DOCUMENT RESUME

ED 368 559 SE 054 254

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TITLE	Comparison of Science Attitudes among Middle and Junior High School Students.
PUB DATE	Nov 93
NOTE	82p.; Paper presented at the Annual Meeting of the Mid South Educational Research Association (New Orleans, LA, November 10-12, 1993).
PUB TYPE	Reports - Research/Technical (143) -- Tests/Evaluation Instruments (160) -- Speeches/Conference Papers (150)
EDRS PRICE	MF01/PC04 Plus Postage.
DESCRIPTORS	*Age Differences; Classroom Research; Elementary School Students; Excellence in Education; Intermediate Grades; Junior High Schools; *Junior High School Students; Middle Schools; *Racial Differences; Science Education; *Scientific Attitudes; *Sex Differences
IDENTIFIERS	*Middle School Students

ABSTRACT

Some researchers have begun to investigate students' attitudes toward science and their scientific attitudes as possible effectors of students' scientific achievement. In this study both of the aforementioned factors are examined by administering the Test of Science Related Attitudes (TOSRA) to 35 sixth grade students, 21 seventh grade students, and 34 eighth grade students. Comparisons made between male and female students, black and white students, and students from grades six, seven, and eight revealed that there are numerous instances where a significant difference exists between each of the corresponding groups. These results combined with recent research findings suggest that students' attitudes do indeed effect classroom performance. This suggested that through the use of innovative teaching methods, hands-on instruction, and enthusiastic teachers much can be done to change students' attitudes. The TOSRA instrument is appended. (ZWH)

Comparison of Science Attitudes Among Middle and Junior High School Students

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Paper presented at the annual meeting of the

Mid South Educational Rearch Association

New Orleans, Louisiana

November 10-12, 1993

Running Head: SCIENCE ATTITUDES AMONG STUDENTS

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Chapter 1 - Introduction

Purpose

In the 1960's, the United States led the world in science and U.S. students scored as well in science as students anywhere in the world; America assumed that it would continue to lead the world in science and that our students would grow up to be scientifically literate to continue that tradition. The earliest indications to shake that assumption occurred in 1970 when the first National Assessment of Educational Progress appeared; science scores were significantly lower than expected (Howe, 1988). The next indication came in 1973 when "Science Education in Nineteen Countries" was published; American students were learning significantly less science than students in many other countries. American students scored below the average on most scales, and the top one percent were only average (Howe, 1988). The general awareness of the problem occurred with the three assessments of the National Assessment of Educational progress conducted in 1969-70; 1972-73; and 1976-77, published in 1979 (Howe, 1988).

"A Nation At Risk" was published on April 26, 1983, by the National Commission of Excellence in Education; since then an additional

200 national, state, and local reports have confirmed the results (Glass, 1990). The evidence is overwhelming; science education in America is failing in its objectives. In "Changing America: The new face of science and engineering (1988)", it was reported that U.S. ten-year-olds were about average compared to ten-year-olds from the other industrialized countries. "However, by the time U.S. fourteen-year-olds enter high school, they have dropped to 14th rank among 17 countries' students. U.S. students score as follows:

9th out of 13 countries in physics

11th out of 13 countries in chemistry

13th out of 13 countries in biology" (Moore, 1990).

Our system is producing scientifically illiterate students and driving students away from science. In early elementary school, more than 70% of students say they are interested in science (Weiss, 1989). By the third grade, only half of all students want to take more science. By the fifth grade, only 20% of these students wants to take more science. Less than 50% of all students take a science course after the tenth grade (Moore, 1990). Science enrollments drop by more than one half each succeeding year. Only 20% of high school students in the U.S. take physics (Hoffman, Stage, 1993).

Science teachers, science education, and teacher education have been blamed for students' low achievement in science and for their reportedly poor attitudes. A variety of reforms have been implemented to improve science instruction, interest, and achievement. College entrance requirements and, hence, graduation requirements have been raised; four courses in laboratory-based high school science are now recommended. Teacher education has been improved; instructional management plans have been implemented. Science textbooks have been improved; and more technology is now available. Many grants for teacher retraining and teacher improvement workshops have been made available. Educational researchers have been spurred to search for solutions to these problems.

One area of educational research has been on student attitudes and what effect the students' attitudes have on student achievement. Attitude research has been going on formally since the 1960's; however, early attempts to measure attitudes began with Thurstone in 1928 and Likert in 1932. Sophisticated psychometrics concerning attitudes were developed in the early 1960's.

Attitude research has come into its own in the 1990's, and many new attitude measurement instruments have been developed and refined. The purpose of this study was to measure the attitudes toward science and scientific attitudes using the Test of Science Related Attitudes of sixth, seventh, and eighth grade students at a middle school and a junior high in the Meridian Public School District.

Research Questions

The following questions were used to establish the problem:

1. Is there a significant difference between attitudes toward science and scientific attitudes among sixth and seventh grade students at a middle school and eighth grade students at a junior high school?

2. Is there a significant difference between attitudes toward science and scientific attitudes between male and female sixth, seventh, and eighth grade students?

3. Is there a significant difference between attitudes toward science and scientific attitudes between black and white sixth, seventh, and eighth grade students?

Limitations

1. The study was limited to 35 sixth grade students, 21 seventh

grade students at Magnolia Middle School and 34 eighth grade students at Kate Griffin Junior High School for the 1992-93 school year.

2. The study was limited to five intact groups taught by the same teacher at these two schools; there was a lack of randomized groups.

3. The small sample size does not permit extrapolation to a larger group.

4. The study was limited by the extraneous variable of maturation.

5. The study was limited by only one testing of attitudes at the end of the 1992-93 school in May.

Definition of Terms

1. Attitude measurement instrument chosen was the TOSRA-the Test of Science Related Attitudes.

2. Only three categories of the TOSRA were chosen for statistical analysis; these were:

A. Attitude to Scientific Inquiry

B. Adoption of Scientific Attitudes

C. Enjoyment of Science Lessons

3. There is a difference between attitudes toward science and scientific attitudes. Scientific attitudes are behaviors associated with

critical thinking and characterize the thinking processes of scientists. Attitudes toward science are learned predispositions to respond in a consistently favorable or unfavorable manner toward science (Koballa, 1988).

4. The students who took part in this survey ranged in age from 10.5 to 16 years old. They were heterogeneously group by grade into three courses; these were:

A. sixth grade-General Science

B. seventh grade-Earth and Space Science

C. eighth grade-Physical Science

5. The independent variables were the grade level, the course taught the students, sex, and race.

6. The dependent variables were the attitudes toward science and the scientific attitudes of the students.

7. The extraneous variables were the two schools attended.

Chapter 2 - Review of Literature

Science is still in trouble. In the Wednesday, July 7, 1993 edition of the Clarion-Ledger (Jackson, MS) newspaper, the article titled, "Black, white gap widens in math, science", states, "Educators said that the results show the United States has a long way to go to meet its goal of having the world's brightest and best math and science students by 2000. 'The results are very disconcerting,' said Luther Williams of the National Science Foundation." The article also states, "Math and science test scores of the nation's eighth-graders climbed slightly last year. . ." (Clarion-Ledger, July 7, 1993, p. l).

The evidence has been overwhelming. While U.S. ten-year-olds are reported to be "about average in the level of science achievement as compared with their peers from other industrialized countries, by the time U.S. 14 year olds enter high school, they score 14th among students from 17 countries" (Moore, 1990). And the rankings of twelfth-graders in biology, chemistry, and physics do not improve; these rankings are also near the bottom of the seventeen country group.

American students are not learning as much science as their counterparts in many other countries. U.S. students scored well

> below the average on most measures; and, even when the U.S. top one percent were compared to the top one percent from other countries, U.S. students were only average. Students in other countries, particularly Japan and the Soviet Union, knew more science and math than U.S. students (Howe, 1988, p. 309).

In the 1983 U.S. high school graduating class only 16% had taken physics, 35% had taken chemistry, and 77% had taken biology (Glass, 1990).

The current educational system is driving students away from science.

> By third grade only 50 percent of all students want to take more science courses. By the time they reach the 8th grade, only one in 5 students wants to take more science. Less than half of all students take a science course after the 10th grade (Moore, 1990, p. 330).

"Although 70 percent of elementary students say they are interested in science by the time they reach high school, science enrollments drop by more than one half each year. Only 20 percent of high school students nationally take the final course in physics. . ."(Hoffman, Stage, 1993, p.

28).

Why do we have these abysmal statistics on low achievement and poor attitude? What does attitude have to do with achievement? This question was the impetus for the formal investigation of the relationship between attitudes toward science and achievement in science. Attitude research in education started with theories borrowed from social psychology. "Beginning with Thurstone (1928) and Likert (1932), psychometrics dealing with attitude assessment climbed to a sophisticated level by the early 1960's" (Shrigley, Koballa, 1992, p. 28). Attitude measurement research has come into its own in the 1990's.

To understand attitude research, one must begin with definitions of attitude. There is a difference between scientific attitudes and attitudes toward science. Simpson and Troost (1980) defined attitude as commitment to science; they used the term "to include the interests, attitude, values, and other affective behaviors of students. . ." (Simpson, Troost, 1980, p. 765). Their definition included not only student desire to major in science but also student desire to take more sciences, to continue reading in science, to explore current scientific topics, and to be involved in science-related social issues (Simpson, Troost, 1980).

Shrigley (1983) did a comprehensive review of the literature to define the difficult term attitude; in his work, he mentioned Bogardus' social distance scale of the mid-1920's as bringing about quantitative measurement of attitude. Shrigley also mentioned Thurstone's paper, "Attitudes Can Be Measured" (1928) as a basis of attitude measurement. Thurstone, and later Likert, hypothesized that attitudes could be measured along a continuum from greatly favorable to greatly unfavorable. The discussion then moved to Carl Hovland's persuasive communication approach in the 1930's; Hovland's approach was the basis of attitude research for more than 30 years. According to Shrigley, attitudes are learned and thus attitudes drive behavior to some extent. (Shrigley, 1983).

Harty, Anderson, and Enochs (1984) tried to show the relationship between interest in science, attitudes toward science, and reactive curiosity of elementary students. They used Secord and Backman's definition of attitudes as "regularities of an individual's feelings, thoughts, and predispositions to act towards some aspect of the environment" (Harty, Anderson, Enochs, 1984, p. 309). Steven Rakow published a study in 1985 on minority students in science: he used the 1981-82

National Assessment in Science to make some definitive statements about minority attitudes and achievement in science.

Koballa and Crawley (1985) defined attitude toward science as "a general and enduring positive or negative feeling about science. It should not be confused with scientific attitude, which may be aptly labeled scientific attributes (e.g. suspended judgment and critical thinking)" (Koballa, Crawley, 1985, p. 223). "Attitudes toward science are not inherited traits but are learned predispositions acquired over a period of time, perhaps years" (Koballa, Crawley, 1985, p. 225).

> Attitude toward science may be viewed as a learned, positive or negative feeling about science that serves as a convenient summary of a wide variety of beliefs about science and is important because it permits the prediction of science related behavior. An attitude toward science may also serve different functions for different people (Koballa, Crawley, 1985, p. 231).

Talton and Simpson (1986) stated, "How American attitudes toward science are formed and manifested represents an important area of study for many researchers in science education. The two goals of such research is to learn how to optimize both commitment to science and achievement in science among students in American schools" (Talton, Simpson, 1986, p. 365).

Krynowskv (1988) stated,

> Two majoı concerns identified in the area of attitude assessment were the lack of conceptual clarity in defining attitude toward science and problems with the instruments used. The lack of conceptual clarity in attitudinal assessment in science education is associated to the broader problem of being able to explain what an attitude is and how it can be defined, measured, and related to behavior. Other disciplines, especially social-psychology, have been grappling with this problem for at least the last century (Krynowsky, 1988, p. 577).

Koballa (1988) stated that,

> Scientific attitudes, or more aptly labelled 'science attributes', are those behaviors associated with critical thinking and typically meant to characterize the thinking process of scientists (e.g. suspended judgment). Science educators, however, must define the term carefully for themselves if it is to be used to better understand and predict the science-related behaviors of students

and teachers. One definition seems to embody the essence of many other definitions and enables us to explore the diversity of the attitude concept. Most investigators would probably agree that attitude can be described as a learned predisposition to respond in a consistently favorable or unfavorable manner toward an attitude object. These attitudes and all others are learned from experience. They may be learned either actively or vicariously. Because attitudes are learned, they are susceptible to change, but they are not momentarily transient. Temporal stability is the term used by Miller and Coleman (1981) to describe this characteristic of attitudes. Wrightsman (1977) suggests that the changeable nature of an attitude is tied to its specificity. While breaking the link with its physical past, attitude has retained its posture of readiness or predisposition to respond. Considered the most important quality of the attitude concept is our favorable or unfavorable feelings toward objects, persons, groups, or any other identifiable aspects of our environment. Bem (1970) writes, 'Attitudes are our likes and dislikes (p. 14). However, it is important to note that attitudes always have a referent That is, they always refer to feelings about or toward some attitude object. The attitude object can be a person, situation, group, policy, issue, or an abstract idea. It is this generality that makes the attitude concept of interest and importance to science educators (Koballa, 1988, p. 116-17).

Koballa, gave three reasons for studying attitudes.

First of all, attitudes are relatively enduring; that is, people's feelings toward objects and issues are relatively stable over time. Although attitudes can be changed, such occurrences are not random: something must happen to cause the change. Second, attitudes are learned (Fishbein and Ajzen, 1975). Our students are not born liking or disliking the study of science in school; they learn to like or dislike it. Third, and most important, attitudes are related to behavior; that is, people's actions reflect their feelings toward relevant objects and issues in a probabilistic way (Ajzen and Fishbein, 1980). The study of attitudes has been historically based on the assumption that attitudes are related to behavior (Koballa, 1988, p. 123-4).

Oliver and Simpson (1988) did a ten-year longitudinal study on attitudes.

The primary goal of the original study was to examine commitment to science and achievement in science in light of the influences from the individual, the home, and the school. Central to this study was the belief that student achievement is influenced by the constructs of attitude toward science, science self-concept, and achievement motivation in science. First, attitude toward science is a reply to the question, to what extent does a student have interest in science? Attitude toward science might be operationally defined as the degree to which a student likes science. Having interest in science is not a required condition for a student to achieve at a high level in the study of science, yet for many students it may provide the extra push needed to engage a person in science. Second, the variable of science self-concept responds to the question, to what extent does a student believe that success is possible in science? This construct is critical to success in science; the student who does not believe that success is possible will have no reason to attempt to succeed. Third, the variable of achievement motivation responds to the question, to what extent does the student try to do as well as possible when engaging in science? A fourth measure used to predict achievement was the student's interest in reading about science. Based on the results of this study, there can be increased hope that changing attitudes will result in improved science achievement. . . (Simpson, Oliver, 1988, p. 143-155).

Simpson and Oliver (1990) stated,

The two major dependent variables have been attitude toward science and achievement in science. Over the past ten years, many results have emerged from this study. A list of the major findings is summarized below.

1. Within this large population of students from grades 6-10, attitude toward science dropped each year. The greatest drop always occurred from beginning to middle of year. There was also a steady decline across grades, from sixth through tenth, with an overall attitude at the end of the tenth grade being near neutral. Attitude toward science was consistently higher among boys.

2. Declines in achievement motivation was markedly similar to declines in attitude toward science. Motivation dropped both

within each grade and across grades 6-10, and by the tenth grade was near neutral. Motivation to achieve in science was consistently higher among girls.

3. Adolescents' attitude toward science are highly positively correlated with their friends' attitudes toward science. This relationship peaks in the ninth grade.

4. When ability tracks were considered, declines in attitude and motivation were most noticeable with the middle group. The conclusion drawn was that the additional attention paid to the "advanced" and "basic" groups may have most of the attention and energies of educators with less resulting attention being paid to the "average" group.

5. School, particularly classroom, variables are the strongest influences on attitude toward science. While individual and home influences contribute significantly to this foundation, it is clear from this study that the basic feelings an adolescent formulates toward the enterprise of science and toward their further involvement with science courses is in large measure mediated by the science classroom.

6. The self-related variables addressed in this study were the strongest predictors of achievement in science. It appears that family and school influences are heavily mediated by self and that science self concept, achievement motivation, and science anxiety are the major filters through which this relationship is formulated.

7. How students feel toward science and their ability to succeed in science at the tenth grade level is a strong predictor of subsequent science achievement in high school. Data from this longitudinal study support a stronger attitude-achievement relationship than do prior reports.

8. Science self concept at the tenth grade level is a good predictor of both number and type of science courses a student will take during high school. In particular, students with lower attitudes do not appear to pursue additional courses in science. A major finding of this study, therefore, is that attitudes toward science play a key role in influencing the amount of exposure to science a student experiences. . . If adolescents enter middle or junior high school with positive feelings toward science and experience success during their initial courses in science, it is

likely that they will elect to take and will be successful in additional science courses. This, in turn, leads to a positive commitment to science that influences lifelong interest and learning in science (Simpson, Oliver, 1990, p. l4).

Misiti, Shrigley, and Hanson (1991) stated that

"a positive student attitude toward science not only superintends scientific literacy, it could also have a bearing on our country's global competitiveness. If a positive science attitude is a reasonable expectation for young Americans, science educators must research the attitudes of adolescents. If attitudes are to be researched, valid instruments are needed. The purpose of this study was to revise and validate a Likert science attitude scale for young students that was first used over two decades ago. . . (Misiti, Shrigley, Hanson, 1991, p. 525).

Shrigley and Koballa (1992) reported disappointing results of more than 20 years of scientific inquiry. Their report addressed two concerns; these are (l) the lack of a theoretical framework upon which to model research and (2) faulty attitude assessment. Shrigley and Koballa discussed Ajzen's (1985) Theory of Planned Behavior, and Petty and

Cacioppo's Elaboration Likelihood Model (based on work by Hovland, Fishbein, and Ajzen). They also discussed Hovland's Learning Theory Model. They further stated,

> . . . contemporary thinking insists that recipients are active participants, that is, they listen, elaborate, and construct their own beliefs and attitudes-at times from long-term memory rather than incoming messages (Greenwald, 1968). Work by Stead (1985), Crawley (1990), Crawley and Coe (1990); Crawley and Myeong (1991); and Coleman, et al. (in press) has confirmed attitude, subjective norm, and perceived control as determinants of science-related behavioral intention (Shrigley, Koballa, 1992, p. 34).

To measure attitudes, attitude measurement instruments must be developed, tested, and validated. In most cases, the researchers who do the studies developed their own assessment instruments, especially in the early days of attitude assessment. Simpson and Troost (1980) developed appropriate instruments because existing instruments designed to measure attitudes and achievement were not suitable for their project from the standpoint of reading level, item complexity, and low internal consistency reliability. During the 1979-80 school year, they developed a total of twelve questionnaires and administered them to the students in the sample of their ten year longitudinal study. Cannon and Simpson (1985) reported on the ten year longitudinal study and reported the use of the Simpson-Troost instrument. Talton and Simpson (1986) later reported on the same study; they documented the use of the Simpson-Troost Attitude Questionnaire, developed specifically for this project. The questionnaire consisted of 60 items with a Likert scale designed for op-scan answer sheets. The questionnaire had 14 subscales. The science attitude subscale consisted of seven items and had a reliability estimate of 0.95. They continued,

> Subscales within the instrument were used in assessing student attitudes toward self, family, classroom environment, and science. Student perceptions of self were measured using four subscales: Achievement Motivation, Anxiety, Science Self-Concept, and Self-Concept. Student attitudes about the family were measured by two subscales: Family Science and Family General. A measurement of student attitudes toward classroom and school environment were obtained from seven subscales:

Climate, Curriculum, Physical Environment, Teacher, Other Students, Friends, and School. Student attitudes toward science were measured by a seven item attitude toward science subscale. The student scores on each subscale were used to obtain a scale score for analyses. If items were stated negatively, they were reflected when scored and used for the subscale score (Talton, Simpson, 1986, p. 366).

In their study, Harty, Andersen, and Enochs (1984) used the "Children's Attitudes toward Science Survey", a slightly modified version of the "Attitude Survey for Junior High School." This instrument consisted of 20 Likert-type items. Harty, Beal, Scharmann (1985) report using this same instrument in their study.

Rakow (1985) reported in "Minority Students in Science: Perspectives from the 1981-82 National Assessment in Science" that

> the items used in the assessment were developed by science educators and evaluated by a panel of science educators representing some of the major sciences and science education professional organizations. All items used in the 1981-82 assessment were also used in the previous assessment (1976-77)

(Rakow, 1985, p. l05).

Schibeci and McGaw (1981) reported on the examination of "the distinctiveness of the subscale structure an attitude instrument, the Test of Science Related Attitudes (TOSRA) developed by Fraser (1978). The importance of undertaking additional analyses of this type is emphasized by a number of researchers who have complained of the proliferation of attitude instruments without further work being attempted with existing ones. Meyer's (1974) handbook containing a collection of unpublished evaluation instruments in science education supports this view. It lists 16 different instruments to measure general attitudes toward science, and 12 instruments to measure attitudes toward a particular science discipline." Schibeci & McGaw (1981) further stated,

> TOSRA is a 70-item instrument in a Likert style format. There are seven scales with ten items per scale. The scales are based on Klopfer's (197l) categories for the affective domain in science education, with five of them measuring what could be described as 'attitudes of science' and with the other two measuring 'scientific attitudes'. Attitudes to science involve an attitude object (for example, 'science' or 'scientists'), whereas scientific attitudes

are those attitudes (such as curiosity, honesty, and open-mindness) which scientists are presumed to display in their scientific work. The distinction has been explored elsewhere (Schibeci, 1977).

The six categories of Klopfer's (197l) taxonomy with the names of the seven TOSRA subscales (A, D, E, and F for attitudes to science and B and C for scientific attitudes) are as follows: (A) Manifestation of favorable attitudes toward science and scientists: (l) Social Implications of Science; (2) Normality of Scientists; (B)Acceptance of scientific inquiry as a way of thought: (3) Attitude towards Scientific Inquiry; (C) Adoption of scientific attitudes; (4) Adoption of Scientific Attitudes; (D) Enjoyment of science learning experiences: (5) Enjoyment of Science Lessons; (E) Development of interest in science and science-related activities: (6) Leisure Interest in Science; and (F) Development of interest in pursing a career in science: (7) Career Interest in Science (Schibeci, McGaw, 1981, p. 1197).

Friend (1985) reported a study done in Queens, New York. His study used The Science Attitudes Appraisal, a 60 item instrument divided into 4 sections.

The first section appraises the Adoption of Scientific Attitudes (30 items and a maximum score of 150). The second section appraises Attitudes Toward Science (l0 items and a maximum score of 50). The third section appraises Attitude Toward Scientists (l0 items and a maximum score of 50). The final section appraises students' Enjoyment of Science Learning Experiences (l0 items and a maximum score of 50). The optimum score is 300 on the Likert-type scale. Each section's items have reverse polarity, so that one-half of the items has the highest numbered choice (5) as the response with the greatest value, while one-half of the items has the lowest number (l) as the response with the greatest value. The entire Appraisal has a reliability (Coefficient Alpha) of 0.87 (Friend, 1985, p. 455).

Krynowsky (1988) proposed the use of the Attitude Toward the Subject Science Scale (ATSSS) to measure attitude; it is based on the Ajzen, Fishbein attitude theory. He also stated,

> Munby (1980) highlighted the problems of assessment and instrumentation through an evaluation of over 50 attitude

instruments. On the basis of an analysis of 50 attitude to science instruments, Munby (1980) concluded 'there are grounds for viewing the affective outcomes of science education with misgiving simply because there seems little to be said of the instruments to enlist our confidence in their use' (p. 273). Specific shortcomings which have been summarized include the need for: (a) specification of some theoretical foundation to underlie the instrument. . . and the clear definition of the construct to be measured. (b) verification or establishment of reliability and validity of attitudinal instruments. Specific suggestion given for the improvement of reliability and validity were:

* the use of test-retest reliabilities.

* separate scores for conceptually distinct aims

* more careful wording and testing of items

* the preliminary trial of the instrument on the population for whom the use is intended. . .(Krynowsky, 1988, p. 577).

Krynowky (1988) further discussed the development of the ATSSS. He also details its modification and validation. Its reliability over time was tested. The test-retest correlation coefficient was 0.82.

Yager and Penick (1989) reported studies modeled after the NAEP studies done by the University of Iowa Science Education Center. These studies used a battery of attitude-measuring items similar to those used by the NAEP; the battery was called the Iowa Preferences and Understanding Assessment. It covered student attitudes toward science classes, science teachers, and science study.

Misiti, Shrigley, and Hanson (1991) constructed a history of science attitude assessment scales. They stated that few researchers detail the design of their instruments; they note the exceptions-Simpson, Oliver (1985), Wareing (1982); Hough, Piper (1982); Fraser (1978); Perrodin (1966); Fisher (1973); Harty et al. (1984); Germann (1988). They then detailed the development of a third-generation measurement scale begun by Shrigley (1968).

There are enormous numbers of attitude research studies. There is a multitude of findings. Every possible influence on attitude toward science and achievement in science has been explored. For the sake of brevity, findings related only to this study will be summarized.

This study dealt specifically with the changes in attitudes between grade levels, gender, and race. Rakow (1985) reported that minority students (9 year olds) averaged significantly below the national average on items dealing with science attitudes. Sex rather than ethnicity was a better predictor of the science attitudes of nine year olds. The male had much more positive attitudes than did the females. The results of attitude assessment of thirteen year olds were mixed. Males again demonstrated much more positive attitudes than did female. The same trends were true for seventeen year olds. At age 17, white students (male and female) were close to the national average on attitude assessment. Black students (both male and female) had much more positive attitudes about science and science teaching despite the fact that black students generally demonstrated the lowest achievement levels. His conclusion was that by age seventeen, the students with the greatest exposure to science were those who had the least positive attitudes about science. (Rakow, 1985).

Cannon and Simpson (1985) reported that science attitudes are more positive at the beginning of the year than at the end of the year. Gender was not found to be significant. Males had more positive attitudes than females but the difference was not statistically significant. (Cannon, Simpson, 1985).

Handley and Morse (1984) examined relationships of achievement in science to attitude toward science with self and gender role perceptions of seventh and eighth grade students. They summarized their results by stating, "that both attitudes and achievement in science were related to the variables of self-concept and gender role perceptions of male and female adolescents. These relationships are more evident in association with attitudes than achievement" (Handley, Morse, 1985, p. 606).

Simpson and Oliver (1990) stated that gender differences were not found to be as significant as expected. Males possessed significantly more positive attitudes toward science and generally achieved higher in science; females were significantly more motivated to achieve in science.

> Attitude differences were often noted for male and female students. Of particular interest were the attitude subscales where one gender was consistently higher than the other over all times and grades. This pattern was noted with all males higher than females, for the subscale(s) labeled--Attitude Toward Science-- When the responses to the subscale Attitude Toward Science were broken down by racial group, black students reported a

lower attitude at all times during sixth, seventh, and eighth grades. In other words, white students reported higher levels of attitude toward science regardless of their gender (Simpson, Oliver, 1990, p. I0).

The findings seem to suggest that attitude declines as grade level increases. They also suggest that male attitudes toward science are more positive than female attitudes toward science. The findings also suggest that white students of both genders have more positive attitudes than do non-white students of both genders.

Chapter 3 - Methods and Materials

In compliance with Mississippi State University policy, an Application to the Institutional Review Board for the Protection of Human Subjects in Research was completed (refer to Appendix A). A letter was also submitted to Mrs. Martha Walker, Principal of Kate Griffin Junior High School and to Mrs. Idora White, Principal of Magnolia Middle School, notifying them of the study's purpose and requesting permission to conduct the research (refer to Appendix B). Both communication were received and approved (refer to Appendix C). Verbal permission was received from the two principals involved and written permission was furnished by Mrs. Martha Walker.

The subjects were sixth and seventh grade students from Magnolia Middle School for the school year (1992-93) and eighth grade students from Kate Griffin Junior High School for the school year (1992-93). As part of Kate Griffin's OTE (Onward To Excellence) Process for the school year, the Test of Science Related Attitudes (TOSRA) was administered to selected eighth grade students to measure science attitudes. In this study, the TOSRA was used and scored (refer to Appendix D) for the sixth, seventh, and eighth grade students taught by the same teacher in 1992-93.

Methodology

The researcher used data collected from the TOSRA to determine attitude toward science and scientific attitudes. One-way analysis of variance was the statistical tool used to measure the difference in responses from the sixth to the seventh to the eighth grade students. The analysis was used to determine if a relationship existed between the dependent variable (attitude toward science) and the independent variables (grade level, gender, race, etc.). The extraneous variable was maturation.

Subjects

The subjects were selected on the basis of their availability to the teacher. Response to the survey was voluntary; ninety of 110 students elected to participate. The subjects were two sixth grade classes and one seventh grade class at Magnolia Middle School and two eighth grade classes at Kate Griffin Junior High School. The subjects ranged in age from 10.5 to 16 years old. There were 90 subjects; there were 35 sixth grade students, 21 seventh grade students, and 34 eighth grade students. There were 43 male and 47 female subjects and 22 white and

68 non-white subjects. The classes were heterogeneously grouped by ability. The subjects were similar in socioeconomic status.

Instrument

The attitude instrument used in the study was the Test of Science Related Attitudes (TOSRA). It is a seventy-item instrument in a Likert style format. There are seven scales, with ten items per scale; these scales are Social Implications of Science, Normality of Scientists, Attitude to Scientific Inquiry, Adoption of Scientific Attitudes, Leisure Interest in Science, Career Interest in Science, and Enjoyment of Science Lessons. Five of the categories measure attitudes toward science; two categories measure scientific attitudes. The Likert scale ranges from Strongly Disagree, Agree, Not Sure, Disagree, Strongly Disagree. For positive items (+) on the TOSRA, responses SA, A, N, D, SD are scored 5, 4, 3, 2, 1 respectively. For negative items (-), responses SA, A, N, D, SD are scored 1, 2, 3, 4, 5 respectively. Omitted or invalid responses are scored 3.

While there are seven categories, the researcher chose three of these seven categories; these categories were Attitude to Scientific Inquiry, Adoption of Scientific Attitudes, and Enjoyment of Science

Lessons. Instructions were given verbally; the transcript of the instructions is included in Appendix E.

Chapter 4 - Results

Is there a significant difference between attitudes toward science and scientific attitudes among sixth and seventh grade students at a middle school and eighth grade students at a junior high school? Is there a significant difference between attitudes toward science and scientific attitudes between white and non-white sixth, seventh, and eighth grade students? Is there a significant difference between male and female sixth, seventh, and eighth grade students? To answer these questions, three categories of indicators on the TOSRA (Test of Related Science Attitudes) were chosen; these were the Attitude to Scientific Inquiry, Enjoyment of Science Lessons, and Adoption of Scientific Attitudes. There were nine responses on each of these categories; there were a total of 27 responses chosen for each respondent. There were 90 respondents. A One-Way analysis of variance was used to analyze the data. The data (refer to Appendix F for data lists) were collected on May 12, 1993, from two sixth grade classes, one seventh grade class, and two eighth grade classes taught by the same teacher at two different schools.

The One-Way analysis of variance for the data is shown in Table 1.

Insert Table 1 about here

The One-Way analysis of variance showed significant difference for eight of 27 items. There was only one extraneous variable that could have affected the results; this variable was maturation.

Only one indicator of the category, Adoption of Scientific Attitudes, showed significant differences. In the category, Attitude to Scientific Inquiry, four indicators showed significant differences. In the category, Enjoyment of Science Lessons, three indicators showed significant differences. There were three indicators that showed significant difference by grade level. There were four indicators that showed significant difference by white and non-white students. There was one indicator that showed significant difference by male and female students.

In the category, Enjoyment of Science Lessons, the indicator, "Science is one of the most interesting school subjects", showed a statistically significant difference with an F probability of .0169.

Insert Table 2 about here

Of the responses to this indicator, 29 percent of the sixth graders agreed with this statement; 20 percent were not sure; 51 percent of the sixth graders disagreed. Of the seventh grade responses, 38 percent agreed; 33 percent were not sure; 29 percent disagreed. For eighth graders, 59 percent agreed; 21 percent were not sure; 21 percent disagreed. These proportions indicated that the attitude toward science subject matter improved from sixth grade to seventh grade to eighth grade, contrary to the research findings of Simpson and Oliver (1990).

Their research findings indicate that students find subject matter more boring as difficulty and grade level increase. There are several possible reasons for this apparent reversal of earlier findings. First, the more mature classes were given more options of how they would study material; they were allowed to choose activities. Secondly, the eighth grade textbook was better illustrated and more interesting than the seventh or sixth grade textbooks. Thirdly, the eighth grade classes were taught in the morning in a regular classroom while the sixth and seventh grade classes were taught in the afternoon in a trailer. The eighth grade classes had more opportunities for hands-on experiments. The eighth grade classes were smaller (less than 20 students) and therefore received more individual attention. For this indicator, class size, teaching method, classroom environment, and text material were the determining factors.

In the category, Enjoyment of Science Lessons, the indicator, "The material covered in science lessons is uninteresting", showed a significant difference with an F probability of .0467.

Insert Table 3 about here

Of the responses to this measure, 11 percent of the sixth graders agreed; 34 percent were not sure; 54 percent disagreed. Of the reactions to this indicator, 33 percent of the seventh graders agreed; 10 percent were not sure; 57 percent of the seventh graders disagreed. Of the responses to this measure, 12 percent of the eighth graders agreed; 24 percent were not sure; 65 percent disagreed. These statistics again indicate that the attitude toward science subject matter improved from sixth to seventh to eighth grade contrary to the same research findings previously mentioned. The reasons for these differences are the same as previously stated for the first indicator.

In the category, Enjoyment of Science Lessons, the measure, "I look forward to science lessons", showed a significant difference of .0056.

Insert Table 4 about here

The responses to this indicator were as follows; 26 percent of the sixth graders agreed; 31 percent were not sure; 43 percent disagreed. Of the responses to this indicator, 48 percent of the seventh graders agreed; 33 percent were not sure; 19 percent disagreed. For the eighth graders, 41 percent agreed; 38 percent were not sure; 21 percent disagreed. Again these findings indicate that the attitude toward science improved from sixth grade to seventh grade and eighth grade; however, there was a decrease from seventh to eighth grade. These findings are contrary to the previously mentioned research findings. Again the increase from sixth to seventh grade indicates a positive response to teaching methods. The increase from sixth grade to eighth grade indicates the response to teaching methods, class size, classroom environment, and text material. The decrease from seventh to eighth grade may be dependent on course material; the seventh graders study earth science with little mathematics involvement while the eighth graders study physical science with much more mathematics involvement. The eighth graders find the mathematics involvement harder to deal with.

In the group, Attitude to Scientific Inquiry, the indicator, "I would prefer to find out why something happens by doing an experiment than by being told", showed a significant difference with an F probability of .0281.

Insert Table 5 about here

This gauge was broken down by white and non-white student responses. On the responses to this measure, 95 percent of the white students agreed while 5 percent disagreed. Of the responses, 68 percent of the non-white students agreed; 18 percent were not sure; 15 percent of the non-white students disagreed. These findings agree with the research unwilling to change my ideas when evidence shows that the ideas are poor", showed a significant difference with an F probability of .0243.

Insert Table 7 about here

Of the answers to this indicator, 23 percent of the white students agreed; 27 were uncertain; 50 percent of the white students disagreed. Of the responses to this measure, 46 percent of the non-white students agreed; 28 percent were not sure; 26 percent of the non-white students disagreed. These findings agreed with the previously mentioned research findings and indicate a greater willingness to change ideas among the white students than among the non-white students surveyed.

In the category, Attitude to Scientific Inquiry, the indicator, "It is better to be told scientific facts than to find them out from experiments" showed a significant difference with an F probability of .0169.

Insert Table 8 about here

The responses were broken down by white and non-white students. Of the responses to this indicator, 43 percent of the non-white students agreed; 24 percent were not sure; only 34 percent disagreed. Of their responses to this indicator, 14 percent of the white students agreed; 23 percent were not sure; 64 percent disagreed. Once more, these findings agree with the previously mentioned research findings. Again, these findings indicate greater passivity and less self-confidence among the non-white students than among the white students.

In the category, Attitude to Scientific Inquiry, the measure, "I would rather agree with other people than to do an experiment to find out myself", showed a significant difference with an F probability of .0284.

Insert Table 9 about here

The responses to this indicator were broken down by gender. Of the responses to this indicator, 23 percent of the males agreed; 28 percent were not sure; 49 percent of the males disagreed. Of their responses to this indicator, 13 percent of the females agreed; 13 percent were not sure: 74 percent of the females disagreed. These findings disagree with the research of Cannon and Simpson (1985), Rakow (1985), and

Simpson and Oliver (1990). These findings indicate that the female students would rather do an experiment than agree with other people. If the responses to this indicator were further broken down by race and grade, the results are as follows:

Insert Table 10 about here

Of the sixth grade responses, 29 percent of the males disagreed; 35 percent were not sure; 35 percent agreed. The female sixth grade responses showed 72 percent disagreed; 22 percent were unsure; 6 percent agreed. In the seventh grade, 57 percent of the males disagreed with this statement; 21 were not sure; 21 percent agreed. The female seventh grade responses showed 86 percent disagreed; 14 percent were not sure; none agreed. For the eighth grade response, the results were 67 percent of the males disagreed; 25 percent were not sure; 8 percent agreed. Of the eighth grade female responses, 73 percent disagreed; 5 percent were not sure; 23 percent agreed. The male students showed an increasing positive attitude while the female attitude was more positive in the seventh grade and about the same in the sixth and eighth grades.

However, female attitude was much more positive at all grade levels than the male attitude. These findings may be related to the fact that the majority of these students were non-white (73 percent), and the majority of these students come from single-parent female-dominated households. These findings would bear further study.

Chapter 5 - Conclusion

The purpose of this study was to compare attitudes toward science and scientific attitudes in relation to grade level, gender, and race. The results indicate that attitudes toward science improved with an increase in grade level; the eighth grade students were more positive than the sixth grade students. The results indicate that white students had more positive scientific attitudes and attitudes toward science than non-white students. The results indicated that female students showed more positive attitudes toward science than male students.

Research has stated that 25 percent of scientific achievement is dependent on student attitudes toward science, 25 percent is dependent on the teacher and classroom environment, and 50 percent is dependent on student ability. Thus, changing students' attitudes toward science can have a significant effect on their achievement in science. Research also states that students enter school with high positive attitudes toward science. It has also stated that girls start school with the same ability level and attitudes toward science as boys. Research indicates that attitudes toward science drop continuously as grade level increases until it reaches neutral in the tenth grade; it also indicates that girls' attitudes decline even more than boys' probably due to sex stereotyping. Research also concludes that non-white students have consistently lower attitudes toward science than white students do probably because of less exposure to science experiences.

In conclusion, attitude research should be conducted and correlated to achievement; these results will give valuable information about the current science programs, teachers, and instruction. The results would give the necessary information to spur reform of current science program and instruction.

Further research needs to be done to confirm these findings. More trials of the same group need to be done; possibly a longitudinal study could be instituted. The group could be expanded to include other teachers and other grade levels. However these findings do suggest that much can be done to change student attitudes by innovative teaching methods, hands-on instruction, and enthusiastic teachers.

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Appendix A

APPLICATION TO
THE MISSISSIPPI STATE UNIVERSITY INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN SUBJECTS IN RESEARCH

1. Name: [illegible] Ann Howell White Mailing Address Rt. 4 Box [illegible]
Dept: Secondary Education Philadelphia, Ms. 39350
Phone No: 4[illegible]3-5224
[illegible]5[illegible]-1375[illegible]

2. Project period: from May 1993 to July 1993. 3. Funding Source(s) none

4. Site of work: Meridian Public Schools

5. Title of project and brief description of its general purpose: The title is "Comparison of Science Attitudes Among Middle and Junior High School Students". I will use the TOSRA to measure attitudes toward science and scientific attitudes among sixth, seventh, and eighth grade science students at Magnolia Middle School and Kate Griffin Junior High School.

6. Give details of the procedures that relate to the subjects' participation, including at a minimum the following information. Use additional page(s) if necessary.

a) How were the subjects selected and recruited? (Append copy of letter or ad or transcript of verbal announcement.) The students were selected as those taught by the teacher doing the study. (Verbal transcript attached).

b) What inducement is offered? none

c) Number and salient characteristics of subject - age range, sex, institutional affiliation, other pertinent characterization(s). Students were age range 1[illegible].5 to 16 years old. Students were mixed male, female, white, non-white, heterogenously grouped class members of five classes currently taught by the teacher doing the study. Ninety students participated in the survey of the [illegible] student available to the teacher.

d) If a cooperating institution is involved - school, hospital, prison, etc.-has written permission been obtained? (Append letter) Written permission was given to use the data already gathered as part of the school's (T[illegible] (Toward To Excellence) program.

e) Number of times observations will be made. Observations will made once.

f) What do the subjects do, or what is done to them, in the study? (Append copy of questionnaires or test instruments, or description of procedure to be conducted on the subject.) The subjects will complete an attitudinal survey.

g) Is it clear to the subjects that their participation is fully voluntary? [illegible]

h) Is it clear to the subject that they can withdraw at any time? yes

i) Is it clear to the subjects that they can refuse to answer any specific question that may be asked them? yes

j) Cite your experience with this type of research.
- have fifteen years classroom teaching experience with a variety of materials and situations including testing and research situations.

7. How do you intend to obtain the subjects' informed consent? If in writing, attach a copy of the consent form. If not in writing, include a written summary of what is to be said to the subjects), and justify the reason that oral rather than written consent is being used. Also, explain how you will ascertain that the subjects understand that they are agreeing to. This data was already available because all students were given the TCSRA as part of the school's OTE program. Parental consent was assumed as the students were registered in and tested as part of the regular school program.
(For any questions, call Dr. Gary Benton at [redacted]-2100).

8. In your view, what benefits may result from the study that would justify asking the subjects to participate? This study will measure attitudes toward science and scientific attitud It will allow comparison among grade levels and schools; it will give feedback to the teacher and allow for improvement of teaching methods a classroom environment.

9. Do you see any chance that subjects might be harmed in anyway? Do you deceive them in any way? Are there any physical risks? Psychological? (Might a subject feel demeaned or embarrassed or worried or upset?) Social? (Possible loss of status, privacy, reputation?) How do you ensure confidentiality of information collected? Consider these things from the point of view of the subject.
No, I see no chance that subjects might be harmed in any way. I did no deceived them in any way. No. there are no physical risks. No, there no psychological risks. No, there are no social risks. I will ensure confidentiality of the information collected by not allowing anyone access to individual surveys.

Judy A. R. White
Applicant's signature

Gary Benton
Faculty advisor's signature
(for student applications)

7/21/9
date

h) It is clear to the subject that they can withdraw at any time? Yes

i) Is it clear to the subjects that they can refuse to answer any specific question that may be asked them? Yes

j) Cite your experience with this type of research.
I have fifteen years classroom teaching experience with a variety of materials and situations including testing and research situations.

7. How do you intend to obtain the subjects' informed consent? If in writing, attach a copy of the consent form. If not in writing, include a written summary of what is to be said to the subject(s), and justify the reason that oral rather than written consent is being used. Also, explain how you will ascertain that the subjects understand that they are agreeing to. This data was already available because all students were given the TCSRA as part of the school's OTE program. Parental consent was assumed as the students were registered in and tested as part of the regular school program.
(For any questions, call Dr. Gary Benton at [redacted]-2100).

8. In your view, what benefits may result from the study that would justify asking the subjects to participate? This study will measure attitudes toward science and scientific attitud It will allow comparison among grade levels and schools; it will give feedback to the teacher and allow for improvement of teaching methods & classroom environment.

9. Do you see any chance that subjects might be harmed in anyway? Do you deceive them in any way? Are there any physical risks? Psychological? (Might a subject feel demeaned or embarrassed or worried or upset?) Social? (Possible loss of status, privacy, reputation?) How do you ensure confidentiality of information collected? Consider these things from the point of view of the subject.
No, I see no chance that subjects might be harmed in any way. I did no deceived them in any way. No, there are no physical risks. No, there are no psychological risks. No, there are no social risks. I will ensure confidentiality of the information collected by not allowing anyone access to individual surveys.

Judy A. R. White	Gary Benton	7/21/95
Applicant's signature	Faculty advisor's signature (for student applications)	date

Appendix B

May 3, 1993

Rt. 4 Box 732B
Philadelphia, Ms. 39350

Mrs. Martha Walker, Principal
Kate Griffin Junior High
2814 Davis Street
Meridian, MS 39301

Dear Mrs. Walker:

I am working on my special problem at MSU. I plan to collect data on attitudes toward science among my students. I need permission to conduct an attitude survey (The Test of Science Related Attitudes) in my first and second period classes sometime this month. This will be the same instrument that was used in other eighth grade classes for our Onward To Excellence program earlier this year. Thank you for your cooperation in this research.

Sincerely,

Judy A. White

Judy A. White

Rt. 4 Box 73BB
Philadelphia, Ms. 39350
May 3, 1993

Mrs. Idora White, Principal
Magnolia Middle School
Meridian, MS 39301

Dear Mrs. White:

I am working on my special problem at MSU. I plan to collect data on attitudes toward science among my students. I need permission to conduct an attitude survey (The Test of Science Related Attitudes) in my fourth, fifth and sixth period classes sometime this month. This will be the same instrument that was used in eighth grade classes at Kate Griffing Junior High School for our Onward To Excellence program earlier this year.

Thank you for your cooperation in this research.

Sincerely,

Judy A. White

Judy A. White

Appendix C

Sponsored Programs Administration
P.O. Box 6156 Mississippi State, MS 39762-6156
(601) 325-7404

July 22, 1993

Ms. Judy Ann Rowell White
Rt. 4 Box 73BB
Philadelphia, MS 39350

Dear Ms. White:

Your proposed research project, "Comparison of Science Attitudes Among Middle and Junior High School Students," has been assigned IRB docket number 93-180. Upon review, it was determined that this project falls within the meaning of §__.101(b)(2)(4) of the Common Rule in that it is research involving educational testing, and surveys and the collection or study of existing data where anonymity of the subjects will be maintained.

As I understand, this research has been done prior to approval by IRB. Please be concerned with the following regulations as written in the "Policies and Procedures for Protection of Human Subjects in Research." As stated in the copy of the handbook I have enclosed for your review, pay careful attention to the protocols listed below:

Section 1.4.5 CHILDREN INVOLVED AS SUBJECTS IN RESEARCH

(A) "Children" are persons who have not attained the legal age for consent to treatments or procedures involved in the research, under the applicable law of the jurisdiction under which the research will be conducted. Mississippi Code 1972 Annotated in Section 41-41-3 addressed only who may consent to surgical or medical treatments or procedures. Thus, for the purpose of this Policy, "children" refers to those persons who shall not have attained their 18th birthday.

Section 1.4.5.1 Children Involved as Subjects in "Exempted" Areas of Research

Provided that the IRB determines that, prior to initiation of research, adequate provisions are taken to obtain the full assent of the child who will participate as a subject, and the permission of the child's parent or guardian, administrative review may be used for the categories of research described as exemptions (1), (2), (5), and (6) under Subpart A of 45 CFR 46.101(b).

Section 4.0 INFORMED CONSENT

No subject *may become involved in research except as defined in Section 1.4.4, "Human Subjects with Possible Risks from Breach of Confidentiality," without the legally-effective, informed consent of the subject or the subject's legally authorized representative. This consent* *must be sought under circumstances that permit the subject (hereinafter understood to include the subject's legally authorized representative) sufficient opportunity to determine whether or not to participate, and that minimize the possibility of coercion or undue influences. The information presented to the subject must be in a language and a terminology understandable to the subject.*

Section 4.1 ***BASIC ELEMENTS OF INFORMED CONSENT***

***No investigator** may involve a human being as a subject in research covered by these regulations unless the investigator has obtained the legally effective, informed consent of the subject or the subject's legally authorized representative.*

Any and all data collected from the project, "Comparison of Science Attitudes Among Middle and Junior High School Students," is considered invalid according to federal regulations and policies at Mississippi State University. The IRB has the responsibility of reporting to the President of the University, and to other institutional officials as warranted, any serious or continuing noncompliance of investigators with the requirements and determinations of the IRB. The IRB has the authority to suspend, if appropriate, terminate approval of research that is not being conducted in accordance with the determinations of the IRB, or in which there is unexpected serious harm to subjects. Any such suspension will be reported promptly to the Principal Investigator, to the President of the University and other institution officials as warranted, and, if appropriate, to the Secretary of the Department of Health and Human Services.

*As authorized by the Mississippi State University Institutional Review Board for the Protection of Human Subjects in Research, who has the authority and responsibility to approve, require modifications in order to secure approval, or disapprove all research involving human subjects conducted at, or under the auspices of, Mississippi State University, I give administrative approval for your project that has already been performed. I would advise that future research activities be given special consideration when human subjects are involved and that proper authorization is given **before** any research begins. This simple procedure not only protects human subjects, but also helps protect you and the institution where the research was conducted if litigation is pursued.*

If I can provide any additional information or literature regarding human subjects, please call me at 325-3216.

Sincerely,

Angela J. Corder
MSU Regulatory Compliance Officer

cc: *G. Benton*
MSU IRB

KATE GRIFFIN JUNIOR HIGH SCHOOL
MERIDIAN PUBLIC SCHOOLS
2814 DAVIS STREET
MERIDIAN, MISSISSIPPI 39301

OFFICE OF THE PRINCIPAL

July 15, 1993

Mrs. Judy White
Rt. 4 Box 73 BB
Philadelphia, MS

Dear Mrs. White:

You have my permission to use the Test of Science Related Attitudes materials collected with your students during the 1992-1993 school term for your research at Mississippi State University.

Sincerely yours,

Martha Walker

Martha Walker
Principal

Appendix D

Sample 3: Attitude Measure

TOSRA

TEST OF SCIENCE-RELATED ATTITUDES

Barry J. Fraser

DIRECTIONS

1 This test contains a number of statements about science. You will be asked what you yourself think about these statements. There are no 'right' or 'wrong' answers. Your opinion is what is wanted.

2 All answers should be given on the separate Answer Sheet. Please do not write on this booklet.

3 For each statement, draw a circle around

- SA if you STRONGLY AGREE with the statement;
- A if you AGREE with the statement;
- N if you are NOT SURE;
- D if you DISAGREE with the statement;
- SD if you STRONGLY DISAGREE with the statement.

Practice Item

0 It would be interesting to learn about boats.

Suppose that you AGREE with this statement, then you would circle A on your Answer Sheet, like this:

	5	4	3	2	1
0	SA	A	N	D	SD

4 If you change your mind about an answer, cross it out and circle another one.

5 Although some statements in this test are fairly similar to other statements, you are asked to indicate your opinion about all statements.

Published by
The Australian Council for Educational Research Limited
Radford House, Frederick Street, Hawthorn, Victoria 3122

Typesetting direct from Wang diskette by
Publication Perspectives
200 Cheltenham Road, Dandenong, Victoria 3175

Printed by Allanby Press
1A Crescent Road, Camberwell, Victoria 3124

ISBN 0 85563 861 3

Appendix I

INSTRUCTIONS FOR ADMINISTRATION AND SCORING

Time required

1 No time limit should be applied when administering TOSRA (although it is not necessary to allow exceptionally slow students to finish). The approximate time taken for instructions and answering ranges from 30-45 minutes at the Year 7 level to 25-30 minutes at the Year 10 level.

Administration

2 Instruct students not to commence writing until told to do so.

3 Hand out the tests and the answer sheets.

4 Make it clear to students that the test is not for grading purposes.

5 Go through the Directions on the first page of the test thoroughly with the class and go over the Practice Item on the chalk board.

6 Emphasize that only one response should be circled for each item, that responses are to be given on the separate Answer Sheet, and that the way to alter an answer is to cross out the old answer and then circle the new choice.

7 Answer any reasonable student queries.

8 Tell students to write their names (if required), school, and year/class designation on the Answer Sheet, and then to commence answering.

9 During testing move around the class to check that pupils are answering as instructed. Continue to answer reasonable queries but do not encourage excessive queries.

10 Students who finish early should be given something quiet to do.

11 Collect the tests and answer sheets when all, or nearly all, students have finished. (It is not necessary to allow exceptionally slow students to finish.) Ask students to check that they have filled in the details on the Answer Sheet.

Scoring

12 Appendix II shows how the 70 items in TOSRA are allocated to the seven different scales and whether each item is positive (+) or negative (−) with respect to scoring. For positive items (+), responses SA, A, N, D, SD are scored 5, 4, 3, 2, 1, respectively. For negative items (−), responses SA, A, N, D, SD are scored 1, 2, 3, 4, 5, respectively. Omitted or invalidly answered items are given a score of 3. The seven separate scale scores are obtained by adding the scores obtained on all items within a given scale. Since each scale contains 10 items, the minimum and maximum scores possible on each scale are 10 and 50, respectively. Scale scores, however, cannot be added to form a meaningful total score. For people wishing to score TOSRA by hand (rather than by computer), use can be made of the convenient hand Score Key described below.

Hand Score Key

13 Check each student's Answer Sheet for any omitted items or invalid responses (e.g. more than one response circled). Amend each of these so that the N response is circled.

14 Place the transparent hand Score Key over the student's Answer Sheet so that the lines ruled on the Score Key correspond with those on the Answer Sheet. The score for a particular item is simply the number on the hand Score Key which is superimposed on top of the student's circled response.

15 Obtain the student's score for Scale S by adding the 10 scores for the individual items in this scale. Each of the 10 items belonging to Scale S is located as the first item in each block of seven items on the Answer Sheet. Also the Hand Score Key has the letter S written on it in various places to indicate which horizontal rows contain items belonging to Scale S. The total score for Scale S can be recorded in the space provided at the bottom of the Answer Sheet.

16 Obtain the student's total scores for the other six attitude scales by following a similar procedure, and record these scores in the spaces provided at the bottom of the Answer Sheet. Scales N, I, A, E, L and C consist, respectively, of the second, third, fourth, fifth, sixth, and seventh items in each block of seven items on the Answer Sheet. The hand Score Key contains the letters N, I, A, E, L and C to indicate which horizontal rows contain items belonging to the different scales.

Processing and Interpreting Results (Optional)

17 One of the most useful ways for teachers to process and interpret results is to calculate the mean score on each TOSRA scale obtained by a particular group of students (e.g. a class), to plot a profile of scale mean scores, and to compare this profile with that obtained for the field-testing sample (see Figure 1).

Test of Science-Related Attitudes

Score Key

Page 2

S	5	4	3	2	1
N	1	2	3	4	5
I	5	4	3	2	1
A	5	4	3	2	1
E	5	4	3	2	1
L	5	4	3	2	1
C	1	2	3	4	5
S	1	2	3	4	5
N	5	4	3	2	1
I	1	2	3	4	5
A	1	2	3	4	5
E	1	2	3	4	5
L	1	2	3	4	5
C	5	4	3	2	1
S	5	4	3	2	1
N	1	2	3	4	5
I	5	4	3	2	1
A	5	4	3	2	1
E	5	4	3	2	1
L	5	4	3	2	1
C	1	2	3	4	5
S	1	2	3	4	5
N	5	4	3	2	1
I	1	2	3	4	5
A	1	2	3	4	5
E	1	2	3	4	5
L	1	2	3	4	5
C	5	4	3	2	1

Page 3

S	5	4	3	2	1
N	1	2	3	4	5
I	5	4	3	2	1
A	5	4	3	2	1
E	5	4	3	2	1
L	5	4	3	2	1
C	1	2	3	4	5
S	1	2	3	4	5
N	5	4	3	2	1
I	1	2	3	4	5
A	1	2	3	4	5
E	1	2	3	4	5
L	1	2	3	4	5
C	5	4	3	2	1
S	5	4	3	2	1
N	1	2	3	4	5
I	5	4	3	2	1
A	5	4	3	2	1
E	5	4	3	2	1
L	5	4	3	2	1
C	1	2	3	4	5

Page 4

S	1	2	3	4	5
N	5	4	3	2	1
I	1	2	3	4	5
A	1	2	3	4	5
E	1	2	3	4	5
L	1	2	3	4	5
C	5	4	3	2	1
S	5	4	3	2	1
N	1	2	3	4	5
I	5	4	3	2	1
A	5	4	3	2	1
E	5	4	3	2	1
L	5	4	3	2	1
C	1	2	3	4	5
S	1	2	3	4	5
N	5	4	3	2	1
I	1	2	3	4	5
A	1	2	3	4	5
E	1	2	3	4	5
L	1	2	3	4	5
C	5	4	3	2	1

CUT ALONG DOTTED LINE AND REMOVE

Appendix II

SCALE ALLOCATION AND SCORING FOR EACH ITEM

S Social Implications of Science	N Normality of Scientists	I Attitude to Scientific Inquiry	A Adoption of Scientific Attitudes	E Enjoyment of Science Lessons	L Leisure Interest in Science	C Career Interest in Science
1 (+)	2 (−)	3 (+)	4 (+)	5 (+)	6 (+)	7 (−)
8 (−)	9 (+)	10 (−)	11 (−)	12 (−)	13 (−)	14 (+)
15 (+)	16 (−)	17 (+)	18 (+)	19 (+)	20 (+)	21 (−)
22 (−)	23 (+)	24 (−)	25 (−)	26 (−)	27 (−)	28 (+)
29 (+)	30 (−)	31 (+)	32 (+)	33 (+)	34 (+)	35 (−)
36 (−)	37 (+)	38 (−)	39 (−)	40 (−)	41 (−)	42 (+)
43 (+)	44 (−)	45 (+)	46 (+)	47 (+)	48 (+)	49 (−)
50 (−)	51 (+)	52 (−)	53 (−)	54 (−)	55 (−)	56 (+)
57 (+)	58 (−)	59 (+)	60 (+)	61 (+)	62 (+)	63 (−)
64 (−)	65 (+)	66 (−)	67 (−)	68 (−)	69 (−)	70 (+)

For positive items (+), responses SA, A, N, D, SD are scored 5, 4, 3, 2, 1, respectively. For negative items (−), responses SA, A, N, D, SD, are scored 1, 2, 3, 4, 5, respectively. Omitted or invalid responses are scored 3.

1. Money spent on science is well worth spending.
2. Scientists usually like to go to their laboratories when they have a day off.
3. I would prefer to find out why something happens by doing an experiment than by being told.
4. I enjoy reading about things which disagree with my previous ideas.
5. Science lessons are fun.
6. I would like to belong to a science club.
7. I would dislike being a scientist after I leave school.
8. Science is man's worst enemy.
9. Scientists are about as fit and healthy as other people.
10. Doing experiments is not as good as finding out information from teachers.
11. I dislike repeating experiments to check that I get the same results.
12. I dislike science lessons.
13. I get bored when watching science programs on TV at home.
14. When I leave school, I would like to work with people who make discoveries in science.
15. Public money spent on science in the last few years has been used wisely.
16. Scientists do not have enough time to spend with their families.
23. Scientists like sports as much as other people do.
24. I would rather agree with other people than do an experiment to find out for myself.
25. Finding out about new things is unimportant.
26. Science lessons bore me.
27. I dislike reading books about science during my holidays.
28. Working in a science laboratory would be an interesting way to earn a living.
29. The government should spend more money on scientific research.
30. Scientists are less friendly than other people.
31. I would prefer to do my own experiments than to find out information from a teacher.
32. I like to listen to people whose opinions are different from mine.
33. Science is one of the most interesting school subjects.
34. I would like to do science experiments at home.
35. A career in science would be dull and boring.
36. Too many laboratories are being built at the expense of the rest of education.
37. Scientists can have a normal family life.

38. I would rather find out about things by asking than by doing an experiment.

39. I find it boring to hear about new ideas.

40. Science lessons are a waste of time.

41. Talking to friends about science after school would be boring.

42. I would like to teach science when I leave school.

43. Science helps to make life better.

44. Scientists do not care about their working conditions.

45. I would rather solve a problem by doing an experiment than be told the answer.

46. In science experiments, I like to use new methods which I have not used before.

47. I really enjoy going to science lessons.

48. I would enjoy having a job in a science laboratory during my school holidays.

49. A job as a scientist would be boring.

50. This country is spending too much money on science.

51. Scientists are just as interested in art and music as other people are.

52. It is better to ask the teacher the answer than to find it out by doing experiments.

53. I am unwilling to change my ideas when evidence shows that the ideas are poor.

54. The material covered in science lessons is uninteresting.

55. Listening to talk about science on the radio would be boring.

56. A job as a scientist would be interesting.

57. Science can help to make the world a better place in the future.

58. Few scientists are happily married.

59. I would prefer to do an experiment on a topic than to read about science in magazines.

60. In science experiments, I report unexpected results as well as expected ones.

61. I look forward to science lessons.

62. I would enjoy visiting a science museum on the weekend.

63. I would dislike becoming a scientist because it needs too much education.

64. Money used on scientific projects is wasted.

65. If you met a scientist, he would probably look like anyone else you might meet.

66. It is better to be told scientific facts than to find them out from experiments.

67. I dislike listening to other people's opinions.

68. I would enjoy school more if there were no science lessons.

69. I dislike reading newspaper articles about science.

70. I would like to be a scientist when I leave school.

Test of Science-Related Attitudes

Answer Sheet

Name ______________________________

School ____________________ Year/Class ____________

Page 2

	STRONGLY AGREE	AGREE	NOT SURE	DISAGREE	STRONGLY DISAGREE
1	SA	A	N	D	SD
2	SA	A	N	D	SD
3	SA	A	N	D	SD
4	SA	A	N	D	SD
5	SA	A	N	D	SD
6	SA	A	N	D	SD
7	SA	A	N	D	SD
8	SA	A	N	D	SD
9	SA	A	N	D	SD
10	SA	A	N	D	SD
11	SA	A	N	D	SD
12	SA	A	N	D	SD
13	SA	A	N	D	SD
14	SA	A	N	D	SD
15	SA	A	N	D	SD
16	SA	A	N	D	SD
17	SA	A	N	D	SD
18	SA	A	N	D	SD
19	SA	A	N	D	SD
20	SA	A	N	D	SD
21	SA	A	N	D	SD
22	SA	A	N	D	SD
23	SA	A	N	D	SD
24	SA	A	N	D	SD
25	SA	A	N	D	SD
26	SA	A	N	D	SD
27	SA	A	N	D	SD
28	SA	A	N	D	SD

Page 3

	STRONGLY AGREE	AGREE	NOT SURE	DISAGREE	STRONGLY DISAGREE
29	SA	A	N	D	SD
30	SA	A	N	D	SD
31	SA	A	N	D	SD
32	SA	A	N	D	SD
33	SA	A	N	D	SD
34	SA	A	N	D	SD
35	SA	A	N	D	SD
36	SA	A	N	D	SD
37	SA	A	N	D	SD
38	SA	A	N	D	SD
39	SA	A	N	D	SD
40	SA	A	N	D	SD
41	SA	A	N	D	SD
42	SA	A	N	D	SD
43	SA	A	N	D	SD
44	SA	A	N	D	SD
45	SA	A	N	D	SD
46	SA	A	N	D	SD
47	SA	A	N	D	SD
48	SA	A	N	D	SD
49	SA	A	N	D	SD

Page 4

	STRONGLY AGREE	AGREE	NOT SURE	DISAGREE	STRONGLY DISAGREE
50	SA	A	N	D	SD
51	SA	A	N	D	SD
52	SA	A	N	D	SD
53	SA	A	N	D	SD
54	SA	A	N	D	SD
55	SA	A	N	D	SD
56	SA	A	N	D	SD
57	SA	A	N	D	SD
58	SA	A	N	D	SD
59	SA	A	N	D	SD
60	SA	A	N	D	SD
61	SA	A	N	D	SD
62	SA	A	N	D	SD
63	SA	A	N	D	SD
64	SA	A	N	D	SD
65	SA	A	N	D	SD
66	SA	A	N	D	SD
67	SA	A	N	D	SD
68	SA	A	N	D	SD
69	SA	A	N	D	SD
70	SA	A	N	D	SD

For Teacher Use Only

S ___ N ___ I ___ A ___ E ___ L ___ C ___

Appendix E

Verbal Transcript of Instructions for

The Test of Science-Related Attitudes

Mrs. White: I am taking a course at the Mississippi State University Meridian Branch, and I am working on a Special Problem (thesis) to complete my requirements. It's basically a research paper. I'd like you to help me with it. I'd like you to do this attitude survey for me; the results will be used to see how you feel about science. The results will be used in my paper, but your names won't be used anywhere at all. That way no one will know who as involved in this project with me. Do you have any questions?

As a further note, you do not have to participate in this survey. Please raise your hand if you would like a survey and answer sheet. Remember, you do not have to do this, and this is not a part of your class requirement or grade.

Appendix F

Table 1

One way analysis of TOSRA Items

Item **	TOSRA ***	F ratio	F probability
1	33	4.2779	0.0169*
2	54	3.1738	0.0467*
3	61	5.5061	0.0056*
4	03	4.9861	0.0281*
5	38	10.4375	0.0017*
6	53	5.2563	0.0243*
7	66	5.9311	0.0169*
8	24	4.9674	0.0284*

* Significant at .05 level

** Number in Study

*** Item Number on TOSRA

Table 2

Percentages of Responses on Item 1: Science is one of the most interesting subjects

Grade	Number of Students	% Agree	% Not Sure	% Disagree	% Total
6	35	29.0	20.0	51.0	100
7	21	38.1	33.3	58.6	100
8	34	58.9	20.6	20.6	100
Total Students	90				

Table 3

Percentages of Responses on Item 2: The material covered in science lessons is uninteresting

Grade	Number of Students	% Agree	% Not Sure	% Disagree	% Total
6	35	11.40	34.3	54.3	100
7	21	33.34	9.5	57.1	100
8	34	11.80	23.5	64.7	100
Total Students	90				

Table 4

Percentages of Responses on Item 3: I look forward to science lessons

Grade	Number of Students	% Agree	% Not Sure	% Disagree	% Total
6	35	26.00	31.00	43	100
7	21	47.62	33.33	19	100
8	34	41.00	38.00	21	100
Total Students	90				

Table 5

Percentages of Responses on Item 4: I would prefer to find out why something happens by doing an experiment than by being told

Race	Number of Students	% Agree	% Not Sure	% Disagree	% Total
White	22	95.46	0.00	4.55	100
Non-White	68	67.65	17.65	14.77	100
Total Students	90				

Table 6

Percentages of Responses on Item 5: I would rather find out things by asking than by doing an experiment

Race	Number of Students	% Agree	% Not Sure	% Disagree	% Total
White	22	13.64	13.64	72.72	100
Non-White	68	45.58	13.24	41.18	100
Total Students	90				

Table 7

Percentages of Responses on Item 6: I am unwilling to change my ideas when evidence shows that the ideas are poor

Race	Number of Students	% Agree	% Not Sure	% Disagree	% Total
White	22	22.73	27.27	50.00	100
Non-White	68	45.59	27.94	26.47	100
Total Students	90				

Table 8

Percentages of Responses on Item 7: It is better to be told scientific facts than to find out from experiments

Race	Number of Students	% Agree	% Not Sure	% Disagree	% Total
White	22	13.64	22.73	63.64	100
Non-White	68	42.65	23.53	33.83	100
Total Students	90				

Table 9

Percentages of Responses on Item 8: I would rather agree with other people than do an experiment to find out myself

Grade	Gender	% Agree	% Not Sure	% Disagree	% Total
6	Males	35.29	35.29	29.41	100
6	Females	5.55	22.22	72.22	100
7	Males	21.43	21.43	57.15	100
7	Females	0.00	14.29	85.72	100
8	Males	8.33	25.00	66.66	100
8	Females	22.73	4.55	72.71	100

Note: Total Students = 90

Table 10

Percentages of Responses on Item 8: I would rather agree with other people than do an experiment to find out myself

Gender	Number of Students	% Agree	% Not Sure	% Disagree	% Total
Male	43	23.26	27.91	48.84	100
Female	47	12.77	12.77	74.47	100

Total Students 90