percent confidence intervals for correlation between science achievement and self concept when pupils are classified by sex

<table>
<thead>
<tr>
<th>Grade level</th>
<th>Sex</th>
<th>r</th>
<th>Confidence intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>lower limit</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>upper limit</td>
</tr>
<tr>
<td>4</td>
<td>Boy</td>
<td>.2884</td>
<td>.2800</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.2900</td>
</tr>
<tr>
<td></td>
<td>Girl</td>
<td>.2907</td>
<td>.2800</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.2900</td>
</tr>
<tr>
<td>7</td>
<td>Boy</td>
<td>.2067</td>
<td>.2066</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.2067*</td>
</tr>
<tr>
<td></td>
<td>Girl</td>
<td>.1605</td>
<td>.1604</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.1605*</td>
</tr>
<tr>
<td>12</td>
<td>Boy</td>
<td>.2042</td>
<td>.2041</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.2042*</td>
</tr>
<tr>
<td></td>
<td>Girl</td>
<td>.1464</td>
<td>.1463</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.1464*</td>
</tr>
</tbody>
</table>

*indicates significance

Hypothesis 4: The correlation between science achievement and self concept is not significantly different for black pupils than for non-black pupils.

Comparisons of black and non-black pupils, as earlier reported, were limited to pupils in five major cities. Findings relative to interpretation of the hypothesis are summarized in Table 11.

Table 11. Ninety-five percent confidence intervals for correlation between science achievement and self concept when pupils are classified by race

<table>
<thead>
<tr>
<th>Grade level</th>
<th>Race</th>
<th>r</th>
<th>Confidence intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>lower limit</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>upper limit</td>
</tr>
<tr>
<td>4</td>
<td>Black</td>
<td>.3548</td>
<td>.3450</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.3500*</td>
</tr>
<tr>
<td></td>
<td>Non-black</td>
<td>.2780</td>
<td>.2700</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.2800*</td>
</tr>
<tr>
<td>7</td>
<td>Black</td>
<td>.2597</td>
<td>.2500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.2600*</td>
</tr>
<tr>
<td></td>
<td>Non-black</td>
<td>.1776</td>
<td>.175</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.1780*</td>
</tr>
<tr>
<td>12</td>
<td>Black</td>
<td>-.1988</td>
<td>-.1987</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-.1998*</td>
</tr>
<tr>
<td></td>
<td>Non-black</td>
<td>.1613</td>
<td>.1612</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.1613*</td>
</tr>
</tbody>
</table>

*indicates significance
Table 11 reveals that the correlation between achievement and self concept is higher for black pupils than for non-black pupils at each grade level. Additionally, these correlations were found to be significantly different at each grade level. In the face of this evidence, the null hypothesis was rejected.

Hypothesis 5: The correlation between science achievement and self concept does not differ significantly when pupils are categorized with respect to the educational level of the parent.

An analysis of Tables 12 through 14 provides substantial evidence to reject the null hypothesis. At all three grade levels the correlation between science achievement and self concept was significantly different when pupils were grouped according to parent education level. In addition, at all but the fourth grade level the coefficients were higher for the lowest level of parent education. For pupils in grades seven and twelve, this means that the higher the parent education level, the lower the correlation between science achievement and self concept.

Table 12. Ninety-five percent confidence intervals for correlation between science achievement and self concept for pupils in grade 4 classified by parent education level

<table>
<thead>
<tr>
<th>Parent education level</th>
<th>r</th>
<th>Confidence intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 8th grade</td>
<td>.2129</td>
<td>.2128</td>
</tr>
<tr>
<td>More than 8th grade but less than high school</td>
<td>.2352</td>
<td>.2351</td>
</tr>
<tr>
<td>High school graduate</td>
<td>.2241</td>
<td>.2240</td>
</tr>
<tr>
<td>Beyond high school</td>
<td>.2755</td>
<td>.2700</td>
</tr>
</tbody>
</table>

*indicates significance
Table 13. Ninety-five percent confidence intervals for correlation between science achievement and self concept for pupils in grade 7 classified by parent education level

<table>
<thead>
<tr>
<th>Parent education level</th>
<th>$r$</th>
<th>Confidence intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 8th grade</td>
<td>.7435</td>
<td>.7350 .7400*</td>
</tr>
<tr>
<td>More than 8th grade but less than high school</td>
<td>.1860</td>
<td>.1859 .1860*</td>
</tr>
<tr>
<td>High school graduate</td>
<td>.1731</td>
<td>.1730 .1731*</td>
</tr>
<tr>
<td>Beyond high school</td>
<td>.1256</td>
<td>.1255 .1256*</td>
</tr>
</tbody>
</table>

*indicates significance

Table 14. Ninety-five percent confidence intervals for correlation between science achievement and self concept for pupils in grade 12 classified by parent education level

<table>
<thead>
<tr>
<th>Parent education level</th>
<th>$r$</th>
<th>Confidence intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 8th grade</td>
<td>.3844</td>
<td>.3700 .3800*</td>
</tr>
<tr>
<td>More than 8th grade but less than high school</td>
<td>.1866</td>
<td>.1865 .1866*</td>
</tr>
<tr>
<td>High school graduate</td>
<td>.1434</td>
<td>.1433 .1434*</td>
</tr>
<tr>
<td>Beyond high school</td>
<td>.1260</td>
<td>.1259 .1260*</td>
</tr>
</tbody>
</table>

*indicates significance

Hypothesis 6: The correlation between science achievement and self concept does not differ significantly when pupils are categorized with respect to grade level.
Table 15 indicates the existence of significant differences for the relationship between self concept and science achievement with respect to grade level and thus the null hypothesis was rejected. This relationship was lower in grade seven than in grade four and lower in grade twelve than in grade seven.

Table 15. Ninety-five percent confidence intervals for correlation between science achievement and self concept when pupils are classified by grade level

<table>
<thead>
<tr>
<th>Grade level</th>
<th>r</th>
<th>Confidence intervals lower limit</th>
<th>upper limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>.2792</td>
<td>.2700</td>
<td>.2800*</td>
</tr>
<tr>
<td>7</td>
<td>.1759</td>
<td>.1758</td>
<td>.1759*</td>
</tr>
<tr>
<td>12</td>
<td>.1576</td>
<td>.1575</td>
<td>.1576*</td>
</tr>
</tbody>
</table>

*indicates significance

Science Achievement and Attitude

Hypothesis 7: The correlation between pupil achievement on selected science measures and measures of pupil attitude toward school is not significantly different than zero.

As reported in Table 16, correlations between science achievement and attitude toward school were significantly different than zero for all grade levels at and beyond the .01 level of significance. The highest correlation was reported for fourth grade and the lowest for twelfth grade. Since significant differences were found at each grade level, the null hypothesis was rejected.
Table 16. Correlation of science achievement with attitude toward school

<table>
<thead>
<tr>
<th>Grade level</th>
<th>N</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>1105</td>
<td>.1995**</td>
</tr>
<tr>
<td>7</td>
<td>1099</td>
<td>.1320**</td>
</tr>
<tr>
<td>12</td>
<td>958</td>
<td>.1223**</td>
</tr>
</tbody>
</table>

**significant at or beyond .01

Hypothesis 8: The correlation between science achievement and each of the subscales on the attitude toward school measure is not significantly different than zero.

All but two subscale scores of the attitude toward school measure in Table 17 were correlated significantly with science achievement at each of three grade levels. At grade twelve, the peer subscale was not significantly correlated with science achievement and at grade four, there was no significant correlation between the learning subscale and science achievement. In general, then, it can be said that the relationship between achievement and attitude subscales is significantly greater than zero.
Table 17. Correlation of science achievement with attitude toward school subscales

<table>
<thead>
<tr>
<th>Grade level</th>
<th>Teacher $r$</th>
<th>Learning $r$</th>
<th>School $r$</th>
<th>Peer $r$</th>
<th>General $r$</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>.2099**</td>
<td>-.0224</td>
<td>.1943**</td>
<td>.1568*</td>
<td>.1034**</td>
</tr>
<tr>
<td>7</td>
<td>.1273**</td>
<td>.0673*</td>
<td>.0815**</td>
<td>.0881**</td>
<td>.1087**</td>
</tr>
<tr>
<td>12</td>
<td>.1064**</td>
<td>.1201**</td>
<td>.1061**</td>
<td>-.0027</td>
<td>.1177**</td>
</tr>
</tbody>
</table>

*significant at .05
**significant at or beyond .01

Hypothesis 9: The correlation between science achievement and attitude toward school is not significantly different for girls than for boys.

Confidence intervals reported in Table 18 indicate significant differences in the correlations between science achievement and attitude toward school for boys and girls at each grade level investigated. Coefficients for boys were consistently higher than those for girls. The consistency of significant correlations at each grade level substantiates the rejection of the null hypothesis.
Title 18. Ninety-five percent confidence intervals for correlation between science achievement and attitude toward school when pupils are classified by sex

<table>
<thead>
<tr>
<th>Sex</th>
<th>Grade level</th>
<th>$r$</th>
<th>Confidence intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>lower limit</td>
</tr>
<tr>
<td>Boy</td>
<td>4</td>
<td>.2503</td>
<td>.2500</td>
</tr>
<tr>
<td>Girl</td>
<td></td>
<td>.1906</td>
<td>.1905</td>
</tr>
<tr>
<td>Boy</td>
<td>7</td>
<td>.1912</td>
<td>.1911</td>
</tr>
<tr>
<td>Girl</td>
<td></td>
<td>.1015</td>
<td>.1014</td>
</tr>
<tr>
<td>Boy</td>
<td>12</td>
<td>.2091</td>
<td>.2090</td>
</tr>
<tr>
<td>Girl</td>
<td></td>
<td>.1005</td>
<td>.1004</td>
</tr>
</tbody>
</table>

*indicates significance

Hypothesis 10: The correlation between science achievement and attitude toward school is not significantly different for black pupils than for non-black pupils.

Comparisons of black and non-black pupils were limited to include only subjects from the five large cities as reported earlier. Table 19 summarizes findings related to the hypothesis under investigation. It can be noted that the relationship between attitude toward school and science achievement for black pupils is higher at all grade levels. Confidence intervals also indicate significant differences between black and non-black pupils at grades four, seven, and twelve. Thus, the hypothesis of no difference was rejected.
Table 19. Ninety-five percent confidence intervals for correlation between science achievement and attitude toward school when pupils are grouped by race

<table>
<thead>
<tr>
<th>Race</th>
<th>Grade level</th>
<th>( r )</th>
<th>Confidence intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>lower limit</td>
</tr>
<tr>
<td>Black</td>
<td>4</td>
<td>.3861</td>
<td>.3800</td>
</tr>
<tr>
<td>Non-black</td>
<td></td>
<td>.1016</td>
<td>.1915</td>
</tr>
<tr>
<td>Black</td>
<td>7</td>
<td>.1387</td>
<td>.1386</td>
</tr>
<tr>
<td>Non-black</td>
<td></td>
<td>.1292</td>
<td>.1291</td>
</tr>
<tr>
<td>Black</td>
<td>12</td>
<td>.2428</td>
<td>.2427</td>
</tr>
<tr>
<td>Non-black</td>
<td></td>
<td>.1202</td>
<td>.1201</td>
</tr>
</tbody>
</table>

*indicates significance

Hypothesis 11: The correlation between science achievement and attitude toward school does not differ significantly when pupils are categorized with respect to the educational level of the parent.

Tables 20 through 22 depict the results relating to the preceding hypothesis. Table 20 reveals confidence intervals for grade four. As the table indicates, the relationship between science achievement and attitude toward school is significantly different for pupils categorized by each of four levels of parent education. In the two lowest parent education levels this relationship is highest.

In Table 21 the relationship between science achievement and attitude toward school, when pupils are grouped according to parent education level, is revealed for grade seven. It can be noted that again differences for this relationship are significant at each level of parent education.
Furthermore, this relationship was lowest for pupils whose parents had education beyond high school.

The same relationship for pupils in grade twelve is examined in Table 22. It can be noted here that the lower relationships existed for pupils whose parents were at either extreme represented by the parent education levels.

Table 20. Ninety-five percent confidence intervals for correlation between science achievement and attitude toward school for grade 4 when pupils are grouped by parent education level

<table>
<thead>
<tr>
<th>Parent education level</th>
<th>r</th>
<th>Confidence intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 8th grade</td>
<td>.2490</td>
<td>.2500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.2500*</td>
</tr>
<tr>
<td>More than 8th grade but less than high school</td>
<td>.2765</td>
<td>.2700</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.2800*</td>
</tr>
<tr>
<td>High school graduate</td>
<td>.1802</td>
<td>.1801</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.1802*</td>
</tr>
<tr>
<td>Beyond high school</td>
<td>.1758</td>
<td>.1757</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.1758*</td>
</tr>
</tbody>
</table>

*indicates significance
Table 21. Ninety-five percent confidence intervals for correlation between science achievement and attitude toward school for grade 7 when pupils are grouped by parent education level

<table>
<thead>
<tr>
<th>Parent education level</th>
<th>r</th>
<th>Confidence intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>lower limit</td>
</tr>
<tr>
<td>Less than 8th grade</td>
<td>.1364</td>
<td>.1363</td>
</tr>
<tr>
<td>More than 8th grade but less than high school</td>
<td>.2270</td>
<td>.2260</td>
</tr>
<tr>
<td>High school graduate</td>
<td>.1661</td>
<td>.1660</td>
</tr>
<tr>
<td>Beyond high school</td>
<td>.0529</td>
<td>.0528</td>
</tr>
</tbody>
</table>

*indicates significance

Table 22. Ninety-five percent confidence intervals for correlation between science achievement and attitude toward school for grade 12 when pupils are grouped by parent education level

<table>
<thead>
<tr>
<th>Parent education level</th>
<th>r</th>
<th>Confidence intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>lower limit</td>
</tr>
<tr>
<td>Less than 8th grade</td>
<td>.0579</td>
<td>.0578</td>
</tr>
<tr>
<td>More than 8th grade but less than high school</td>
<td>.1922</td>
<td>.1921</td>
</tr>
<tr>
<td>High school graduate</td>
<td>.1613</td>
<td>.1612</td>
</tr>
<tr>
<td>Beyond high school</td>
<td>.0788</td>
<td>.0787</td>
</tr>
</tbody>
</table>

*indicates significance

Tables 21 and 22, for grades seven and twelve respectively, also display confidence intervals which are significantly different. Thus, the hypothesis was rejected.
In summary, the relationship between science achievement and attitude toward school, when pupils are grouped by parent education levels, does differ significantly.

Hypothesis 12: The correlation between science achievement and attitude toward school does not differ significantly when pupils are categorized with respect to grade level.

Table 23 contains a summary of findings regarding the relationship of science achievement to attitude toward school for grades four, seven, and twelve. Confidence intervals established for each grade level are significantly different, thus supporting the decision to reject the null hypothesis. It can be noted that the relationship between science achievement and attitude toward school is higher for grade four than for grade seven and higher for grade seven than for grade twelve.

Table 23. Ninety-five percent confidence intervals for correlation between science achievement and attitude toward school when pupils are classified by grade level

<table>
<thead>
<tr>
<th>Grade level</th>
<th>Confidence intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lower limit</td>
</tr>
<tr>
<td>4</td>
<td>.1994</td>
</tr>
<tr>
<td>7</td>
<td>.1319</td>
</tr>
<tr>
<td>12</td>
<td>.1222</td>
</tr>
</tbody>
</table>

*indicates significance
SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this research was to determine if significant relationships, among pupil performance on measures of science achievement, attitude toward school, and self concept, existed.

Is it true that high self concept and a "good" attitude toward school accompany scientific achievement? Is this true for black as well as non-black pupils--girls as well as boys? Furthermore, are the subscales of attitude and self concept positively associated with achievement? Do these associations hold no matter what the educational background of the parent?

The research was conducted using science items from the National Assessment of Educational Progress, and attitude toward school and self concept measures developed by Instructional Objectives Exchange at the University of California at Los Angeles. The affective measures were developed under contract to an 18 state consortium, which included Iowa.

The three measures were administered to a total of 3,162 Iowa public school pupils in grades four, seven, and twelve. Pupils were drawn at random from 83 school districts throughout the state. Measures were administered in April, 1971, by specially trained proctors. The administration of measures was standardized through the use of pre-taped instructions. Pupil responses were marked directly in the exercise booklets to control for possible transformation errors. The data were then punched onto cards and subsequently put on tape for processing. Processing of data was completed by Measurement Research Center in Iowa City, Iowa.
Additional pupil information was collected on sex, race, and parent education level. Pupils were grouped according to these classifications to explore the relationships between science achievement and self concept and between science achievement and attitude toward school.

From the research conducted, the following relationships were discovered. Positive associations were found to exist between science achievement and self concept and between science achievement and attitude toward school at all three grade levels. These relationships were present at each grade level for both boys and girls.

The relationship between science achievement and attitude toward school existed for black pupils in grades four and twelve. This relationship was not present for non-black pupils at any of the grade levels investigated.

The relationship between science achievement and self concept existed for both black and non-black pupils at grades four and seven, but not at grade twelve.

When pupils were grouped according to parent education levels, relationships between science achievement and self concept were present at all but the lowest level of parent education for grades four and twelve, and at all levels of parent education for grade seven.

For this same classification, relationships between science achievement and attitude toward school were found to exist at all but the lowest parent education level in grade four, and at all but the highest and lowest levels of parent education for grades seven and twelve.

Most of the attitude toward school subscales were found to be correlated with science achievement at all three grade levels. Exceptions were
the learning subscale, which was not correlated with science achievement at fourth grade, and the peer subscale, which was not correlated with science achievement at the twelfth grade level.

For the relationship between science achievement and self concept, all self concept subscales at the fourth grade level were found to be correlated with science achievement. For grade seven, all subscales were correlated with science achievement except the peer subscale. In grade twelve, only the school subscale was correlated with science achievement.

Conclusions

The following conclusions appear warranted.

1) The correlation between science achievement and self concept is significantly greater than zero for pupils in grades four, seven, and twelve.

2) The correlation between science achievement and subscale scores on the self concept measure is significantly greater than zero for the following subscales: school (at all grade levels); family (at grades four and seven); general (at grades four and seven); and peer (at grade four only).

3) The correlation between science achievement and self concept is significantly greater than zero for both boys and girls at all grade levels. Additionally, this relationship is significantly different for boys than for girls.

4) The correlation between science achievement and self concept is significantly greater than zero for black and non-black pupils in grades four and seven, but not for either group in grade twelve. In addition,
the correlation between science achievement and self concept is significantly different for black pupils than for non-black pupils at all three grade levels.

5) The correlation between science achievement and self concept is significantly greater than zero for pupils in all four classifications of parent education levels in grade seven, and for all but the lowest classification of parent education level in grades four and twelve. Also, the correlation between science achievement and self concept differs significantly when pupils are grouped according to parent education levels. This is true for all grade levels.

6) The correlation between science achievement and self concept differs significantly when pupils are classified with respect to grade level.

7) The correlation between science achievement and attitude toward school is significantly greater than zero for pupils in grades four, seven, and twelve.

8) The correlation between science achievement and subscale scores on the attitude toward school measure is significantly greater than zero for the following subscales: teacher, school, and general (at all grade levels); learning (for grades seven and twelve); and peer (for grades four and seven).

9) The correlation between science achievement and attitude toward school is significantly greater than zero for both boys and girls at each grade level. Also, this relationship is significantly different for girls than for boys.
10) The correlation between science achievement and attitude toward school is significantly greater than zero for black pupils at grades four and twelve only. No such relationship was found to exist for non-black pupils at any of the three grade levels investigated. The correlation between science achievement and attitude toward school was, however, found to be significantly different for black pupils than for non-black pupils at all grade levels.

11) The correlation between science achievement and attitude toward school differs significantly when pupils are grouped according to parent education levels. This holds true for all grade levels. In addition, the relationship between achievement and attitude toward school is significantly greater than zero for all but the lowest parent education level in grade four, and for all but the highest and lowest parent education levels in grades seven and twelve.

12) The correlation between science achievement and attitude toward school differs significantly when pupils are grouped according to grade level.

Discussion

Findings of this research were, in general, similar to findings of previous studies involving attitude and achievement. The cognitive factor of achievement was found to be correlated quite consistently with the affective factors of self concept and attitude toward school. These relationships were in a positive direction, but were all rather low (generally from .10 to .26).
An additional aspect of this study was the attempt to subdivide the broad categories of attitude toward school and self concept into such components as peer group, learning, teacher, school setting, and family. Excepting the school subscale of self concept, these components of attitude and self concept had low but significant association with achievement.

Generally speaking, the broad categories of self concept and attitude toward school produced the same or better results with respect to their association with science achievement.

A discussion of some of the more pertinent findings appears below in the following order: 1) sex differences for achievement and attitude; 2) race differences for achievement and attitude; 3) race differences for achievement and self concept; and 4) parent education level differences for achievement and attitude.

Sex differences for achievement and attitude

It can be noted that boys consistently had significantly lower attitudes toward school and significantly higher achievement than girls. From this standpoint it could be argued that boys do not like school as well as girls, yet do better in science. A logical question to ask is why does this phenomenon exist? The reason for this is probably not some basic biological or physiological difference which exists between the sexes; more likely it is due to environmental conditions. Since these lower attitudes of boys are related to school, the environment which produces, or at least stimulates, the development of lower attitudes toward school is probably the school environment itself. Further support of this argument is evident from findings related to attitude subscales. The attitude
subscale "school," (which measures the influence of the school social structure on pupils' attitude toward school) was significantly correlated with achievement for all grade levels as was the teacher subscale.

Few would argue the point that the teacher is a major influence in shaping pupil attitude toward school, or that the environment of the classroom contributes to the degree of pupil like or dislike for school. In addition, it seems appropriate to say from findings reported in this research that the school environment at all grade levels appears to be more conducive to the development of positive attitudes toward school for girls than for boys. The teacher's role also appears to influence the development of positive attitudes toward school more for girls than for boys.

Race differences for achievement and attitude

Another interesting point is that concerning the relationship between achievement and attitude toward school with regard to race. Results of the investigation indicate that black pupils had significantly lower attitudes toward school than non-blacks (except at grade twelve), and that they also had significantly lower achievement than non-black pupils at all grade levels. In addition, significant relationships between attitude toward school and achievement were found only for black pupils.

Although causation cannot be inferred for the data at hand, it is interesting to speculate on the possibility that attitude toward school at least influences, if not stimulates, achievement in science for black pupils or vice versa. The argument for this is based upon findings which indicate that: 1) the only significant relationships between science
achievement and attitude toward school found were for black pupils; 2) black pupils had significantly lower achievement; and 3) black pupils had significantly lower attitudes toward school.

If these associations were subsequently found to be true for black pupils at lower grade levels, it would seem that one of two explanations is warranted. First, either these pupils come to school with pre-formed attitudes toward the school setting which are less positive than those attitudes held by non-black pupils, or such attitudes are developed in school prior to or during fourth grade.

Whichever might be the case, it is apparent that appropriate measures need to be taken during the first few years of school to stimulate growth of more positive attitudes toward school for black pupils. It is suggested that the curricula should provide learning experiences for these pupils that emphasize development in affective areas as well as in cognitive areas and that readiness activities should, for these pupils, be geared to stimulate pupils to look forward to future learning experiences in school.

This also supports the need for continued attention to individual differences not only between groups of pupils, but between individual pupils, and not only in terms of differentiated levels of cognitive-oriented print and non-print materials, but in terms of differentiated roles for teachers and differentiated learning environments.

**Race differences for achievement and self concept**

With respect to self concept and race, it is interesting to note that there were no significant differences found between black and
non-black pupils in terms of self concept at any grade level, yet significant correlations between self concept and achievement existed for both black and non-black pupils at all but the twelfth grade level. In addition, this relationship was higher for black pupils than for non-black in each case where such a relationship existed.

In other words, there was no difference in the self concepts of black and non-black pupils (as measured by these instruments), but there was a positive relationship between achievement and self concept for both black and non-black pupils (except for black pupils at grade twelve) and this relationship was higher for black than for non-black pupils in every instance.

These conclusions lend support to the argument that self concept may not be as important a factor in relation to achievement for black pupils as previously thought. On the other hand, it may be that achievement is not as closely associated with self concept as previously thought.

**Parent education level differences for achievement and attitude**

A relationship between achievement and attitude was generally not present for pupils in the highest and lowest parent education classifications, and in no instance was attitude for pupils in the highest and lowest parent education classifications significantly different. In fact, in only one instance (grade four) did attitude differ significantly among any of the four levels of parent education. Furthermore, in only one instance were significant differences in both achievement and attitude found for pupils within the same parent education classification.
It seems appropriate to conclude from this, that although significant relationships (between achievement and attitude) do exist for pupils grouped according to parent education level, the attitudes toward school held by pupils within each parent education classification do not, as a rule, differ.

Therefore, previous arguments suggesting that pupils whose parents have limited amounts of formal education have poorer attitudes toward school than other pupils do not appear to be supported by this research.

Limitations

The conclusions drawn from results of this research are constrained in part by certain assumptions which were made in Chapter I. First, it was assumed that each of the measures used in conducting the research would measure what it purported to measure. Secondly, it was assumed that science achievement, attitude toward school, and self concept were characteristics which could be measured. In addition, it was assumed that sampling procedures used would yield a sample representative of pupils in Iowa.

The sample drawn excluded all non-public school pupils, pupils from non-public schools attending public schools on a shared-time basis, and pupils enrolled in special education classes.

The sample was drawn from fourth, seventh, and twelfth grade pupils and, therefore, conclusions drawn may not be generalizable to pupils at other grade levels. In addition, comparisons made between black and non-black pupils apply only to the five major cities specified in Chapter II, since only pupils from these cities composed the special sample designed for such comparisons.
The investigation was further limited by the correlation treatment. Partial correlation or multiple regression would have permitted a determination of the variance in achievement attributable to a number of attitude, self concept, and other pupil variables.

Recommendations for Further Research

Based upon the findings and insights gained from this research, the following recommendations for further research are made.

1) A longitudinal study, beginning with pupils in the primary grade levels, should be conducted to further explore the relationships among attitude toward school, self concept, and achievement. From such a study, it could be determined if relationships found to exist in the present study continued to exist over time.

2) Although studies have been done to determine the relationships between certain cognitive and affective factors, such as achievement, self concept, and attitude toward school, few studies involving experimental and control groups and utilizing various treatments have been conducted. A study of this sort might prove helpful in answering questions left unanswered by this investigation, e.g., why girls had better attitudes toward school but did not achieve as well as boys.

3) It is also recommended that a study be conducted to determine the effect of various school environments on self concept and attitude toward school. Such an investigation was suggested by the consistently significant correlations found between achievement and the school subscale of attitude toward school and between achievement and the school subscale of self concept.
4) The only significant correlations between attitude and achievement were found for black pupils. The lack of such an association for non-black pupils suggests that further investigation is necessary.

5) Since significant but low correlations were found between affective and cognitive factors in the present study, it is suggested that additional research be conducted to seek out factors which may be of value in predicting pupil development in various achievement areas.

6) Since positive correlations between achievement and attitude and between self concept and achievement have been noted, it is suggested that future investigation be undertaken to study pupil achievement in learning situations where the major goal is to increase positive attitudes toward school and positive self concepts.

7) Research might also be undertaken to replicate the present study using techniques of regression and partial correlation.
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APPENDIX A. INTERMEDIATE SELF APPRAISAL INDEX
Directions: Please complete the following items by marking each either t (true) or f (false).

1. I like to meet new people.
2. I can disagree with my family.
3. Schoolwork is fairly easy for me.
4. I am satisfied to be just what I am.
5. I wish I got along better with other children.
6. I often get in trouble at home.
7. I usually like my teachers.
8. I am a cheerful person.
9. Other children are often mean to me.
10. I do my share of work at home.
11. I often feel upset in school.
12. I often let other kids have their way.
13. Most children have fewer friends than I do.
14. No one pays much attention to me at home.
15. I can always get good grades if I want to.
16. I can always be trusted.
17. I am easy to like.
18. There are times when I would like to leave home.
19. I forget most of what I learn.
20. I am popular with kids my own age.
21. I am popular with girls.
22. My family is glad when I do things with them.
23. I often volunteer in school.
24. I am a happy person.
25. I am lonely very often.
26. My family respects my ideas.
27. I am a good student.
28. I often do things that I'm sorry for later.
29. Older kids do not like me.
30. I behave badly at home.
31. I often get discouraged in school.
32. I wish I were younger.
33. I am always friendly toward other people.
34. I usually treat my family as well as I should.
35. My teacher makes me feel I am not good enough.
36. I always like being the way I am.
37. Most people are much better liked than I am.
38. I cause trouble to my family.
39. I am slow in finishing my school work.
40. I am often unhappy.
41. I am popular with boys.
42. I know what is expected of me at home.
43. I can give a good report in front of the class.
44. I am not as nice looking as most people.
45. I don't have many friends.
46. I sometimes argue with my family.
47. I am proud of my school work.
48. If I have something to say, I usually say it.
49. I am among the last to be chosen for teams.
50. I feel that my family always trusts me.
51. I am a good reader.
52. I don't worry much.
53. It is hard for me to make friends.
54. My family would help me in any kind of trouble.
55. I am not doing as well in school as I would like to.
56. I have a lot of self control.
57. Friends usually follow my ideas.
58. My family understands me.
59. I find it hard to talk in front of the class.
60. I often feel ashamed of myself.
61. I wish I had more close friends.
62. My family often expects too much of me.
63. I am good in my school work.
64. I am a good person.
65. Sometimes I am hard to be friendly with.
66. I get upset easily at home.
67. I like to be called on in class.
68. I wish I were a different person.
69. I am fun to be with.
70. I am an important person to my family.
71. My classmates think I am a good student.
72. I am sure of myself.
73. Often I don't like to be with other children.
74. My family and I have a lot of fun together.
75. I would like to drop out of school.
76. I can always take care of myself.
77. I would rather be with kids younger than me.
78. My family usually considers my feelings.
79. I can disagree with my teacher.
80. I can't be depended on.
APPENDIX B. SECONDARY SELF APPRAISAL INDEX
Directions: Please complete the following items by using one of the responses below.

a. strongly agree
b. agree
c. disagree
d. strongly disagree

1. I like to meet new people.
2. I can disagree with my family.
3. Schoolwork is fairly easy for me.
4. I am satisfied to be just what I am.
5. I ought to get along better with other people.
6. My family thinks I don't act as I should.
7. I usually like my teachers.
8. I am a cheerful person.
9. People often pick on me.
10. I do my share of work at home.
11. I often feel upset in school.
12. I often let other people have their way.
13. Most people have fewer friends than I do.
14. No one pays much attention to me at home.
15. I can get good grades if I want to.
16. I can be trusted.
17. I am easy to like.
18. There are times when I would like to leave home.
19. I forget most of what I learn.
20. I am popular with kids my own age.
21. I am popular with girls.
22. My family is glad when I do things with them.
23. I often volunteer in school.
24. I am a happy person.
25. I am lonely very often.
26. My family respects my ideas.
27. I am a good student.
28. I often do things that I'm sorry for later.
29. Older kids do not like me.
30. I behave badly at home.
31. I often get discouraged in school.
32. I wish I were younger.
33. I am always friendly toward other people.
34. I usually treat my family as well as I should.
35. My teacher makes me feel I am not good enough.
36. I always like being the way I am.
37. Most people are much better liked than I am.
38. I cause trouble to my family.
39. I am slow in finishing my school work.
40. I am often unhappy.
41. I am popular with boys.
42. I know what is expected of me at home.
43. I can give a good report in front of the class.
44. I am not as nice looking as most people.
45. I don't have many friends.
46. I sometimes argue with my family.
47. I am proud of my school work.
48. If I have something to say, I usually say it.
49. I am among the last to be chosen for teams.
50. I feel that my family always trusts me.
a. strongly agree  c. disagree
b. agree  d. strongly disagree

51. I am a good reader.
52. I don't worry much.  
53. It is hard for me to make friends.
54. My family would help me in any kind of trouble.
55. I am not doing as well in school as I would like to.
56. I have a lot of self control.
57. Friends usually follow my ideas.
58. My family understands me.
59. I find it hard to talk in front of the class.
60. I often feel ashamed of myself.
61. I wish I had more close friends.
62. My family often expects too much of me.
63. I am good in my school work.
64. I am a good person.
65. Sometimes I am hard to be friendly with.
66. I get upset easily at home.
67. I like to be called on in class.
68. I wish I were a different person.
69. I am fun to be with.
70. I am an important person to my family.
71. My classmates think I am a good student.
72. I am sure of myself.
73. Often I don't like to be with other children.
74. My family and I have a lot of fun together.
75. I would like to drop out of school.
76. I can always take care of myself.
77. I would rather be with kids younger than me.
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78. My family usually considers my feelings.

79. I can disagree with my teacher.

80. I can't be depended on.
APPENDIX C. INTERMEDIATE SCHOOL SENTIMENT INDEX
Directions: Please complete the following items by marking each either \( t \) (true) or \( f \) (false).

1. Other children bother me when I'm trying to do my school work.
2. My teacher always tells me when she is pleased with my work.
3. My teacher is interested in the things I do outside of school.
4. Each morning I look forward to coming to school.
5. This school is like a jail.
6. In our class, we often get a chance to make decisions together.
7. I often feel rushed and nervous in school.
8. My teacher gives me work that is too hard.
9. Other children often get me into trouble at school.
10. My teacher seldom tells me whether my work is good or bad.
11. My teacher listens to what I have to say.
12. It is hard for me to stay happy at school.
13. I follow the rules at school.
14. There are many different activities at school from which I can choose what I would like to do.
15. When I do something wrong at school, I know I will get a second chance.
16. My teacher gives me work that is too easy.
17. I often must do what my friends want me to do.
18. My teacher tries to make school interesting to me.
19. I try to do my best in school.
20. My teacher does not care about me.
21. School gives me a stomachache.
22. The principal of my school is friendly toward the children.
23. I get as many chances as other children to do special jobs in my classroom.
24. My teacher does not give me enough time to finish my work.
25. The other children in my class are not friendly toward me.
26. In school I have to remember too many facts.
27. I like to do school work at home in the evenings.
28. My teacher doesn't understand me.
29. I often get headaches at school.
30. The principal's main job is to punish children.
31. My teacher treats me fairly.
32. My teacher makes sure I always understand what she wants me to do.
33. I really like working with the other children in my class.
34. I would rather learn a new game than play one I already know.
35. I'm afraid to tell my teacher when I don't understand something.
36. I feel good when I'm at school.
37. I get scared when I have to go to the office at school.
38. My teacher unfairly punishes the whole class.
39. I get tired of hearing my teacher talk all the time.
40. School is a good place for making friends.
41. I wish my class could have this teacher next year.
42. I like trying to work difficult puzzles.
43. My teacher scares me.
44. I like to stay home from school.
45. When I have a problem on the playground at recess, I know I can find a nice teacher to help me.
46. I don't like most of the children in my class.
47. My teacher is not very friendly with the children.
48. The biggest reason I come to school is to learn.
49. My teacher is mean.
50. I am embarrassed to be in the class I'm in.
51. My teacher grades me fairly.
52. I think a new child could make friends easily in my class.
53. I feel like my teacher doesn't like me when I do something wrong.
54. There are too many children in my class.
55. When a new child comes into our class, my friends and I try very hard to make him or her feel happy.
56. My teacher likes some children better than others.
57. I feel unhappy if I don't learn something new in school each day.
58. When I do something wrong, my teacher corrects me without hurting my feelings.
59. I like school better than my friends do.
60. I have to share books with other children too often at school.
61. I know what my teacher expects of me.
62. My teacher is often too busy to help me when I need help.
63. I want to be a very good student.
64. My teacher does not scare the children.
65. I often feel lost at school.
66. My teacher usually explains things too slowly.
67. There's no privacy at school.
68. Older children often boss my friends and me around at my school.
69. At school other people really care about me.
70. I would rather get books for my birthday than toys or clothes.
71. I would rather eat lunch at home than at school.
72. My teacher bosses the children around.
73. The children in my class nearly always obey the teacher.
74. We change from one subject to another too often in my class.
75. I like my teacher.
APPENDIX D. SECONDARY SCHOOL SENTIMENT INDEX
Directions: Please complete the following items by using one of the responses below.

a. strongly agree
b. agree
c. disagree
d. strongly disagree

___ 1. My teachers rarely explain to me why I deserve the grades I earn on assignments and tests.

___ 2. I do my best in school.

___ 3. My teachers are interested in the things I do outside of school.

___ 4. Each morning I look forward to coming to school.

___ 5. My school has too many rules.

___ 6. My teachers allow students some choice in what they study in class.

___ 7. I often feel rushed and nervous at school.

___ 8. My teachers give assignments that are too difficult.

___ 9. Students here aren't very friendly.

___ 10. My teachers try to make their subjects interesting to me.

___ 11. I hate having to do homework.

___ 12. My teachers are interested in what I have to say.

___ 13. When I'm at school, I'm usually unhappy.

___ 14. This school is run like a prison.

___ 15. In most of my classes, individual students can choose assignments which are interesting to them.

___ 16. If I did something wrong at school, I know I would get a second chance.

___ 17. My teachers give assignments that are just busy-work.

___ 18. I enjoy working on class projects with other students.

___ 19. My teachers really like their subjects.

___ 20. I would rather learn a new sport than play one I already know.

___ 21. My teachers are personally concerned about me.

___ 22. School depresses me.
a. strongly agree    c. disagree
b. agree    100    d. strongly disagree

23. Whenever I'm called to one of the offices at school, I feel upset.
24. I think there is too much pressure in school.
25. My teachers give me too much work.
26. School is a good place for making friends.
27. My teachers are boring.
28. I like the challenge of a difficult assignment.
29. My teachers don't try to understand young people.
30. I stay home from school whenever I can.
31. My classes are too big.
32. I'm very interested in what goes on at this school.
33. My teachers explain assignments clearly.
34. In school I have to memorize too many facts.
35. The main reason for going to school is to learn.
36. If I had a serious problem, I don't know one teacher in my school I could go to.
37. Students have enough voice in determining how this school is run.
38. My teachers have encouraged me to think for myself.
39. My teachers have been fair to me.
40. I usually don't get involved in many school activities.
41. My teachers won't give me any idea of what will be on their tests.
42. I really like most of the kids at this school.
43. My teachers don't allow me to be creative.
44. Teachers recognize my right to a different opinion.
45. I get tired of listening to my teachers talk all the time.
46. I attend many school events.
47. I like to talk to my teachers after class.
48. I think my teachers are too old-fashioned.
49. I really feel I'm part of my school.
50. My teachers frequently show a lack of preparation.
51. It is difficult for a new student to find friends here.
52. I have a good relationship with most of my teachers.
53. My favorite classes are those in which I learn the most.
54. I would like to go to school all year long.
55. Each September I look forward to the beginning of school.
56. Our school is so large, I often feel lost in the crowd.
57. I usually get the grade I deserve in a class.
58. My teachers are friendly toward the students.
59. I try to do good work in my class.
60. My teachers still respect me as a person even when I've done poorly on my school work.
61. I like school better than my friends do.
62. There's no privacy at school.
63. My teachers let me know what is expected of me.
64. I enjoy the social life here.
65. My teachers grade me fairly.
66. There are many closed groups of students here.
67. My teachers like working with young people.
68. I often buy books with my own money.
69. My teachers are too concerned with discipline.
70. I liked school better when I was in elementary school than I do now.
71. At school, other people really care about me.
72. If I thought I could win, I'd like to run for an elected student body office.
73. My teachers will discuss grade changes with me.
74. My teachers just don't care about students if they're not going to college.
a. strongly agree   c. disagree
b. agree   d. strongly disagree

75. I do more school work than just what is assigned.
76. Teachers at my school cannot control their classes.
77. My teachers give me individual help willingly.
78. Lunch time at school is not fun.
79. My teachers are often impatient.
80. If I had the choice, I wouldn't go to school at all.
81. My teachers have "pets".
82. My teachers often waste too much time explaining things.
83. I follow the school rules.
APPENDIX E. NAEP GRADE FOUR SCIENCE ITEMS
PUPIL INFORMATION GRADE 4

(1) Sex
   ___ Boy   ___ Girl

(2) Parent's Level of Education
   ___ Less than eighth (8th) grade
   ___ More than eighth (8th) grade but less than High School
   ___ High School Graduate
   ___ More than High School
Directions:

We would appreciate your cooperation in answering a number of questions related to science. Each question, as well as the responses, will be read aloud. You are asked to follow along by reading from your exercise booklet.

Please turn to the next page and follow along as the example is read.
Example: The planet on which we live is
   a. Venus.
   b. Earth.
   c. Mars.
   d. I don't know.

Now circle the letter which corresponds to the correct answer.

You should have circled the letter b since Earth is the correct answer. Each of the exercises to follow should be marked in the same manner. If you do not know the answer to a question, then circle the "I don't know" response.

Please wait until you hear the instructions before going on to the next question.

Are there any questions before we begin?

All right, now turn to question number one in the green section of your exercise booklet.
1. Where does a human baby come from?
   a. The stork brings the baby.
   b. The baby comes from its mother's body.
   c. The doctor gives the baby to the mother.
   d. The father buys the baby for the mother.
   e. The hospital keeps many babies and the mother picks one out.
   f. I don't know.

2. If you want to burn a stick, you should
   a. wet it.
   b. float it in a pond.
   c. see that it is dry.
   d. cover it with dirt.
   e. I don't know.

3. For which of the following reasons should you brush your teeth?
   a. To straighten your teeth.
   b. To make your teeth harder.
   c. To make your teeth sharper.
   d. To help your teeth grow larger.
   e. To help keep your teeth from decaying.
   f. I don't know.

4. All of the following can be burned in a fireplace EXCEPT
   a. iron.
   b. leaves.
   c. paper.
   d. wood.
   e. I don't know.

5. Bees go to flowers in order to
   a. see the flowers.
   b. smell the flowers.
   c. get nectar for food.
   d. hide from the wind and rain.
   e. I don't know.

6. On a summer day, which of the following clouds is most likely to bring rain?
   a. Thin fluffy clouds.
   b. Red clouds at sunset.
   c. Thick dark-gray clouds.
   d. Clouds that look like white sheep.
   e. I don't know.

7. The surest way to put out a fire of wood sticks is to
   a. fan the fire.
   b. soak the wood with water.
   c. put some dry grass on the fire.
   d. put some smaller sticks on the fire.
   e. I don't know.
8. Which of the following is most important in building muscles?
   a. Fat.
   b. Protein.
   c. Salt.
   d. Starch.
   e. Sugar.
   f. I don't know.

9. Nearly all rocks on the Earth's surface are
   a. gas.
   b. liquids.
   c. solids.
   d. I don't know.

10. One reason that there is day and night on Earth is that the
    a. Sun turns.
    b. Moon turns.
    c. Earth turns.
    d. Sun gets darker at night.
    e. I don't know.

11. If you see a bottle labeled ACID, you should
    a. add soap to it.
    b. put it in a box.
    c. be careful with it.
    d. put it under water.
    e. pour it down the sink.
    f. I don't know.

12. Which of these trees stays green in the United States during the winter?
    a. Apple.
    b. Elm.
    c. Maple.
    d. Pine.
    e. I don't know.

13. One is most likely to find an alligator in
    a. a swamp.
    b. the woods.
    c. the desert.
    d. a cold lake.
    e. I don't know.

14. For you to see something, what must reach your eyes?
    a. Light.
    b. Smoke.
    c. Sound.
    d. Nothing.
    e. I don't know.
15. Which of these plants does NOT have green leaves?
   a. A dandelion.
   b. Grass.
   c. A mushroom.
   d. A willow tree.
   e. I don't know.

16. If a lid is put on a jar in which a candle is burning, what happens?
   a. The candle breaks.
   b. The candle gets longer.
   c. The candle burns faster.
   d. The candle flame goes out.
   e. I don't know.

17. It is sunny, there is little wind, and a thermometer outdoors in the shade looks like the picture below.

   How should you dress to be comfortable outdoors?

   a. Wear a swim suit.
   b. Just wear your indoor clothes.
   c. Put on a sweater or light coat over your indoor clothes.
   d. Put on a heavy coat, muffler, wool cap, and boots over your indoor clothes.
   e. I don't know.

18. Which of these tasks would take the most work?
   a. Lifting a 10-pound weight 1 foot.
   b. Lifting a 20-pound weight 1 foot.
   c. Lifting a 10-pound weight 2 feet.
   d. Lifting a 20-pound weight 2 feet.
   e. I don't know.

19. You can see the Sun only in the daytime because
   a. the Earth is turning.
   b. people sleep at night.
   c. there are more clouds at night.
   d. the Sun shines only part of the time.
   e. I don't know.
20. Which of the following insects are most helpful to man?

a. Honeybees.
b. Lice.
c. Locusts.
d. Termites.
e. I don't know.

21. What can scientists learn by studying some fossils?

a. Why earthquakes took place.
b. What animals lived long ago.
c. How far the Moon is from the Earth.
d. What the weather will be tomorrow.
e. I don't know.

22. Jane wrapped the end of a piece of wire around the base of a flashlight bulb. When she touched the bottom of the bulb to the center of the top of a new battery, the bulb did not light. What should Jane do next to light the bulb?

a. Touch the end of the wire to the bulb.
b. Put the end of the wire in a drop of water.
c. Touch the bulb to the bottom of the battery.
d. Touch the end of the wire to the bottom of the battery.
e. I don't know.

23. Most land plants get most of their water directly from which of the following?

a. Animals.
b. Other plants.
c. Rivers.
d. The soil.
e. I don't know.

24. Most scientists think that the center of the Earth is very

a. cold.
b. dusty.
c. hot.
d. muddy.
e. I don't know.
25. The Sun and a penny are alike in which of the following ways?

a. Both weigh the same.
b. Both are made of atoms.
c. Both are made of metals.
d. Both are at the same temperature.
e. I don't know.

26. Our Sun is a

a. planet.
b. satellite.
c. solar system.
d. star.
e. I don't know.

27. The temperature that is thought most comfortable for a schoolroom is about

a. 40° Fahrenheit.
b. 50° Fahrenheit.
c. 70° Fahrenheit.
d. 90° Fahrenheit.
e. 100° Fahrenheit.
f. I don't know.

28. Cactus plants can live in the desert because

a. they are all very large.
b. they have large flowers.
c. they lose little water through leaves.
d. there are no animals in the desert to eat them.
e. I don't know.

29. A different substance is formed when

a. cloth is cut.
b. a cup breaks.
c. a candle burns.
d. a piece of chalk falls apart.
e. I don't know.
30. Tom wanted to find out whether plants can grow better in the dark or in the light. He put a pot with 6 radish seeds in a dark room and a pot with 6 bean seeds on the window sill.

He added the same amount of water to both pots. The bean seeds grew better than the radish seeds, so Tom said his plants grow best in the light.

To be able to say this, he should have

a. watered both plants more.
b. watered the radish seeds more.
c. put the same kind of seeds in both pots.
d. grown the seeds in water instead of soil.
e. I don't know.

31. Which of the following insects spread serious human diseases?

a. Ants.
b. Honeybees.
c. Houseflies.
d. Moths.
e. I don't know.

32. Which of the following is true of all matter?

a. It has a shine.
b. It has no taste.
c. It takes up space.
d. It has a square shape.
e. I don't know.

33. A quart of which of the following would weigh the most?

a. Air.
b. Mercury.
c. Sawdust.
d. Water.
e. I don't know.

34. Soon after a cold front has passed over St. Louis, one expects to find in St. Louis

a. clearing skies.
b. 100-mile-an-hour winds.
c. low atmospheric pressure.
d. the start of a 3-day snow.
e. I don't know.

35. Could a rock be broken into smaller and smaller pieces forever and still be rock?

a. Yes, because most rocks are made up of several things.
b. Yes, because there is no smallest piece of rock.
c. No, because you would finally get to atoms.
d. No, because rocks are very hard.
e. I don't know.
36. Coal is formed from
   a. dead plants.
   b. sand and mud.
   c. tiny sea animals.
   d. lava from volcanoes.
   e. I don't know.

37. A pint of water at a temperature of 50° Fahrenheit is mixed with a pint of water at 70° Fahrenheit. The temperature of the water just after mixing will be about
   a. 20° Fahrenheit.
   b. 50° Fahrenheit.
   c. 60° Fahrenheit.
   d. 70° Fahrenheit.
   e. 120° Fahrenheit.
   f. I don't know.

Weights of some Chemical Elements
Found in a 100 pound Human

<table>
<thead>
<tr>
<th>Element</th>
<th>Weight</th>
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<tbody>
<tr>
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<td>2 ounces</td>
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<tr>
<td>Sulfur</td>
<td>4 ounces</td>
</tr>
</tbody>
</table>

38. From the chart above, which chemical element is found in the GREATEST amount in the body?
   a. Calcium.
   b. Carbon.
   c. Hydrogen.
   d. Oxygen.
   e. Phosphorus.
   f. I don't know.

39. John has a flat tire on his bicycle. He pumps the tire up with an air pump and begins to ride. In a few minutes the tire is flat again. To fix his tire, John must find
   a. a better air pump.
   b. whether the tire is made of rubber.
   c. where the air leaks out of the tire.
   d. how many minutes it takes the tire to go flat.
   e. I don't know.
40. Someone said that if you mix salt and sugar with water and let the mixture stand you get salt-water taffy—a kind of candy. Which of the following would be the best way for you to test this idea?

   a. Take a vote among your friends.
   b. Buy some salt-water taffy and see if it has salt in it.
   c. Find out if salt and sugar have the same chemicals in them.
   d. Grind up some salt-water taffy to see if you get salt, sugar, and water.
   e. Try to mix salt, sugar, and water, let them stand, and see what happens.
   f. I don't know.

41. A man has been planting seeds and keeping records of how fast they grow. Could he be doing a science experiment?

   a. Yes.
   b. No.
   c. I don't know.

42. A doctor kept records of breathing rates of people when they were resting. He made the chart below.

   \[
   \begin{array}{|c|c|}
   \hline
   \text{Person} & \text{Breaths in a minute} \\
   \hline
   \text{Baby boys} & 38 \\
   \text{7-year-old girls} & 25 \\
   \text{7-year-old boys} & 25 \\
   \text{10-year old boys} & 20 \\
   \text{Mothers} & 16 \\
   \hline
   \end{array}
   \]

The chart suggests

   a. boys breathe faster than girls.
   b. girls breathe faster than boys.
   c. older people breathe faster than younger people.
   d. younger people breathe faster than older people.
   e. I don't know.

43. John took the outside temperature in the morning, at noon, and at night for two days. His record is shown below.

   \[
   \begin{array}{|c|c|c|}
   \hline
   \text{Day} & \text{Morning} & \text{Noon} & \text{Night} \\
   \hline
   \text{Tuesday} & 19° F & 16° F & 14° F \\
   \text{Wednesday} & 20° F & 16° F & 13° F \\
   \hline
   \end{array}
   \]

When was the temperature highest?

   a. Tuesday morning.
   b. Tuesday noon.
   c. Wednesday morning.
   d. Wednesday noon.
   e. I don't know.
44. Why do very few people get smallpox in the United States today?
   a. The weather conditions have changed.
   b. Most people get smallpox vaccinations.
   c. People move more often than they used to.
   d. People drink more milk today than ever before.
   e. All the germs that cause smallpox have been killed.
   f. I don't know.

45. You turn on a water faucet in your home and find that no water comes out. Which of the following could NOT have caused this to happen?
   a. The sink is full of water.
   b. The water pipe is full of rust.
   c. A water pipe is broken somewhere.
   d. Your home has been cut off from the water supply.
   e. I don't know.

46. Weights of some Chemical Elements
    Found in a 100 pound Human
    
    | Element   | Weight   |
    |-----------|----------|
    | Calcium   | 2 lb.    |
    | Carbon    | 18 lb.   |
    | Hydrogen  | 10 lb.   |
    | Oxygen    | 64 lb.   |
    | Phosphorus| 14 oz.   |
    | Sodium    | 2 oz.    |
    | Sulfur    | 4 oz.    |

   From the chart above, which of the following chemical elements is found in the SMALLEST amount in the body?
   a. Calcium.
   b. Carbon.
   c. Hydrogen.
   d. Sodium.
   e. Sulfur.
   f. I don't know.

47. Ice melts to water at 32° F. If water is cooled from 40° F, one should expect the freezing to take place at
   a. 30° F or lower.
   b. 32° F.
   c. 33° F.
   d. 34° F or higher.
   e. I don't know.

48. Mary blew up a balloon and rubbed it against the wall of her room. When she took her hand away, the balloon stayed on the wall without falling. Mary's friend who saw this said the following things about the balloon. Which is the MOST scientific?
   a. I do not believe that the balloon stayed up.
   b. It is a magic trick and cannot be explained.
   c. The balloon wanted to stay on the wall and not fall down.
   d. I cannot explain it, but there must be a reason why it stays up.
   e. I don't know.
49. Scientists would have most trouble testing which of the following?

a. I have a fever.
b. I weigh 101 pounds.
c. I am 62 inches tall.
d. I can lift a 20-pound box.

e. My dog is better than your dog.
f. I don't know.

50. What is a scientific theory?

a. It uses arithmetic.
b. It describes a scientist.
c. It describes an experiment.
d. It explains why some things act the way they do.

e. I don't know.

51. In science one is LEAST likely to do which of the following things with an apple?

a. Weigh it.
b. Measure its size.
c. Describe its color.
d. Write a poem about it.

e. Find how many seeds it has.
f. I don't know.

52. A plant grows this way: The first week it is 1 inch high. The second week it is 2 inches high. The third week it is 4 inches high. Which of the following graphs shows this growth?

- Graph A
- Graph B
- Graph C
- Graph D

53. When Block 1 swings down and hits Block 2, which of the following will most likely happen?

a. Block 2 will not move at all.
b. Block 2 will swing off to the left.
c. Block 2 will swing off to the right.
d. The string holding Block 2 will break.
e. I don't know.
54. Which of the letters on the map above is on an island?
   a. A  
   b. B  
   c. C  
   d. D  
   e. I don't know.

55. Do you think that the number thirteen (13) brings you bad luck?
   a. Yes.  
   b. No.  
   c. I don't know.

56. Big leaves usually give off more water than little leaves. Which of the following leaves gives off the most water?
   a.  
   b.  
   c.  
   d.  
   e. I don't know.

57. Which of the following will cause you to have bad luck for several years?
   a. Breaking a mirror.  
   b. Walking under a ladder.  
   c. Letting a black cat cross your path.  
   d. None of these.  
   e. I don't know.
When a rock is put into a pail of water, the water comes up to the line as the picture above shows. If the rock is broken into three pieces, which of the following pictures shows how high the water is?

a. A  
b. B  
c. C  
d. D  
e. E  
f. I don't know.
APPENDIX F. NAEP GRADE SEVEN SCIENCE ITEMS
PUPIL INFORMATION GRADE 7

(1) Sex  ____Boy  Girl ____

(2) Parent's Level of Education

____ Less than eighth (8th) grade
____ More than eighth (8th) grade but less than High School
____ High School Graduate
____ More than High School
Directions:

We would appreciate your cooperation in answering a number of questions related to science. Each question, as well as the responses, will be read aloud. You are asked to follow along by reading from your exercise booklet.

Please turn to the next page and follow along as the example is read.
Example: The planet on which we live is

a. Venus.
b. Earth.
c. Mars.
d. I don't know.

Now circle the letter which corresponds to the correct answer.

You should have circled the letter b since Earth is the correct answer. Each of the exercises to follow should be marked in the same manner. If you do not know the answer to a question, then circle the "I don't know" response.

Please wait until you hear the instructions before going on to the next question.

Are there any questions before we begin?

All right, now turn to question number one in the green section of your exercise booklet.
1. Where does a human baby come from?
   a. The stork brings the baby.
   b. The baby comes from its mother's body.
   c. The doctor gives the baby to the mother.
   d. The father buys the baby for the mother.
   e. The hospital keeps many babies and the mother picks one out.
   f. I don't know.

2. For which of the following reasons should you brush your teeth?
   a. To straighten your teeth.
   b. To make your teeth harder.
   c. To make your teeth sharper.
   d. To help your teeth grow larger.
   e. To help keep your teeth from decaying.
   f. I don't know.

3. On a summer day, which of the following clouds is most likely to bring rain?
   a. Thin fluffy clouds.
   b. Red clouds at sunset.
   c. Thick dark-gray clouds.
   d. Clouds that look like white sheep.
   e. A few lines of clouds high in the sky.
   f. I don't know.

4. Which of the following would most closely represent a balanced meal?
   a. Steak, bread, carrots, and milk.
   b. Ice-cream soda and cake.
   c. Potatoes, oatmeal, bread, and bananas.
   d. Poultry, steak, and fish.
   e. Hamburger and coke.
   f. I don't know.

5. The temperature that is considered most comfortable for a schoolroom is about
   a. 40° Fahrenheit.
   b. 50° Fahrenheit.
   c. 70° Fahrenheit.
   d. 90° Fahrenheit.
   e. 100° Fahrenheit.
   f. I don't know.

6. Fanning can make a campfire burn better because the fanning
   a. raises the atmospheric pressure.
   b. warms materials to their kindling points.
   c. increases the supply of materials that can burn.
   d. increases the supply of oxygen for the burning.
   e. provides the energy needed to keep the fire going.
   f. I don't know.
7. Which of the following diseases presently CANNOT be controlled by a vaccine that one receives by inoculation (shot) or swallowing?
   a. Cancer.
   b. Polio.
   c. Smallpox.
   d. Tetanus.
   e. Typhoid fever.
   f. I don't know.

8. Which of the following could be done on the Moon, where there is no air?
   a. Flying a kite.
   b. Building a bonfire.
   c. Flying an airplane.
   d. Floating a balloon.
   e. Launching a rocket.
   f. I don't know.

9. Which of the following is usually true of sedimentary rock?
   a. It is formed in layers.
   b. It has large shiny crystals.
   c. It will dissolve easily in water.
   d. It is formed on mountain tops.
   e. It can be melted over a burner flame.
   f. I don't know.

10. Recent scientific observations indicate that the earliest men on Earth
    a. lived in cities.
    b. lived on ocean beaches.
    c. were small, hairy, and stooped.
    d. had brains the size of a walnut.
    e. lived near the north and south poles.
    f. I don't know.

11. Which of the following is true of hot water as compared with cold water?
    a. It is denser.
    b. It is easier to see through.
    c. Its molecules are moving faster.
    d. It has more free oxygen dissolved in it.
    e. It has more free hydrogen dissolved in it.
    f. I don't know.

12. Information about which one of the following is most important in predicting weather?
    a. The available supplies of water.
    b. The daily extremes of humidity.
    c. The daily extremes of wind speed.
    d. The daily extremes of temperature.
    e. The movement and characteristics of air masses.
    f. I don't know.
13. Which of the following would LEAST upset the balance of animal and plant life in a small area?
   a. Burning a forest.
   b. Draining a swamp.
   c. Constructing a dam.
   d. Broadcasting radio waves.
   e. Killing all hawks, owls, and vultures in the area.
   f. I don't know.

14. Flower seeds develop from
   a. leaves.
   b. ovules.
   c. petals.
   d. roots.
   e. stems.
   f. I don't know.

15. In order to make the beam balance, you should hang a 2-pound weight on the LEFT-HAND SIDE at position
   a. 1.
   b. 2.
   c. 3.
   d. 4.
   e. 5.
   f. I don't know.

16. A spoon in a glass of water appears to bend sharply at the water surface. This apparent bending is due to
   a. absorption.
   b. color bands.
   c. interference.
   d. refraction.
   e. shadows.
   f. I don't know.

17. Most of the chemical energy of the gasoline in a car is not used to move the car but is changed into
   a. electricity.
   b. heat.
   c. light.
   d. magnetism.
   e. sound.
   f. I don't know.
18. Mercury can be enclosed in glass to make a thermometer because mercury
   a. is a metal.
   b. is more dense than glass.
   c. conducts heat better than glass.
   d. conducts electricity better than glass.
   e. expands more than glass when both are heated together.
   f. I don't know.

19. Which of the following best describes the results of pasteurization of milk?
   a. All bacteria are killed.
   b. The milk is homogenized.
   c. The taste of milk is improved.
   d. Bacteria harmful to man are killed.
   e. The milk is permanently kept from spoiling.
   f. I don't know.

20. A block of wood floats in fresh water as shown above. If this block were placed in salt water from the ocean, which of the following diagrams shows what would happen?

   a. A
   b. B
   c. C
   d. D
   e. E
   f. I don't know.

21. Most caves are formed by the action of underground water on
   a. granite.
   b. limestone.
   c. pumice.
   d. sandstone.
   e. shale.
   f. I don't know.
22. In terms of the theory of natural selection, what is the explanation of why giraffes have come to have such long necks?
   a. Stretching to get food in high trees has made their necks longer.
   b. There is something inside of giraffes which keeps making longer necks.
   c. Giraffe food contained vitamins which caused vertabrae to lengthen.
   d. Giraffe necks have gotten longer and longer as time has gone on, but nobody has any idea why this is.
   e. Giraffe born with the longest necks have been able to stay alive when food was scarce and have passed this trait on to their offspring.
   f. I don't know.

23. Which of these is characteristic of birds but of no other animals?
   a. Ability to fly.
   b. Ability to lay eggs.
   c. Tendency to migrate.
   d. Body covering of feathers.
   e. Regulated body temperature.
   f. I don't know.

24. Why do we think that matter is made up of atoms?
   a. We can see atoms with a microscope.
   b. We can see atoms with our unaided eyes.
   c. We can see atoms with a magnifying glass.
   d. Matter behaves as if it were made up of atoms.
   e. A famous wise man said many hundreds of years ago that matter is made of atoms.
   f. I don't know.

25. Which of the following should you do when a person faints?
   a. Tightly bandage him.
   b. Lay him down and keep him warm.
   c. Hold him up and apply hot packs.
   d. Hold him up and apply cold packs.
   e. Lay him down and apply cold packs.
   f. I don't know.

26. Which of the following most clearly forms molecules different from those present at the start?
   a. Ice melting.
   b. A cup breaking.
   c. Cloth being torn.
   d. A candle burning.
   e. A piece of chalk falling apart.
   f. I don't know.
27. In mammals, which of the following is the center of memory and intelligence?

a. Cerebellum.
b. Cerebrum.
c. Medulla.
d. Optic nerve.
e. Spinal cord.
f. I don't know.

28. A fossil of an ocean fish was found in a rock outcrop on a mountain. This probably means that

a. fish once lived on the mountain.
b. the relative humidity was once very high.
c. the mountain was raised up after the fish died.
d. fish used to be amphibians like toads and frogs.
e. the fossil fish was probably carried to the mountain by a great flood.
f. I don't know.

29. Weights of some Chemical Elements Found in a 100 pound human

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</tr>
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From the chart above, which chemical element is found in the GREATEST amount in the body?

a. Calcium.
b. Carbon.
c. Hydrogen.
d. Oxygen.
e. Phosphorus.
f. I don't know.

30. A man notices that the paint on one side of his house is not lasting as well as the paint on the other sides. Which of the following is the most likely cause?

a. Termites.
b. Cosmic rays.
c. Wind or sun.
d. Fallout from atom bombs.
e. Sonic booms from low-flying jets.
f. I don't know.
Weights of some Chemical Elements  
Found in a 100 pound Human  

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</tbody>
</table>

31. From the chart above, which of the following chemical elements is found in the LEAST amount in the body?
   a. Calcium.
   b. Carbon.
   c. Hydrogen.
   d. Sodium.
   e. Sulfur.
   f. I don't know.

32. The three solid objects shown above have the same volume.  If they float as shown in the diagram, which one weighs the most?
   a. Object A.
   b. Object B.
   c. Object C.
   d. They all weigh the same.
   e. It is impossible to tell without additional information.
   f. I don't know.

33. Skill in which of the following is most useful in scientific research?
   b. Magic.
   c. Marketing.
   d. Mathematics.
   e. Manufacturing.
   f. I don't know.
34. Two guinea pigs, I and II, were put on different diets for a month. The graph above shows what happened to their weights. Which of the following statements is correct according to the information in the graph?

a. Guinea pig I lost weight while guinea pig II gained weight.
b. Guinea pig I and guinea pig II weighed the same at the beginning of the experiment.
c. Guinea pig I and guinea pig II weighed the same on the 15th day of the experiment.
d. Guinea pig I was given meat and corn whereas guinea pig II was given sugar and crackers.
e. Guinea pig II lost weight at first, but started to gain about halfway through the experiment.
f. I don't know.

35. In each of five experiments, two objects were weighed four times each. Which experiment gives the strongest evidence that object I weighs more than object II?

<table>
<thead>
<tr>
<th>Object I</th>
<th>Object II</th>
</tr>
</thead>
<tbody>
<tr>
<td>80 lb.</td>
<td>70 lb.</td>
</tr>
<tr>
<td>81</td>
<td>69</td>
</tr>
<tr>
<td>80</td>
<td>71</td>
</tr>
<tr>
<td>82</td>
<td>70</td>
</tr>
<tr>
<td>69</td>
<td>81</td>
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<td>71</td>
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<td>78</td>
<td>75</td>
</tr>
<tr>
<td>77</td>
<td>74</td>
</tr>
</tbody>
</table>

f. I don't know.
Michael kept a record of his dog's weight from birth on May 1 in order to find out how much dog food to give his dog. The directions on the bag of dog food for feeding a dog are as follows:

<table>
<thead>
<tr>
<th>Weight of Dog</th>
<th>Number of Cups of Food Daily</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 20 pounds</td>
<td>1</td>
</tr>
<tr>
<td>20 to 40 pounds</td>
<td>2</td>
</tr>
<tr>
<td>41 to 60 pounds</td>
<td>3</td>
</tr>
<tr>
<td>Over 60 pounds</td>
<td>4</td>
</tr>
</tbody>
</table>

In what month should the dog's daily allowance have been increased to 4 cups?

a. July.
b. August.
c. September.
d. October.
e. November.
f. I don't know.

37. Scientists would have most trouble testing which of the following?

a. I have a fever.
b. I am 62 inches tall.
c. I weigh 101 pounds.
d. I can lift a 20-pound box.
e. My dog is better than your dog.
f. I don't know.

38. Whenever scientists carefully measure any quantity many times, they expect that

a. all of the measurements will be exactly the same.
b. only two of the measurements will be exactly the same.
c. all but one of the measurements will be exactly the same.
d. most of the measurements will be close but not exactly the same.
e. I don't know.
Select the pieces of apparatus shown above that one would use to find the boiling point of water.

a. 1, 4, 5, 6, 7.
b. 2, 3, 4, 6, 7.
c. 4, 5, 6, 8, 9.
d. I don't know.

d. 1, 4, 5, 6, 7.
e. 1, 4, 5, 7, 9.
f. 4, 5, 6, 8, 9.
a. I don't know.

41. What is a scientific theory?

a. It uses arithmetic.
b. It describes a scientist.
c. It describes an experiment.
d. It tells all there is to know about something.
e. It explains why some things act the way they do.
f. I don't know.
42. **Women can be successful scientists.**

   a. I believe this statement.
   b. I don't believe this statement.
   c. I don't know.

43. **Do you think that scientists always work in laboratories?**

   a. Yes.
   b. No.
   c. I don't know.

44. **Do you ask questions about why things in nature are the way they are?**

   a. Often
   b. Sometimes.
   c. Never.
APPENDIX G. NAEP GRADE TWELVE SCIENCE ITEMS
PUPIL INFORMATION GRADE 12

(1) Sex ______Boy   Girl ______

(2) Parent's Level of Education

_____ Less than eighth (8th) grade

_____ More than eighth (8th) grade but less than High School

_____ High School Graduate

_____ More than High School
Directions:

We would appreciate your cooperation in answering a number of questions related to science. Each question, as well as the responses, will be read aloud. You are asked to follow along by reading from your exercise booklet.

Please turn to the next page and follow along as the example is read.
Example: The planet on which we live is

a. Venus.
b. Earth.
c. Mars.
d. I don't know.

Now circle the letter which corresponds to the correct answer.

You should have circled the letter (b) since Earth is the correct answer. Each of the exercises to follow should be marked in the same manner. If you do not know the answer to a question, then circle the "I don't know" response.

Please wait until you hear the instructions before going on to the next question.

Are there any questions before we begin?

All right, now turn to question number one in the green section of your exercise booklet.
1. Which of the following groups of animals and plants would be found in a desert community?
   a. Ground hogs, deer, oak, fern.
   b. Grizzly bears, buffaloes, fir, grass.
   c. Ducks, herons, water lilies, cattails.
   d. Starfish, sand dollars, kelp, plankton.
   e. Snakes, road runners, cactus, sagebrush.
   f. I don't know.

2. Which of the following would most closely represent a balanced meal?
   a. Steak, bread, carrots, and milk.
   b. Ice-cream soda and cake.
   c. Potatoes, oatmeal, bread, and bananas.
   d. Poultry, steak, and fish.
   e. Hamburger and coke.
   f. I don't know.

3. At the present time nearly all gasoline comes from
   a. coal.
   b. petroleum.
   c. water.
   d. wood.
   e. I don't know.

4. Which of the following animals that have been found as fossils in rocks have NEVER been seen alive by man?
   a. Dinosaurs.
   b. Horses.
   c. Locusts.
   d. Oysters.
   e. Shrimp.
   f. I don't know.

5. Information about which one of the following is most important in predicting weather?
   a. The available supplies of water.
   b. The daily extremes of humidity.
   c. The daily extremes of wind speed.
   d. The daily extremes of temperature.
   e. The movement and characteristics of air masses.
   f. I don't know.

6. All of the following help to increase the total amount of food available to the human race EXCEPT
   a. irrigating crops.
   b. developing hybrids.
   c. improving fertilizers.
   d. outlawing the use of insecticides.
   e. controlling the growth of undesirable plants.
   f. I don't know.
7. Any galaxy contains many
   a. moons.
   b. planets.
   c. satellites.
   d. stars.
   e. winds.
   f. I don't know.

8. An electric current in a copper wire involves mainly the movement of
   a. copper atoms.
   b. copper molecules.
   c. electrons.
   d. neutrons.
   e. protons.
   f. I don't know.

9. The idea of natural selection is usually associated with the theory of evolution by
   a. Charles Darwin.
   b. Edward Jenner.
   c. Jean Lamarck.
   d. Louis Pasteur.
   e. Jonas Salk.
   f. I don't know.

10. Changes such as the conversion of limestone to marble or of soft coal to hard coal are explained as having been brought
    a. by sudden cooling of the materials.
    b. by exposure to gases from a volcano.
    c. by exposure to an underground river.
    d. by the action of CO2 from the atmosphere.
    e. by heat and pressure below the Earth's surface.
    f. I don't know.

11. The solid, liquid, and gaseous states of water differ in which of the following ways?
    a. The number of protons per molecule.
    b. The number of electrons per molecule.
    c. The net charge on the individual molecules.
    d. The number of neutrons per individual molecule.
    e. The average speed with which the molecules are moving.
    f. I don't know.

12. Which of the following can be detected with unaided human eyes?
    a. X-rays.
    b. Radio waves.
    c. Television waves.
    d. The Earth's magnetic field.
    e. Certain wavelengths of light.
    f. I don't know.
13. Research into the nature of matter shows that it is made up of

a. continuous uniform material.
b. uniform stationary particles.
c. individual moving particles.
d. smooth rolling disks.
e. rigid cubes.
f. I don't know.

14. In terms of the theory of natural selection, what is the explanation of why giraffes have come to have such long necks?

a. Stretching to get food in high trees has made their necks longer.
b. There is something inside of giraffes which keeps making longer necks.
c. Giraffe food contained vitamins which caused the vertebrae to lengthen.
d. Giraffe necks have gotten longer and longer as time has gone on, but nobody has any idea why this is.
e. Giraffes born with the longest necks have been able to stay alive when food was scarce and have passed this trait on to their offspring.
f. I don't know.

15. If 2 pints of water at 40°F are mixed with a pint of water at 100°F, the temperature of the mixture immediately after mixing will be about

a. 40°F.
b. 50°F.
c. 60°F.
d. 80°F.
e. 100°F.
f. I don't know.

16. Which of the following acts as a stimulant to the heart?

a. Adrenaline.
b. Alcohol.
c. Aspirin.
d. Barbituates.
e. Penicillin.
f. I don't know.

17. Mercury can be enclosed in glass to make a thermometer because mercury

a. is a metal.
b. is more dense than glass.
c. conducts heat better than glass.
d. has a higher specific heat than glass.
e. expands more than glass when both are heated together.
f. I don't know.

18. For most chemical changes, which of the following most nearly describes what occurs?

a. Atoms are formed from energy.
b. Atoms are converted into energy.
c. Atoms are rearranged into new molecules.
d. Molecules are formed from energy.
e. Molecules are converted into energy.
f. I don't know.
19. A 5-pound rock is dropped from a cliff 500 feet high. The longer the rock falls, the greater is its
   a. acceleration.
   b. potential energy.
   c. speed.
   d. total energy.
   e. volume.
   f. I don't know.

20. A motor boat can travel 5 miles per hour on a still lake. If this boat travels downstream on a river that is flowing 5 miles per hour, how long will it take the boat to reach a bridge that is 10 miles downstream?
   a. 15 min.
   b. 30 min.
   c. 45 min.
   d. 60 min.
   e. 75 min.
   f. I don't know.

21. Which of these is characteristic of birds but of no other animals?
   a. Ability to fly.
   b. Ability to lay eggs.
   c. Tendency to migrate.
   d. Body covering of feathers.
   e. Regulated body temperature.
   f. I don't know.

22. If a person who is a light eater has a tendency to be overweight, it is most likely due to
   a. too much exercise.
   b. a carefully balanced diet.
   c. a tendency toward nervousness.
   d. an excessive dosage of vitamins.
   e. highly efficient utilization of food by the body.
   f. I don't know.

23. The purpose of a fuse in an electric circuit is
   a. to increase the current in the circuit.
   b. to increase the voltage across the circuit.
   c. to decrease the resistance of the circuit.
   d. to prevent possible damage to the circuit.
   e. to raise the temperature of the wires in the circuit.
   f. I don't know.

24. The musical note middle C is sounded on a violin string, and then C one octave higher is sounded on the same string. Which of the following is correct in comparing the two notes?
   a. Both have the same frequency but different wavelengths.
   b. Both have the same frequency but different amplitudes.
   c. Middle C has a higher frequency and longer wavelength.
   d. Upper C has a higher frequency and shorter wavelength.
   e. I don't know.
25. What is the function of the placenta in a pregnant human female?
   a. To push the baby out at birth.
   b. To keep the baby warm and moist.
   c. To carry nourishment to the baby.
   d. To cushion the baby against shocks.
   e. To keep the baby's body temperature constant.
   f. I don't know.

26. Adding table salt to water results in the water's
   a. freezing at a lower temperature.
   b. changing into its elements.
   c. evaporating faster.
   d. dissolving more air.
   e. becoming radioactive.
   f. I don't know.

27. What carries sound to your ears from a radio or television receiver 15 feet away?
   a. Electric currents.
   b. Molecules of air.
   c. Polarized waves.
   d. Radio waves.
   e. I don't know.

28. If the cells referred to were all in the same organism, in which of the following is the amount of DNA present stated correctly?
   a. It would be identical in mature egg and sperm cells.
   b. It would be identical in sperm cells and liver cells.
   c. It would be identical in a mature egg cell and a brain cell.
   d. It would be half as much in a thyroid cell as in a liver cell.
   e. It would be half as much in the fertilized egg as in a thyroid gland cell.
   f. I don't know.

29. Two light waves are traveling in a vacuum. The wave with the higher frequency will have the
   a. higher speed.
   b. lower speed.
   c. longer wavelength.
   d. shorter wavelength.
   e. more nearly horizontal direction.
   f. I don't know.

30. On the average, in human females, the egg is released how many days after menstruation begins?
   a. 2 days.
   b. 9 days.
   c. 14 days.
   d. 20 days.
   e. 24 days.
   f. I don't know.
31. In the section of the electric circuit shown below, the voltmeter registers 100 volts and the ammeter registers 20 amperes.

If the connecting wires and the ammeter have negligible resistance, the resistance of resistor X is

a. 1 ohm.
b. 5 ohms.
c. 10 ohms.
d. 100 ohms.
e. 2,000 ohms.
f. I don't know.

32. Scientists can determine the age of certain rocks and their fossils by measuring

a. their specific gravities.
b. their crystalline structure.
c. the rate at which they have eroded.
d. the ratio of calcium to phosphorus in them.
e. the amounts of uranium and lead they contain.
f. I don't know.

33. Experiments in which subatomic particles were shot at metal foil showed that atomic nuclei

a. rotate counterclockwise.
b. are electrically neutral.
c. are more dense than the rest of the atom.
d. vibrate to and fro in simple harmonic motion.
e. are nearly as large as the atoms that contain them.
f. I don't know.

34. Which of these is synthesized in the mitochondria, then later broken down in the nucleus and endoplasmic reticulum, with a resulting release of energy?

a. ATP.
b. DNA.
c. RNA.
d. Lysosome.
e. Golgi body.
f. I don't know.

35. Which of these has been used to obtain accurate estimates of the age of the oldest known rock strata?

a. Radiocarbon dating.
b. Uranium-lead dating.
c. Potassium-argon dating.
d. Estimation of sedimentation rates.
e. Correlation of age of fossils contained in the strata.
f. I don't know.
36. In the equation below, which of the following elements are oxidized?

\[ \text{SnS} = 4\text{HNO}_3 \rightarrow \text{S} + \text{SnO}_2 + 4\text{NO}_2 + 2\text{H}_2\text{O} \]

- a. Tin and sulfur.
- b. Tin and nitrogen.
- c. Sulfur and oxygen.
- d. Oxygen and hydrogen.
- e. Nitrogen and oxygen.
- f. I don't know.

37. Metal cans for holding foodstuffs are chiefly made of

- a. copper.
- b. iron.
- c. nickel.
- d. tin.
- e. I don't know.

38. A horizontal wire extends in the north-south direction. When a compass is placed directly beneath the wire, the compass needle turns and points east. It would be reasonable to infer that

- a. electrons are flowing north in the wire.
- b. electrons are flowing south in the wire.
- c. the wire is magnetized.
- d. the wire is positively charged.
- e. the wire is negatively charged.
- f. I don't know.

39. In each of five experiments, two objects were weighed four times each. Which experiment gives the strongest evidence that object I weighs more than object II?

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Object I</th>
<th>Object II</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>80 lb.</td>
<td>70 lb.</td>
</tr>
<tr>
<td></td>
<td>81</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td>80</td>
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<tr>
<td>B</td>
<td>69</td>
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<td></td>
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<td>80</td>
</tr>
<tr>
<td>C</td>
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<td>75</td>
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<td></td>
<td>77</td>
<td>74</td>
</tr>
</tbody>
</table>

- f. I don't know.
40. In a particular meadow there are many rabbits that eat the grass. There are also many hawks that eat the rabbits. Last year a disease broke out among the rabbits and a great number of them died. Which of the following probably then occurred?

a. The grass died and the hawk population decreased.
b. The grass died and the hawk population increased.
c. The grass grew taller and the hawk population decreased.
d. The grass grew taller and the hawk population increased.
e. Neither the grass nor the hawks were affected by the death of the rabbits.
f. I don't know.

41. Which of the following is a theory rather than a fact or an opinion about platinum?

a. Platinum is a metal.
b. Platinum is more dense than water.
c. Platinum is the most beautiful metal.
d. Wedding bands should be made of platinum.
e. Mesons account for the stability of the nuclei of platinum atoms.
f. I don't know.

42. A student made the following statement, "Some carbon atoms in the bread that I ate last night might have once been part of a dinosaur's body."

Which of the following is the best appraisal of the student's statement?

This statement

a. contradicts the law of conservation of matter.
b. is ridiculous because dinosaurs lived so long ago.
c. could be true because atoms are rarely created or destroyed.
d. could be true only if the bread was grown in soil containing dinosaur fossils.
e. could not possibly be true because dinosaurs were animals but wheat is a plant.
f. I don't know.

43. A particular cell is shaped like a cube. If all its linear dimensions were doubled, its volume would increase

a. 3 times.
b. 4 times.
c. 6 times.
d. 8 times.
e. 16 times.
f. I don't know.
44. Corn is planted in a flask as shown below. The flask is weighed each day for three weeks. The flask shows a daily weight loss.

Which of the following is the best explanation of this loss of weight?

a. The original water evaporates within the first day.
b. Carbon dioxide is lighter in weight than ordinary air.
c. Seed material is changed to leaves and roots that weigh less.
d. The seedlings use starch in the seeds and give off gases that escape.
e. Dry air enters through the stopper and replaces the moist air in the flask.
f. I don't know.

45. Skill in which of the following is most useful to scientific research?

b. Magic.
c. Marketing.
d. Mathematics.
e. Manufacturing.
f. I don't know.

46. Whenever scientists carefully measure any quantity many times, they expect that

a. all of the measurements will be exactly the same.
b. only two of the measurements will be exactly the same.
c. all but one of the measurements will be exactly the same.
d. most of the measurements will be close but not exactly the same.
e. I don't know.

47. Boyle's law, Charles' law, and Graham's law dealing with the behavior of gases can all be generalized in terms of which of the following?

a. Quantum theory.
b. Recapitulation theory.
d. Kinetic-molecular theory.
e. Theory of natural selection.
f. I don't know.

48. Most scientists

a. want to know more about the world.
b. plan experiments as hastily as possible.
c. believe that some things happen without causes.
d. permit likes and dislikes to outweigh their observations.
e. use facts gathered by their own experiments and observations and pay no attention to results of others.
f. I don't know.
49. United States scientists are ahead of scientists in other countries in every field of research.

a. I believe this statement.
b. I don't believe this statement.
c. I don't know.

50. If you learn about a special television program dealing with a scientific topic, do you watch it?

a. Often.
b. Sometimes.
c. Never.
APPENDIX H. THIRTEEN STRATA
Figure 1. Category: other
Figure 2. Category: urban
Figure 3. Category: suburban
APPENDIX I. INTER-ITEM CORRELATIONS FOR AFFECTIVE MEASURES
Table 24. Correlation matrix with representative sample of inter-item coefficients for school subscale of secondary attitude measure

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Table 25. Correlation matrix with representative sample of inter-item coefficients for teacher subscale of intermediate attitude measure

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1. Tables 24-27 include examples (drawn at random) of inter-item coefficients for items within various subscales of the affective measures.
Table 26. Correlation matrix with representative sample of inter-item coefficients for family subscale of secondary self concept measure

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Table 27. Correlation matrix with representative sample of inter-item coefficients for peer subscale of intermediate self concept measure

<table>
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APPENDIX J. FLANAGAN DISCRIMINATION INDICES
Table 28. Flanagan Discrimination Index for grade 4 NAEP science exercises

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Source: Reference 27.
Table 29. Flanagan Discrimination Index for grade 7 NAEP science exercises\(^a\)

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