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AN INVESTIGATION OF THE ATTITUDES TOWARD SCIENCE AND SCIENCE TEACHING OF SCIENCE EDUCATION MAJORS IN KOREA

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AN INVESTIGATION OF THE ATTITUDES TOWARD SCIENCE AND SCIENCE TEACHING OF SCIENCE EDUCATION MAJORS IN KOREA

A Dissertation Submitted in Partial Fulfillment
of the Requirement for the Degree of
Doctor of Education

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College of Arts and Science
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ABSTRACT

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The purpose of this study was to investigate the status of the attitudes toward science and science teaching among science education majors in Korea. Their attitudes were analyzed with respect to sex, grade level, specialty, college, birth place, high school attended, religion, army service, career goal and self-estimation of academic achievement.

Position and attitude statements for science and science teaching were written by this researcher and scrutinized by thirty panel members. A trial test was done with Koreans in the USA and Korea. The final forms of the Attitudes Toward Science Scale (AS scale) and the Attitudes Toward Science Teaching Scale (AT scale) were four-choice, forty-item Likert type tests which were administered at eight colleges in Korea, from which 1,576 student responses were analyzed.

Concurrent validity with Moore's scale was investigated to yield a correlation coefficient of 0.60. Five groups of students

majoring in science education at the undergraduate and the graduate levels, in physics, medicine and humanities were compared for construct validity. Item correlation ranges (${}_{i}r_{s}$:0.11~0.52, ${}_{i}r_{t}$:0.38~0.60), scale coefficient alphas (α_s=0.73, α_t=0.82), and correlations between total and positive or negative attitude related-item scores (${}_{p}r_{T.s}$=0.78, ${}_{n}r_{T.s}$=0.83, ${}_{p}r_{T.t}$=0.81, ${}_{n}r_{T.t}$=0.84) showed good reliability of the scales.

The conclusions of the study are:

1. The majority of science education majors have tendencies toward positive attitudes toward science and science teaching. Two-thirds among them have a balanced attitude toward science and science teaching, and one-third have tendencies toward biased attitudes about either science or science teaching.

2. The attitudes toward science of science education majors are moderately correlated with their attitudes toward science teaching. The total attitudes toward science and science teaching of the students are strongly correlated with their attitudes toward science and science teaching respectively.

3. There are no differences among the groups of grade level, birth place and religion for science education majors in attitudes toward science and science teaching.

4. There are differences among the groups of sex, specialty, college, high school attended, army service, career goal

and self-estimation of academic achievement for science education majors in their attitudes toward science and/or science teaching. Some pairs of the groups are significantly different. These are listed.

a. Male students' total attitudes toward science and science teaching are more positive than those of female students.

b. Physics teaching majors' attitudes toward science and science teaching are more positive than those of biology and chemistry teaching majors.

c. Special and old national college students' attitudes toward science and science teaching are more positive than those of students in new colleges. The attitude differences of new college students are greater than those of the students in special and old colleges.

d. Attitudes toward science of students who intend to become either scientists or educators are more positive than those of other groups. Attitudes toward science teaching of students who have no special intention are more negative than the other groups.

e. Attitudes toward science teaching of students who estimate their academic achievement at a grade of B are more positive than those who estimate at A.

5. One-third of science education majors had no specific intention to become an educator when they entered college, and estimate their academic achievement at a grade of C or lower.

6. One-fourth of science education majors have an opinion or belief in the absoluteness of science and the authoritative role of teachers, are confused about the main goals of science and technology, and have a pessimistic view of scientific development and their chosen profession of science education.

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CHAPTER I

NATURE AND BACKGROUND OF THE STUDY

Introduction

Even though both cognitive and affective domains of educational objectives are recognized to be important in the education of science teachers, the professional knowledge of science has been mainly emphasized without much consideration of attitudes concerning science and science teaching. Students' attitudes may be more important than their understanding and skills because their attitudes will determine what they study and how they use acquired knowledge and techniques. Having considered especially the exponential growth of knowledge, Schwab (1961, p. 8) said:

> It means that the notion of coverage, of conveying the current knowledge of a field, which was once the essence of science teaching, is called into question. It means that expertise, authoritative possession of a body of knowledge about a subject matter, is no longer enough to qualify men as the best teachers of science. It means that the education of the science teacher must be something more than, perhaps something quite different from, the inculcation of conclusions and training in ways and means to pass them on.

Green (1969) also insisted that the traditional research-oriented program is not a desirable vehicle for the training of secondary school science teachers.

Science educators must possess proper attitudes concerning science and science teaching in addition to the knowledge and intellectual skills of science and pedagogy. Arntson (1975) said that teachers must imbue their students with strong positive feeling for the subject and their professions if they are to be true ambassadors of their field. Shrigley (1973, p. 243) described,

> Stollberg (1962) asserts that teachers with neutral or negative attitudes can either avoid the teaching of science or pass their negative attitudes along to young students. The author further concludes ". . . that unless the teacher is attracted toward science, all the content and all the teaching methods which he may have learned can well serve no good purposes whatever."

Ignorance of attitudes might be due to persistence in "implicit belief that if cognitive objectives are developed, there will be a corresponding development of appropriate affective behaviors. Research summarized by Jacob (1957) raises serious questions about the tenability of this assumption. The evidence suggests that affective behaviors develop when appropriate learning experiences are provided for students much the same as cognitive behaviors develop from appropriate learning experiences" (Krathwohl, 1964, p. 20).

There has been some research on attitudes toward science of elementary, secondary and college students including elementary education majors, but it is rare to find the results of studies on attitudes toward science teaching of science educators. In general, it is expected that science education majors in colleges, secondary school science teachers and other science educators should have good attitudes toward science and science teaching. But systematic studies should be done to determine whether their attitudes toward science and science teaching are positive, and whether their attitudes toward science are balanced with their attitudes toward science teaching. The significance of this study and more detailed background information will be discussed in the section on significance of the study at the end of this chapter.

This study required the development of two attitude scales: one concerned with attitudes toward science and the other with attitudes toward science teaching. These instruments were used to survey the attitudes of science education majors in Korea.*

Statement of the Problem

What is the status of attitudes toward science and science teaching among science education majors in Korea when analyzed

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*Korea: Republic of Korea.

with respect to sex, grade level, specialty, college, birth place, high school attended, religion, army service, career goals, and self-estimation of academic achievement?

Definition of Terms

The following words and phrases are defined for purposes of this study:

Attitude statement.--Statement in the Attitude Toward Science Scale or the Attitude Toward Science Teaching Scale (Moore and Sutman, 1970, p. 86). In common terminology the questionnaire items correspond to attitude statements in this study.

Attitude toward science.--The feelings and opinions which individuals have formed as a result of interacting directly or indirectly with various aspects of science, and which exert a directive influence on their behavior toward science (Allport, 1967).

Attitude Toward Science Scale (abbr. AS scale).--The instrument developed for this study to measure attitudes toward science.

Attitude Toward Science Score (abbr. AS score).--The score of a student's attitude toward science measured by the Attitude Toward Science Scale. The minimum and maximum score of the scale are 40 and 200 points each.

Attitude toward science teaching. --The feelings and opinions which individuals have formed as a result of interacting directly or indirectly with various aspects of science teaching, including some aspects of education in general, and which exert a directive influence on their behavior toward science teaching.

Attitude Toward Science Teaching Scale (abbr. AT scale). --The instrument developed for this study to measure attitudes toward science teaching.

Attitude Toward Science Teaching Score (abbr. AT score). --The score of a student's attitude toward science teaching measured by the Attitude Toward Science Teaching Scale. The minimum and maximum score of the scale are 40 and 200 points each.

Balanced attitude toward science and science teaching. --Attitude of a student whose AS and AT scores are the same or show less than 10 points difference.

Confused attitude. --An undefined attitude toward science or science teaching. In this study a student's attitude is classified as a confused attitude if his/her AS or AT score is between 107 and 133 points.

National college. --A college which was established and has been supported by the government in Korea.

Negative attitude.--An attitude of dislike with bad opinions. In this study, a student's attitude is operationally classified as negative attitude if his/her AS or AT score is less than 81 points.

Negative-trend attitude.--An attitude tending toward the negative. In this study a student's attitude is classified as negative-trend attitude if his/her AS or AT score is between 81 and 106 points.

New college.--A college which was established after 1970 in Korea.

Old college.--A college which was established before 1970 in Korea.

Position statement.--The statements of attitude assessed by the AS or AT scale (Moore and Sutman, 1970, p. 86).

Positive attitude.--An attitude of liking with good opinions. In this study, a student's attitude is operationally classified as positive attitude if his/her AS or AT score is more than 159 points.

Positive-trend attitude.--An attitude tending toward the positive. In this study, a student's attitude is classified as positive-trend attitude if his/her AS or AT score is between 134 and 159 points.

Private college.--A college which was established and has been supported by a private school foundation in Korea.

Science. --In this study, science means the basic natural sciences.

Science-biased attitude. --Attitude of a student whose AS score is more than 30 points greater than his/her AT score.

Science-trend attitude. --Attitude of a student whose AS score is 11 to 30 points greater than his/her AT score.

Special college. --A national college which is the oldest one in Korea. In this study a special college is the college of education, Seoul National University.

Specialities of science education majors. --The science areas of physics, chemistry, biology, or earth science, selected by science education majors as their teaching field, following one or two years of study after having entered the college or university.

Teaching-biased attitude. --Attitude of a student whose AT score is more than 30 points greater than his/her AS score.

Teaching-trend attitude. --Attitude of a student whose AT score is 11 to 30 points greater than his/her AS score.

Hypotheses

1. There are no significant differences among the mean scores of science education majors on attitudes toward science as measured by the AS scale when analyzed with respect to (a) sex, (b) grade level, (c) specialty, (d) college, (e) birth place,

(f) high school attended, (g) religion, (h) army service, (i) career goal, and (j) self-estimation of academic achievement.

2. There are no significant differences among the mean scores of science education majors on attitudes toward science teaching as measured by the AT scale when analyzed with respect to (a) sex, (b) grade level, (c) specialty, (d) college, (e) birth place, (f) high school attended, (g) religion, (h) army service, (i) career goal, and (j) self-estimation of academic achievement.

3. There are no significant differences among the total mean scores of science education majors on attitudes toward science and science teaching as measured by the AS and AT scale when analyzed with respect to (a) sex, (b) grade level, (c) specialty, (d) college, (e) birth place, (f) high school attended, (g) religion, (h) army service, (i) career goal, and (j) self-estimation of academic achievement.

4. There are no significant differences between the mean scores of science education majors on attitudes toward science and science teaching as measured by the AS and AT scale when analyzed with respect to (a) sex, (b) grade level, (c) specialty, (d) college, (e) birth place, (f) high school attended, (g) religion, (h) army service, (i) career goal, and (j) self-estimation of academic achievement.

5. There is no significant correlation between the following scores of science education majors on attitudes toward science and science teaching as measured by the AS and AT scale when analyzed with respect to the scores of (a) the AS and AT, (b) the AS and AS + AT, (c) the AS and AS - AT, (d) the AT and AS + AT, and (e) the AT and AS - AT.

Significance of the Study

There are sixteen departments of science education in Korean colleges and universities to provide for the education of secondary school science teachers. Two-year junior teachers' colleges, which are entirely separated from colleges of education and universities, are responsible for educating elementary school teachers. Because of the high enthusiasm of Korean people toward education and respect for teachers, traditionally good students from the high schools come to the colleges of education in spite of very competitive entrance examinations. The Ministry of Education (1978) permits only a strictly limited number of students to study at the colleges. Many of the students unsuccessful in the entrance examination try again in the following academic year. This has raised many unexpected and undesirable problems and social issues. Rather than studying at school, many students receive extra tutoring at high cost to learn how to solve test style problems.

With modernization of the nation, the Korean people recognized the importance and the requirement of a large body of qualified scientific and technological manpower. The incentives of increased payment and rapid progress toward professional status in science and technology-related jobs would threaten the balance of supply and demand of qualified science teachers. Because of the short orientation toward various professions in high school, very crucial competitiveness in college entrance examinations for science and engineering studies, the lack of permission to change majors, and the similarity of curriculum in the college of education and the natural science college, many students who passed the entrance examination of the college of education and study in the department of science education do not intend to become science teachers. The low salary scale for teachers and the acceptance of many science education majors into scientific research institutes and factories are factors here also. According to this researcher's informal survey by simple questionnaire forms about the future planning of students who belong to the department of science education of a leading national university in Korea, there were less than 30 percent of students who mentioned their desire to become science teachers. They were more interested in studying courses in science than education or psychology, and made light of teaching.

Even though the number of science education departments has grown recently, as tabulated in Chapter III, it is doubtful whether a simple increase in number will contribute to the preparation of qualified science teachers. Students who have majored in science education might teach science temporarily in a secondary school after graduation with a license for teaching, but they may give up teaching whenever they have an opportunity to be employed in industry or a business field.

A survey analysis done by the Korean Federation of Teachers showed that the ratio of retirement of secondary school teachers increased to 14.9 percent in 1977 compared with about 3 percent in the 1960's, and more than 44.9 percent of the teachers wanted another job. Only 19 percent of teachers are satisfied with the job of teaching. However, science educators in Korea have no specific and objective data concerning the status of the attitudes of science teachers and science education majors in college.

This study provides two scales for the measurement of attitudes toward science and science teaching, which have been used for collecting data on the present attitudes of science education majors. The results of this study should be useful for developing a national policy for the recruitment of future science teachers, and revision of curriculum and instructional methods for science education majors in Korea.

Basic Assumptions

1. The response to the questionnaire of the AS and AT scale indicates the students' true feelings and/or opinions toward science and science teaching.

2. Subjective attitudes can be measured in a quantitative way by Likert type paper and pencil test so that each respondent's attitude can be represented by some numerical score.

3. Each attitude statement has the same meaning for all respondents and thus a given response is scored identically for each person making it.

Limitation of the Study

1. The sample of this study is limited to selected students of eight departments among sixteen departments of science education in Korean colleges and universities.

2. The AS and AT scale were administered by the faculties who had the sample students in their classes.

3. The subscales of the AS and AT scale are limited to some aspects of (a) goals and values, (b) knowledge or content, (c) methods, (d) social aspects, and (e) professional personnel and careers of students.

4. The survey of related literature is limited mainly to materials written in English and obtained in the United States of America.

CHAPTER II

SURVEY OF RELATED LITERATURE

Introduction

In the following sections, definitions of attitude and classification of the measuring instruments are described first. After summarizing a brief historical background of research on attitudes in science education, measuring instruments of attitudes toward science and science teaching are compared. Finally, studies on attitudes toward science and science teaching are surveyed.

Affective Domain and Attitudes in Science Education

Many definitions and explanations of the affective domain indicate five levels identified by Krathwohl, Bloom, and Masia (1964) which give an analytic basis for evaluation and research. Each level has two or three sub-levels. They analyzed many of the commonly used affective terms such as interest, appreciation, attitude, values, and adjustment by pointing out the span of five to eight sub-levels of the domain. Lewy (1968, p. 76) summarized his research conducted to validate Krathwohl's affective domain taxonomy in the following manner,

> From analysis of the data, we conclude that the constructs of the model have empirical referents among affective educational objectives, and that the hierarchical structure of these referents corresponds to that claimed by the model.

Nevertheless, there is a lack of systematic research using Krathwohl's Taxonomy of the Affective Domain. Eiss (1969, p. 11) insisted,

> The affective domain is central to every part of the learning and evaluation process. It begins with the threshold of consciousness, where awareness of the stimulus initiated the learning process. It provides the threshold for evaluation, where willingness to respond is the basis for psychomotor responses, without which no evaluation of the learning process can take place. . . . It provides the bridge between the stimulus and the cognitive and the psychomotor aspects of an individual's personality. Why, then, has so little effort been made to assess student progress in the affective domain?

Eiss (1969, p. 9) also pointed out that "most of the instruction in our school is built upon the first two of the five categories" of Krathwohl's taxonomy, even though the levels above the third may be more important.

Downs (1972, p. 5) said:

> Attitudes, according to the analysis of Krathwohl's group, refer to situations where the student is expected to display a particular behavior, especially with a certain amount of emotion (enthusiasm, warmth, disgust) to situations in which he may go out of his way to display the value or to communicate to others about it. These terms expand the levels of the affective domain from the middle category of responding to the lower category of organization.

Zimbardo (1974, p. 6) said,

> Attitudes have generally been regarded as either mental readiness or implicit predispositions which exert some general and consistent influence on a fairly large class of evaluative responses. These responses are usually directed toward some objective, person, or group. In addition, attitudes are seen as enduring predispositions, but ones which are learned rather than innate. Thus, even though attitudes are not momentarily transient, they are susceptible to change.

Short definitions can be chosen to express the key points about characteristics of attitude. Webster (1970, p. 9) describes attitude as "a manner of acting, feeling, or thinking that shows one's disposition, opinion, etc." Klausmeier and Ripple (1971, p. 356) said that attitudes are "emotionally toned dispositions of individuals" to react in a consistent way, toward a person, object or idea.

Fellers (1972, p. 10) pointed out several common factors among the various definitions of attitudes as follows:

1. Attitudes are learned.
2. Attitudes are relatively permanent.
3. Attitudes involve the interplay of a person's internal make-up with an external object or criterion.
4. Attitudes are complex and involve many facets of a person's background in the make-up of a single attitude.

Wick and Yager (1966, p. 269) stress the need for teaching attitudes in school:

> To state that a student's success in a particular course is highly dependent upon his attitude borders on a triviality. Most experienced teachers would add a hearty "amen." The student who does well in a course he strongly dislikes is a rarity indeed.

Schwirian (1968) said that the development of healthy, positive attitudes regarding scientific enterprise and its practitioners is one of the major responsibilities of science educators at all levels.

Attitudes concerning science can be classified into two categories. One is attitudes toward science and the other is scientific attitudes. Attitudes toward science refer to one's feelings, opinions, and beliefs toward the processes of science, scientific knowledge, scientists, values and social interactions of science. Scientific attitudes are those attributes which are displayed maximally by scientists, to some degree by everyone and such as are necessary to carry on the process of scientific inquiry (Arntson, 1976, p. 7). A list of scientific attitudes can be found from the Educational Policies Commission's "Education and The Spirit of Science" (1965) or twenty components analyzed by Diederich (1967).

Attitudes concerning science teaching also can be classified into attitudes toward science teaching and science teaching attitudes. The former refer to feelings, opinions and beliefs about science teaching with a certain degree of fanaticism. The latter refers to attitudes expected to be displayed maximally by science educators in teaching science. An example can be found from Bybee's "Science Educators' Perceptions of the Ideal Science Teachers" (1978).

Classification Scheme for Instruments

Campbell (1950, p. 15) introduced a classification scheme for measuring instruments for attitudes with four possible arrangements.

1. Non-disguised-structured: the classic direct attitude tests of Thurstone (1929), Likert (1932), et al.
2. Non-disguised-non-structured: the free-response interview and questionnaire approaches, the biographical and essay studies.
3. Disguised-non-structured: the typical "projective" techniques.
4. Disguised-structured: tests which approximate the objective testing of attitudes.

Thurstone and Chave (1929) developed a judgmental technique where a large number of items are sorted into eleven categories by a panel of judges. The judging criteria of the eleven categories is the degree to which agreement with the item reflects the underlying attitudes. The categories are then numbered one through eleven and a scale value is computed for each item. Fellers (1975, p. 33) pointed out several objectionable features to the Thurstone scale:

a. The laborious detail involved in the construction of the scale often prohibits the application of the technique to small groups.
b. The lack of objectivity makes the scale insensitive to changes of attitudes.
c. The validity of scaling has been criticized. Guilford (1954, p. 458) stated that "the scale values for opinions will not depend upon the attitudes of the judges."
d. It requires additional information to determine item validity, for example, item intercorrelations and item-total correlations (Guilford, 1954, p. 458).

Likert (1932) developed a scaling technique similar to Thurstone's.

Shaw (1967, p. 24) summarized as follows:

> These items are then given to a sample of the target population, and respondents indicate their reaction to the items by means of a five-category rating system: strongly approve, approve, undecided, disapprove, and strongly disapprove. Categories are scored by assigning values of 5, 4, 3, 2 and 1, respectively. This scoring is correlated with total score, and items that correlate highly with the total score are selected for the final scale.

Murphy and Likert (1938, p. 32) stated that questions should permit "judgment of value" rather than a "judgment of facts," and the inquiry should relate to "the wants, desires, conative disposition of the subjects, --every issue might be presented in such a way as to allow the subject to take sides as between two clearly opposed alternatives."

These nondisguised types are classified as a direct approach because the information is obtained without any pretense.

There are three commonly used disguised or indirect techniques, which were summarized by Hein (1973, p. 18) as follows:

> The Error-Choice Technique requires that all attitude objects must have two equally erroneous responses, one in the favorable and the other in the unfavorable direction compared to the attitude object. This forces the choice of an error and the direction of the error statement reflects the attitude of the respondent.
>
> The Sentence-Completion Technique forces the respondent to freely react to a series of incomplete sentences. The manner in which the sentence is completed then reflects the respondent's attitude toward the contrived attitudinal situation.

Pictures or ambiguous visual forms used as stimuli are the basis of the Pictoral Technique. The respondent's attitude toward visual stimuli is determined by his selection of alternate interpretations of the picture he has viewed.

Summers (1966, p. 201) discussed good and bad aspects of both the direct and indirect techniques:

> There are just criticisms of the direct test of attitude. Those persons who are in favor of using indirect measurement of attitudes have pointed to at least two of these. No doubt the direct measurement approach does at times create an unreal situation, and there is interaction between the testing instrument and the attitudes of the subjects. An attempt to correct the shortcomings is a worthwhile effort. However, in the case of the indirect measurements that have been developed, there is little indication that the weaknesses have been corrected. Hence, there still remains the two weaknesses which have been indicated. In addition to these two weaknesses of attitude measurement, there is the serious weakness of lack of validity. This seems to be a much more serious error or weakness than either of the two criticisms of direct measurement indicated by the proponents of indirect attitude measurement.

In addition, indirect techniques are characterized by lack of objectivity, precision, and reliability and by ease of administration (Fellers, 1973, p. 15).

Early Studies on Attitudes in Science Education

Early efforts by science educators in the USA were directed at defining scientific attitudes and isolating their characteristics in the affective domain of science teaching (Hein, 1973). One of the earliest investigations (Curtis, 1926) dealt with a defining and listing of scientific attitude from the literature, including such books as Pearson's "A Grammar of Science," Dewey's "How We Think?," and Kramer's "The Method of Darwin."

Davis (1935) assessed which of the scientific attitudes defined by Curtis were held by students, and was interested in designing a method of teaching them, while Noll (1935) stated that scientific attitudes are "habits of thinking--such habits can be developed and measured" and he developed a test, "What Do You Think?". Noll said that these attitudes could be achieved by mastering basic problem solving skills.

Crowell (1937) found 29 attitudes and 25 skills, and Mullikan (1937, p. 66) defined the scientific attitude as much the same as the intellectual attitude, as following.

> It is a mental condition, never completely realized in practice, in which the feelings and emotions are encouraged to help, but not allowed to interfere, with logical thinking.

Hein (1973, p. 10) said:

> Efforts of science educators to teach the newly identified scientific attitudes are reflected in the studies conducted by Reiner (1939), Eberhard and Hunter (1940), and Wessel (1941). They used control versus experimental group methods and found no significant differences in the teaching methods used. From these results they concluded that attitudes could not be taught in short periods of time.

These kinds of studies on scientific attitudes have been continued by many researchers. One important thing to realize is that the concept of scientific attitude and attitude toward science had been mixed and/or confused in the early stages of research so that it is difficult to know from the title or summary exactly what the research studied.

Recently, science educators have become concerned with the whole realm of the affective domain, for example, comprehensive attitudes toward science.

Measuring Instruments for Attitudes Toward Science

It is found that there are three types of measuring instruments for attitudes toward science. The indirect approach is introduced first and the direct approach including Thurstone's and Likert's type is surveyed second.

Indirect Approach

Lowery (1966) set up the Projective Test of Attitude which consists of three parts: The Word Association Test, the Laurence Lowery Apperception Test, and The Sentence Completion Test to investigate attitudes toward science and scientists of the fifth grade students.

The tests were given to 40 boys and girls, students from four elementary schools, twice in an 8 week period individually. To each test the children supplied words, interpreted pictures, and completed sentence fragments. Lowery said that in these three tests the stimuli were neutral and the respondent answered in a neutral way. Three judges, professors at the University of California at Berkeley, scored the results. Lowery claimed a high validity based on the consistency between judges, the consistency of the same judge between the two tests and the consistency of responses by the students.

Hackett (1972) mentioned that Perrodin (1966) constructed a projective type instrument consisting of 20 sentence fragments, which were intended to stimulate students (fourth, sixth, and eighth grade level) in the expression of their feelings toward science.

Direct Approach--Thurstone's Type

Dutton and Stephans (1963) developed a scale assessing attitude toward science of prospective elementary teachers using equal intervals by Thurstone's method. The subjects are given a stack of cards which have a single statement. The students are told to separate the cards into a designated odd number of piles. The piles range from "strongly disliked" on the far left with number one to "strongly liked" in the last pile on the right with number eleven. The center pile represents neutrality. The arrangement of the piles can be interpreted as an attitude score because the statements were pre-judged as favoring or disfavoring science.

Myers (1967) asked high school teachers enrolled in a NSF Summer Institute at Pennsylvania State University to write their opinions about science and scientists. He obtained 232 statements from teachers' writings and from a review of science textbooks. Seventy-three teachers rated the edited 105 statements from very favorable to very unfavorable toward science. The scale value for each statement was taken as the median of the judges' value for that statement. The scale was administered to 212 college chemistry students, and the reliability was determined by both the split-half method, for which a value of 0.60 was obtained, and by the test-retest method, for which a value of 0.63 was obtained. The new scale with 44 items showed split-half reliabilities in two administrations of 0.44 and 0.70.

Downs (1972, p. v) developed a self-report instrument named the Affective Domain Measuring Scale (ADMS) to assess the change in affective behavior toward science for high school students using Thurstone techniques and summarized as follows:

> Two methods of item discrimination were used on the original 110 statements. A statistical criterion for the "doubtfulness" of the statements was provided by using the width of the range between the 25th and 75th percentiles. This is termed the "Q" value. Each item on the final ADMS had a "Q" value no greater than 3.5. The scores used a discriminatory power measure to test the validity of each item on the best compared to the test as a whole. The t-test, using the .05 level, was used to test the significance of the correlation value found for each item.
>
> Construct validity of the ADMS was determined using correlation coefficients calculated between the ADMS and "Attitude Toward Any School Subject," and "Attitude Toward the Aesthetic Value." Coefficients of .64 and .26 were found respectively.

Reliability was measured using two different methods: (1) correlation scores on two forms in the pre-test and post-test settings, (2) and the test-retest method. Reliability values of 0.86 and 0.89 were found for the two forms on the pre- and post-test settings. A correlation of 0.85 was found for the test-retest method.

Hasan and Billeh (1975) developed a Thurstone type attitude scale to assess the attitudes toward science by secondary school science teachers. A pool of 120 items was presented to a group of 46 science professors and instructors from the American University of Beirut and the University of Jordan, who were asked to rate the items on an equal distance interval scale ranging from one to eleven. Only 32 items were selected to form the two parallel halves of the instrument used in their study in Arabic. The split-half reliability ranged from 0.63 - 0.42 and 0.62 when the scale was administered to a few groups of secondary school students and a group of science teachers.

Ost and White (1979) developed a simplified Q-sort instrument, the Scientists' Activities Inventory, for use with junior high school students, based upon the belief that descriptive data are useful and that existing instruments do not require students to employ comparisons when making responses.

Direct Approach--Likert Type

Allison (1972, p. 19) summarized the procedure of a scale development by Allen (1959) as:

Allen (1959) based his attitude scale on a review of current literature from which questions were formulated. These questions were then used in interviews with scientists, professors of science, and high ability high school seniors. The interviews resulted in a 95 item attitude scale, on which the responses could be analyzed relative to specific aspects of scientific endeavor. The respondent was asked to indicate the extent of his agreement with a statement in five choices. The rank of the statements, based on favorableness to the scientific endeavor, was determined by a panel of judges, scientists and professors of science.

In the original version the Allen Inventory of Attitude Toward Science and Scientific Careers had 95 items with 3 subscales written for a high school age population. Allison (1966) used the 95 item scale for his study with fourth-, fifth-, and sixth-grade students by rewriting the Allen Inventory. The reliability findings for the Allen Scale and Allison Scale on the same population of 39 students were 0.92 and 0.95, respectively. The Allison version used the three subscales and had a total reliability coefficient of 0.92 when used with 1348 students in his study. Anderson and Herrera (1976) translated the Allison version into Spanish and administered it to Latin American students at Pennsylvania State University and to elementary school teachers in Panama in 1973 to find out if the instrument was reliable. Reliability coefficient alphas were 0.89 and 0.80, respectively.

Schwirian (1968) developed an inventory, Science Support Scale (Tri-S), for assessing attitudes toward science for college students, who were all non-science majors and were primarily freshmen and sophomores. Using a "theoretical orientation" by Bernard Barber (1962), her instrument has five underlying values: "rationality, utilitarianism, universalism, individualism, and a belief in 'progress and meliorism'." Each value comprises a subscale of eight questions totaling forty for the whole scale. Half the items support the dimension under question and half opposed it. Item analysis was used to improve the original instrument. A reliability coefficient for the total test was obtained (0.873) and validity was developed by a panel of experts in science education and attitude scale constructors.

Vitrogan (1967) developed a scale for assessing two groups of New York high school students. He developed eight "criteria of a positive generalized attitude toward science" and eight "criteria of a non-positive generalized attitude toward science" from his own experience and a study of the literature, including writings of John Dewey, Ernest Nagel and Bertrand Russell. The final scale was six-choice Likert type, consisting of forty items.

Moore and Sutman (1970, p. 85) developed a scale concerning science called the Scientific Attitude Inventory, and they claimed that of all the attitude scales developed in recent years, none of them has contained all of the following characteristics.

1. Preparation based upon specification of the particular attitude to be assessed.
2. Use of several items to assess each attitude.
3. Provision for the respondent to indicate the extent of his acceptance or rejection of an attitude statement.
4. Concern with intellectual and emotional scientific attitudes.

The inventory included intellectual and emotional attitudes, which are explained as follows (Moore and Sutman, 1970, p. 86).

> Intellectual attitudes are said to be based upon some knowledge about the psychological object of the attitude, and emotional attitudes are said to be based upon a feeling or emotional reaction to the psychological object of the attitude.

There were twelve position statements to be assessed (Appendix B) and for each of the position statements, eight to nine attitude statements were written. A panel of judges was asked to determine whether the attitude statement expressed the positive, negative, or neutral position of the attitude. Five attitude statements were finally selected for each attitude to be assessed. They said that the experimental results of three groups of low ability biology students established the construct validity of their scale with the method outlined by Kerlinger (1964, p. 451), and also the scale reliability was determined by the test-retest method to be 0.934.

Hackett (1972) developed a four-choice Likert type scale, The Affective Self-Report Instrument (ASRI), and The Observed Affective Behavior Checklist (OABC), which were constructed from affective behavioral objectives to study "the correlation between teacher observed and student self-reported affective behavior toward science" for eighth grade students. The OABC contained twenty-one statements of desired affective behaviors which were overt verbal or non-verbal. The observer indicated the relative frequency of occurrence of each stated behavior for each pupil. The ASRI contained forty-two statements of affective behaviors matching those on the OABC. Reliability of the ASRI was calculated using the split-half techniques to find a coefficient of 0.82. Correction for shortening the test by this method was handled by using the Spearman Brown prophecy formula resulting in a reliability of 0.90.

Fellers (1972) developed the American River College Science Attitude Inventory to assess "the change in attitudes toward science upon completion of a one-semester general education physical science course at the junior college level." The instrument consisted of fifty-five statements on which the students recorded their degree of agreement or disagreement. The average reliability of the test-retest of the instrument was 0.71. The correlation coefficient for the parallel forms was 0.839. The internal reliability of the total test control group was 0.667 for the pretest and 0.708 for the post test.

Shrigley and Johnson (1974) developed the Shrigley-Johnson Science Attitude Scale for in-service elementary teachers. While thirty-eight attitude statements were gleaned from comments made voluntarily by students enrolled in an undergraduate method course in the former case, fifty in-service elementary teachers volunteered to serve as a pilot group by responding anonymously to each of the forty-one attitude statements in the latter case. The reliability coefficient alpha was 0.91 and 0.92 each for the total scale and reliability coefficients of test-retest were 0.92 and 0.94, respectively.

Arntson (1975) developed The Attitude Toward Science Test to assess "the effect of an interdisciplinary course in Futuristics on attitudes toward science among students in a two-year college." The test consists of forty statements. A panel of eleven judges helped to select test items in order to insure content validity. Test-retest reliability was 0.68. Correlation coefficient and t-scores were calculated and used to test obtained data for significance at the 0.05 level.

Gardner (1976) developed a Physics Attitude Index to study personal and environmental influence of attitudes toward physics of high school physics students. Corrected split-half reliability of the four subscales were 0.78 or greater.

Dillon and James (1977) developed a seven-choice Likert type scale to study "attitudes of black college students toward science." The four groups (Science and society, science and black, self-estimates of proficiency, and science as a career) were submitted to a panel consisting of twenty-eight black scientists and science educators for content validity. Alpha coefficients for the subscales are 0.668 or up.

Fraser (1978) discussed three important shortcomings of some existing scales: first, the statistical characteristics of some scales fall below a satisfactory level; second, lumping distinct attitudinal dimensions together into a single scale represents a confused mixture of variables; third, lack of economy. He claimed to have developed a set of four science attitude scales for which the three criticisms outlined above are overcome. At the same time, he reported in another paper that he had developed a seven-choice Likert type scale named the Test of Science Related Attitudes (TOSRA) by extending the previous battery by field testing with seven to ten grade students. The scales names include "Social Implication of Science, Normality of Scientists, Attitude Toward Scientific Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science, Career Interest in Science." Alpha coefficients were 0.64 and greater. Test-retest reliability coefficient ranged from 0.69 to 0.84 with a mean of 0.78. Intercorrelations among TOSRA scales were calculated as indices of discriminant validity to be ranged from 0.10 to 0.59 with a mean of 0.33.

Krajkovich and Smith (1979) developed a six-choice Likert type inventory with 48 items, The Image of Science and Scientists

Scale (ISSS), to assess secondary school students' attitudes toward science. The instrument items are based on the 1957 summaries presented by Margaret Mead and Rhoda Metraux. The reliability of the instrument, using coefficient alpha, ranged from 0.76 in the pilot to 0.86 in the second phase of the study. Construct validity was obtained by comparing a science-oriented group versus a random sample to determine if the instrument could discriminate between the groups as suggested by Kerlinger (1964). With IQ controlled, the science group performed significantly higher at the 0.012 level. Furthermore, scores in ISSS contributed significantly to the prediction of science grades as determined by multiple regression analysis.

So far, twenty-one cases of development of measuring instruments for attitudes toward science have been described; only two cases used the indirect approach and the others are the direct approach including five Thurstone type and fourteen Likert type scales.

Two indirect approaches (Lowery, 1966; Perrodin, 1966) are for elementary school children. Although the researchers said indirect methods show better validity and reliability, they have not been popular in studies of attitudes toward science.

The Thurstone type of direct approach has been adapted in a rather wide range of levels except elementary school. Five cases are related to each one of the following levels: junior high (Ost and White, 1979), senior high (Downs, 1972), college (Myers, 1967), elementary education major (Dutton and Stephen, 1963), and secondary school science teachers (Hasan and Belleh, 1975). Reliability ranges from 0.42 and 0.89 with the average number of about forty items.

Fourteen Likert type researchers have been described. The objects of the instrument concern a wider range of levels than the other two cases. There are some special characteristics of these Likert type instruments: theoretical approach (Schwirian, 1968; Vitrogan, 1969; Moore, 1970), subscaling (Fraser, 1978), variety, such as, physics related (Gardener, 1976), black sample (Dillon and James, 1977), translating into Spanish (Anderson and Johnson, 1976). In addition to the original five-choice response, four-choice (Hackett, 1972), six-choice (Vitrogan, 1969; Krajkovich and Smith, 1979), and seven-choice (Dillon and James, 1977; Fraser, 1978) response style have been tried, but there are no decisive criteria indicating which style of response is the best. The number of items varies from 21 (Hackett, 1972) to 95 (Allen, 1959) but the average number is about 40 items. Correlation coefficient for reliability ranges from 0.68 (Arntson, 1975) to 0.95 (Allison, 1966) and coefficient alpha ranges from 0.64 (Fraser, 1978) to 0.92 (Shrigley and Johnson, 1974).

Measuring Instruments for Attitudes Toward Science Teaching

There are fewer measuring instruments for attitudes toward science teaching than for attitudes toward science. The first part of this section concerns the instruments developed for elementary school teachers and the second part for secondary school science teachers.

Moore (1973) developed a four-choice 30-item Likert type instrument named the Science Teaching Attitude Scale (STAS) which is available to assess teachers emotional and intellectual attitudes toward teaching science in the elementary school. He reported that the scales (Moore, 1973, p. 271)

> were developed by the same procedures used to develop an inventory of science attitudes, the Scientific Attitude Inventory, and are compatible with it.

The first step was to write the position statements which are listed in Appendix B. The fifth pair of positive and negative position statements in Appendix B represent "emotional attitude," while the sixth and seventh ones represent "intellectual attitude." Eight or nine attitude statements were written for each position statement. An initial pool of fifty items was presented to a panel of sixteen judges and to a group of 105 elementary teachers so that five attitude statements were selected to represent each position statement. For the field test time-series design which Campbell and Stanley classify as a quasi-experimental design was persuaded according to the theoretical background of construct validity by Kerlinger (1964). The Duncan multiple range test of significance for differences between means was carried out for the pre-pretest versus pre-test pairs, and the pretest versus posttest pair. The null hypothesis of the former was accepted, while the null hypothesis of the latter was not accepted beyond the 0.01 level. The test-retest reliability coefficient obtained by this method was 0.816.

Jaus (1976) developed a Likert type instrument to measure the attitudes of elementary teachers toward teaching the integrated science process skills in the classroom. The content validity was determined by seven science education doctoral students and four professors. The reliability was determined on three different occasions using the test-retest method, with Pearson product-moment correlation coefficient of 0.76, 0.81, and 0.87, respectively.

Bratt and DeVito (1978) developed a four-choice Likert type inventory of humanistic attitudes toward science teaching for elementary teachers, named Bratt Attitude Test (BAT), by using Moore's model for scale development. In addition to Moore's three pairs of positive and negative position statement for the Science Teaching Attitude Scale (1973), Bratt added the following position statements (Bratt and DeVito, 1978, p. 552):

Scale

4-P In education and teaching, the needs of students and teachers should be more important than the subject matter.
4-N In education and teaching, covering subject matter, i.e., science, should be more important than the needs of students.
5-P Educational programs should find teachers and students working together for mutual benefit so that both learn something.
5-N The teacher should be the sole authority in the classroom.
6-P Students and teachers alike are responsible for the learning that takes place in the classroom.
6-N The teacher should be the sole determiner of the activities in the classroom.

The five attitude statements achieving the highest ratings by panel members were chosen to represent the position statements. The final instrument contained 60 items that assessed 12 position statements. The items were randomly placed in the inventory. Each of the items in the scales was scored similarly to Moore's (1973). The researcher claimed a K-R 20 estimate of 0.79 at the first trial by administering to 26 in-service teachers enrolled in a graduate school course at Purdue University. The revised scales were administered to 75 preservice teachers and obtained a K-R 20 estimate of 0.85. After the second revision, a K-R of 0.86 was obtained. He also reported eight scales (1P, 2P, 2N, 3N, 4N, 5N, 6P and 6N) had reliabilities above 0.80, three scales (1N, 4P, and 5P) had above 0.60, and one scale (3P) had a reliability of 0.09.

Blankenship (1966) used four different methods (Attitude Inventory, Peer Rating, Instructors' Rating, and Follow-up Questionnaire) to determine the science teachers' attitudes and analyzed the effectiveness of each of the measures. The data used in determining the teacher's attitudes to the BSCS Program were all obtained following a summer institute training period in which 55 teachers were given the opportunity to become thoroughly acquainted with the content, philosophy, and method of the BSCS Biology Program. The Attitude Inventory was developed by the investigator by review of literature, interviewing those who were involved in the BSCS program, as well as the others who had not been involved. Seventy statements were prepared reflecting specifically whether a view was favorable to the BSCS Program or unfavorable to the program. Final number of statements was reduced to forty-six items. The Peer Rating score was obtained by determining the relative position of each individual in the group as seen by all the other group members. The Instructor's Rating was done after a summer institute by each instructor who was asked to base his rating on any comments made by an individual in either the favorable or unfavorable attitude category. The Follow-up Questionnaire was mailed to each of them after starting the new school year, asking whether they actually used or not. The Attitude Inventory and the Peer Rating were equally effective in correctly identifying the science teacher attitudes. The Instructors' Rating was least accurate in correctly identifying these attitudes. The combined use of different methods of measuring attitudes should result in a more accurate identification of the attitudes in question due to the checks and balance which are provided through the use of a composite assessment of attitude.

Hein (1973) developed a self-report instrument named the Affective Domain Measuring Scale-Teaching (ADMS-T) for assessing affective behavior toward science teaching. He used the same method employed by Downs (1972) for his study of an evaluation of the affective domain component of a teacher preparation project as measured by instruments using the affective domain continuum. Essentially, Hein used Thurstone's techniques. The validity was established using the point-biserial correlation technique for discrimination of the test items and correlating the ADMS-T with Minnesota Teacher Attitude Inventory for concurrent validity. As a result, statements with a significant level greater than the 0.5 probability level were removed from the test. The correlation coefficient was 0.14 when calculated by Pearson product-moment correlation coefficient formula. The reliability of the ADMS-T was 0.859 by using K-R technique.

Lazarowitz (1976) developed a Likert type instrument named Inquiry Science Teaching Strategies to determine the inquiry attitudes of secondary science teachers. The researcher identified eight-three items of inquiry to form the first instrument based on the work of "Bruner (1961), Lee (1960), McRel-BSCS (1969), NSTA (1971), Schwab (1963), and Steiner (1970)" referring to "classroom teacher-student interaction, laboratory investigation, and textbooks used." The author asked seven professors of science education to evaluate each item for content validity, and did computation of a biserial correlation coefficient for each item with thirty secondary science teachers' responses, at first followed by an additional 735 teachers. Forty items which correlated higher than 0.25 with the total score and were recommended by the panel of judges were selected for the final instrument. Construct validity was achieved by five known groups with alpha coefficient of 0.85.

Measuring instruments for attitudes toward science teaching have been developed in small numbers, rather recently, according to the same procedure used to develop inventories of attitudes toward science. The Likert type of direct approach has been mainly adapted to teacher's attitude measurement rather than the measurement of attitudes of college students majoring in elementary or secondary science education.

Studies on Attitudes Toward Science

For convenience, the survey will be divided into three parts: the first part reporting studies on attitudes toward science of elementary school children and teachers, the second concerning secondary school pupils and science teachers, and the third relating to college students and scientists.

Elementary School Children and Teachers' Attitudes Toward Science

Bixler (1959) studied the effect of teacher attitudes on elementary children science attitudes. The researcher found that children's scientific information was related to their teacher's attitudes, children's science attitudes were related to their teacher's attitudes, and science information and science attitudes were inversely related to children's intelligence.

Krockover and Malcolm (1978) investigated the effect of the SCIS upon a child's attitude toward science as measured by the way children respond to the SCIS "Faces" attitude instrument and "Science Report Card" class perception instrument (Peterson, 1971, p. 7). The results of the study showed that instruction utilizing the SCIS elementary school science program does enhance selected areas of a child's attitude toward science. But both the experimental and control groups indicated that they did not like science as well as before the experiment started. The control group for each grade level showed a negative gain in attitude after their instruction, and participation in the SCIS program does affect a child's attitude toward science, but not to the extent anticipated.

Dutton and Stephens (1963) tested 226 female elementary education majors. The respondents had not taken any content and method courses on elementary school science teaching. The main findings of this study were (Dutton and Stephens, 1963, p. 48):

1. University students in this sampling expressed considerable liking for elementary school science. Six statements (centering around field trips, need for science instruction, studying animals, and student participation) were selected by over 90 percent of the students.
2. There were 39 percent of the students who felt that they would not pursue independent study of science but had no real dislike for the subject.
3. Twenty-five percent of the students in this sampling were afraid of bugs, worms, snakes, insects.
4. This study sampled the attitudes of women students. Since most elementary school teachers at present are women, these findings are important for those professors teaching science classes for prospective elementary school teachers. Also this study has implications for in-service activities for teachers given by local school districts.
5. The general attitude of the vast majority of prospective elementary school teachers toward science, measured by the average of all of their responses, was quite high. The mean for the distribution of scores was 8.03 with a standard deviation of 0.53.
6. In their free-response statements, students expressed favorable feelings toward simple experiments, field trips, and the opportunities for doing creative work.

Kane (1968, p. 170) studied the attitudes of 58 elementary education majors at Purdue University by asking them to rank-order the subject areas of English, Mathematics, Science and Social Studies in response to six statements. Science rated last for the following statements:

1. I enjoy my work in this field (science) in high school.
2. This field (science) was the most worthwhile for me to study in high school.
5. I probably will enjoy teaching this subject (science the most.
6. I probably will be the most competent to teach this subject (science).

Science rated first the following statements:

3. I enjoyed courses in this field (science) the most in college.
4. I learned the most in courses in this field (science) in college.

The researcher summarized the results as "science was not well regarded on the high school and teaching item, but it was the most popular first choice in response to the college course items."

Nance (1972) conducted a study to determine the change in attitudes toward science of elementary education majors who were taking a traditional or modern physics course during one quarter. The researcher reported a significantly positive attitude change in those students enrolled in the course of modern physics by using The Purdue Master Attitude Scale, while no change of attitudes toward science in those students enrolled in the course using traditional content.

Thomson and Thomson (1975) tried an experiment of building attitudes toward science for pre-service elementary teachers with a program which emphasized direct student experiences with scientific phenomena, student involvement in short term investigation, and development of understanding that comes through "doing" rather than merely "telling." The investigator did not test any formal scale, but quoted a few phrases of students' response, i.e. (Thomson and Thomson, 1975, p. 216)

> I just don't believe how much one can learn by experience. If you told us to read ten books on teaching science, I'm sure I wouldn't have learned as much as I did just by my weekly observation and participation. The teachers were terrific, truly helpful.

Bratt (1977) investigated two methods of science instruction and teacher attitudes toward science. A three-group pretest-treatment-posttest design was used to test the hypothesis of no differences between groups on attitude measure, on students who were enrolled in the elementary science methods course at a large midwestern university and reported (Bratt, 1977, p. 536)

> The data supported the influence that a humanistic teaching-learning environment can produce more positive attitudes toward science than a more traditional method, at least for the population studies.

Secondary School Pupils and Science Teachers' Attitudes Toward Science

Mead and Metraux (1957) conducted a study on the image of the scientist of 145 United States high school students. Samples randomly drawn from the 35,000 responses were analyzed.

> In general, the study showed that while an official image of the scientist. . . has been built up which is very positive, this is not so when the student's personal choices are involved. . . . as a career choice or involving the choice of a husband, the image is overwhelmingly negative.

The researchers pointed out that high school students hold some strange notions about scientists as follows (Mead and Metreaux, 1957, p. 387).

> His work is uninteresting, dull, monotonous, tedious, time-consuming. . . he doesn't know what is going on in the world. He has no other interests. . . He can only talk, eat, breathe, and sleep science. He neglects his family. . . has no social life, no other intellectual interest, no hobbies or relaxations. He bores his wife, his children and their friends. . . with incessant talk that no one can understand. . . A scientist should not marry.

Belt (1959) studied the attitudes toward science and scientists of college-bound seniors from New Jersey high schools by using a Likert type scale. The results showed that high ability students have a more favorable attitude toward science and scientists than others, and attitudes toward science and scientists were generally positive.

Anderson and Neeley (1967) studied attitudes toward the various sciences of the gifted high school science students from a Florida high school at a Summer Science Camp. At the end of the period, a questionnaire was administered requesting the ranking from 1 to 10 of the ten participating departments on four categories: contribution to human welfare, intellectual complexity, popular interest, and social prestige. The researchers concluded that "the perennially strong preferences for physics and chemistry were indicated, while anthropology and oceanography occupied low ranks.

The high position of psychology, displacing mathematics, was noted" (Anderson and Neeley, 1967, p. 275).

Hedley (1967) found that secondary students in CHEM and PSSC programs scored significantly more interest in science and had a more positive attitude toward the course content and usefulness of the laboratory than students in traditional programs.

Vitrogan (1967) found a significant difference in attitude scores between the two groups of New York secondary school students; the one group was compared to students who showed high interest and achievement in science and possessed a high degree of educational development in science while the other group showed just the opposite. The following correlations were found to be significant: attitudes toward science and educational development in science, attitudes toward science and motivational involvement in science, attitudes toward science and achievement in science courses.

Moore and Sutman (1970) did a field test of their instrument with three intact groups of low-ability tenth grade biology students. The first group which received no special instruction showed a decrease in the mean from pretest to posttest, the second group which received instruction to develop the positive attitude showed a significant gain in mean score, and the third group which received instruction designed to develop positive attitudes and to eliminate negative attitudes expressed in the inventory showed a significantly larger gain than the second group.

Gardner (1976) measured the attitudes of student toward various aspects of a two-year high school physics course based on PSSC materials, and related those attitudes to various pupil personality characteristics and various teacher characteristics as a part of the Physics Evaluation Project conducted in Victoria, Australia, started in 1967 and concluded in 1970. Four affective objectives were views toward physics learning (authoritarian/ nonauthoritarian), beliefs about physics as a process (classic/open), views toward scientists (eccentric/normal), enjoyment of physics (antipathy/commitment). These objectives were measured by four-choice Likert type scale known as the Physics Attitude Index. The major finding of the study was a sharp decline in enjoyment of physics displayed by most pupils. "Clearly, the PSSC course in Victoria is failing to achieve one of its objectives which is to increase, or at least maintain, enjoyment of the subject. Only intellectual, achievement-motivated pupils with intellectual, achievement-pressing teachers maintained a high level of enjoyment."

McMillan and May (1979, p. 22) studied factors influencing attitudes toward science of junior high school students and summarized as follows:

> First, despite the fact that previous research has been mixed with regard to the effect of curriculum, it was clear that pupils in this school preferred classroom formats which stressed active involvement and experiences. The students indicated that this was the factor they liked best about science classes. In support of other studies concerning the effect of the teacher, the pupils mentioned the teacher, in both personality and interrelationships with students, as a crucial variable in attitude formation.

Wickline (1964) claimed that grade level, course content, mental age, total SCAT score, sex, and elective science course were all found not to be significantly related to science attitudes measured by the Allen Attitude Scale.

Inventasch (1968) compared the effects of teacher-directed and self-directed problem solving on attitudes and understandings in science of seventh grade students. During the course, various forms of the test were used to compare the progress of the groups, and made conclusions that no significant difference was found in the two groups' abilities to solve problems, understanding of science, and attitudes toward science and scientists.

Gudaitis (1971) attempted to determine the effect of inquiry experiences on student attitudes, science process skills, and critical thinking abilities in two suburban New York junior high schools. The investigator found that "from pre-test to post-test on attitude toward science the experimental program showed no significant decrease in attitude. Hypothesis 1 was rejected."

Ost and White (1979) studied an alternative approach to characterizing student perceptions of science, and provided a teaching device useful for focusing on attitudes of junior high school students. The investigator said that there is not as great a disparity between the perceptions of young students and professional scientists with respect to what a scientist does as earlier studies suggested. Students seem to be able to differentiate between activities which are scientific as opposed to technological. They also said that use might be made of the instrument for both formative or summative evaluation efforts by teachers who wish to evaluate individual courses, by school personnel in program evaluation, by researchers, and by curriculum developers. If administered to a class of students, the results can be used as a focal point for discussing the relationship of science and technology.

Hasan and Billeh (1975) investigated the relationship between secondary school science teachers' change in attitudes toward science and some professional variables. The sample selected for this study, being largely volunteer, consisted of 129 teachers comprising 70 percent of the population of secondary school teachers in Jordan. The investigators found that the mean score of teachers did not increase significantly as a result of the four-week summer training course in science teaching as measured by a Thurstone type attitude scale developed by themselves.

But "analysis of variance of multiple regression of the teachers' gain scores on the investigated variables: teaching experience, previous professional inservice training, and level of education, indicated the presence of a significant relationship at the 0.005 level. . . . Further analysis indicated that teaching experience was not significantly related to teacher's change in attitudes. However, professional inservice training was found to be positively related to teachers' change in attitudes, while the level of education had a negative relationship."

College Students and Scientists' Attitudes Toward Science

Mitias (1970) showed college students' attitudes toward science were generally positive and high ability students have a more favorable attitude toward science and scientists than others.

Williamson (1972) studied the social attitudes and understandings of science of junior college freshmen before and after one year of introductory science, and found significant changes in social attitudes toward science.

Fellers (1972, p. iv) studied the change in attitude toward science upon completion of a one semester general education physical science course at the junior college level, and concluded that

> The study found the science student had a significant pro-science change in attitudes when compared with the control group. Students over twenty-one change in attitudes than those students under twenty-one. No significant difference in change in attitudes was found between men and women; between students with previous science courses and those taking their first course in science; between students taking the course with laboratory and those not taking the laboratory; or between those who received grades of "A" and "B" versus those who received grades of "D," "F," "incomplete," or "withdrawal." The study found some trend toward the attitudes of the student's instructor, but not significant at 0.05 level.

Spears and Hathaway (1975) used the Schwirian Science Support Scale to study the attitude toward science and its relationship to society of a broad cross section of nonscience students. The investigator summarized some general conclusions as follows (Spears and Hathaway, 1975, p. 345):

> (Students enrolled in an introductory physical science course) Man's Physics World and academic physicist populations differed little in their support of universalism, but differed more significantly in support of rationality, utilitarianism, individualism, and progress and meliorism.

Arntson (1975) studied the effect of a one-semester interdisciplinary science course on attitudes toward science among students in a two-year college. A significantly positive correlation was noted between attitude change and American College Test science scores. No significant correlation was found between attitude change and grades earned for the course. No significant difference in attitude change was formed between the experimental group and a group of forty students in one-science courses matched by sex and pretest attitude scores with the experimental group.

Both groups were less pro-science at the conclusion of the semester. Females in the experimental group were not significantly different from males in attitude toward science, either before or after the course.

Dillon and James (1977) studied attitudes of black college students toward science. The results of the study "tend to support already existing ideas that a view of science in its proper socio-cultural perspective may enhance the pursuit of science. Similarly, the belief that high school science courses have a lasting impact on attitude toward science appears to be valid, especially when the lack of evidence of a similar influence of college science courses is considered.

Vavoulis (1962) compared a laboratory-centered freshmen chemistry course to a usual lecture-laboratory course, and found no difference in achievement and attitude between the two groups.

Allison (1972) investigated the attitudes toward science of college chemistry students as a function of laboratory experience, and concluded that the inquiry approach in a college chemistry laboratory is neither more nor less effective than the structured approach in improving total attitudes toward science, and both approaches do not result in significant changes in attitudes toward science, but the inquiry approach results in significant improvement in intellectual attitudes toward science and in critical thinking skills.

Hinrichs (1964) isolated three basic attitudes patterns by principal component analysis of questionnaire data from roughly one-third of the American Ph. D. graduates in chemistry in 1960-1961. These were: (1) attitudes valuing freedom and "pure science," (2) materialistic attitudes accepting business values, possibly at the expense of science values, and (3) attitudes which see little conflict between industry and science values. New Ph. D.'s with high pure science attitudes tended to enter academic employment; others to enter industry. For an independent sample of 286 industrial chemists, orientation was stronger for chemists with high number of years' experience than for recent hire.

As a brief summary of studies on attitudes toward science, it is noticeable that research at the secondary school level started earlier than any others and were abundant in numbers. Among the surveyed studies there are five cases of research for elementary teachers but only one case for secondary school teachers. Even though there are eight cases of research on college students, there are very few studies of elementary and secondary science education majors.

There have been described eighteen cases of experimental studies of attitude change and twelve cases of status surveys or correlation studies. The former have been done more frequently at elementary and college levels and the latter done more at secondary level.

Studies on Attitudes Toward Science Teaching

Very little research has been done on attitudes toward science teaching in comparison with attitudes toward science. Some researchers included both attitudes toward science and science teaching or mixed the two categories in a study, although the research title is limited to one only. These kinds of research are discussed in this section.

Shrigley (1974) investigated the attitudes toward science and science teaching of 207 third year elementary education majors at Pennsylvania State University. The study was conducted as an initial investigation of four forces believed by the investigator to be pertinent in analyzing the attitude of elementary education majors, and summarized the results as follows (Shrigley, 1974, p. 249):

1. There was no significant sex difference in attitudes toward science and science teaching.
2. Neither sex would have a more positive effect on the science attitude of their students.
3. An organized elementary science program affects the science attitude of preservice teachers positively.
4. The student who enrolls in four or more high school science courses is the one with a more positive attitude toward science.

These results implied that little need for differentiated professional training in science instruction for the different sexes, but the instructor could better individualize his course by assigning tasks to the subgroup requiring a more positive attitude.

Shrigley and Johnson (1974) investigated the status of attitudes toward science and science teaching of in-service elementary teachers. The study dealt with six factors (sex, age, grade, school size, classroom organization, innovative science program) that may be pertinent in analyzing the attitudes of elementary teachers. They found a significant sex difference in attitudes toward science and science teaching, which "supports the truism that science has a masculine bias." This refutes an earlier study (Shrigley, 1974) indicating no sex difference in attitude toward science of pre-service teachers. They said the disagreement in the two studies could mean that "a more negative attitude is developed by teachers from the time they enroll in a science methods course until they become in-service teachers." They discussed as follows (Shrigley and Johnson, 1974, p. 445):

> Although the mean differences were not significant, the mean of teachers forty years or older was higher. Schwirian (1969) found younger teachers having the more positive attitude. . . .
>
> The lack of a significant finding of attitudinal differences among k-3, 4-6, and 7-8 graders refutes the assumption that, if primary teachers do spend less time on science, it is due to their science attitude.
>
> The lack of significant findings of attitudinal difference on the variable of school size refutes the assumption that the supportive services, in the form of supplies and consultants, of larger schools affect science attitude of teacher. Perhaps Blackwood's study (1964) completed a decade ago, should be repeated. . . .

> The lack of significant findings of attitudinal differences on the variable of classroom organization refutes the assumption that teachers in self-contained classroom have a less favorable science attitude than teachers in other forms of organization. . . .
>
> In view of an educational bias to in-service programs that directly involve teachers with the supplies and processes of SAPA, ESS and SCIS, the lack of a significant finding refutes the assumption that such involvement motivates teachers, and therefore, improves the science attitude of the in-service teacher.

Earl and Winkeljohn (1977) argued about the results of Shrigley and Johnson's (1974) study for classroom organization in their research on attitudes of elementary teachers toward science and science teaching. The investigators insisted that "one must consider both attitudes toward science and attitudes toward science teaching." Earl and Winkeljohn (1977, p. 45) concluded that

> There is no difference between the two groups in their attitude toward science. . .
>
> On the scales assessing attitudes toward science teaching, there is a significant difference between groups on the negative scales. . .

The data support the contention that elementary teachers who have become "science specialists" have done so not because of more positive attitudes toward science but because of more positive attitudes toward the teaching of science.

Barufaldi, Huntsberger, and Lazarowitz (1976) did a research study on changes in attitude of elementary education majors toward inquiry teaching strategies. This study indicated that elementary education majors demonstrated a more favorable attitude toward inquiry strategies upon completion of an elementary science methods course.

Jaus (1977) did a research study to determine the effects of microteaching on the attitudes of inservice elementary teachers toward teaching science as a process rather than as a body of knowledge. The study indicated that the teachers who received integrated science process skill instruction plus the microteaching experience possessed significantly more positive attitudes toward teaching the integrated science process skills than the teachers who received the same science process skill instruction plus the curriculum activities.

Hein (1973) did an evaluation of the affective domain component of a project for the undergraduate preparation of chemistry-physics teachers (PUPCPT) as measured by the Affective Domain Measuring Scale-Science (ADMS-S) developed by Downs (1972) and the Affective Domain Measuring Scale-Teaching (ADMS-T) developed by the researcher. His study revealed that students' affective behavior toward science and teaching were not significantly changed among the four grades. Therefore, the PUPCPT did not succeed in changing the students' affective behavior toward science and teaching, but students' affective behavior toward science and teaching correlated at the 0.05 level of significance for the total sample and all the grade levels except the fourth. It appears there is a direct relationship between the affective behavior toward science and the affective behavior toward teaching.

While five cases of study on attitudes toward science teaching of elementary teachers have been surveyed, this researcher has been able to find only one study on attitude toward science teaching of secondary school science teachers.

CHAPTER III

METHOD OF STUDY

Introduction

For the description of the research procedure, this chapter will first discuss how to select the study sample, secondly describe a procedure for development of two scales, including some strategies for obtaining validity and reliability, and thirdly, explain the methods of data gathering and statistical treatment.

The Population and Study Sample

In every academic year the Ministry of Education in Korea permits a limited number of students among the applicants who passed entrance examinations to study under the programs of science education in the sixteen colleges. It allocates the permitted numbers of students as follows (Ministry of Education in Korea, 1978).

TABLE 1. --Classification of colleges and universities in Korea which have a Department of Science Education

	Old (520)	New (540)
National: (700)	Seoul, (120) *Kongju, (90) *Kyongbuk, (80)	*Pusan, (90) *Chungbuk, (60) *Jeju, (40)
	Kyongsang (90)	Junbuk, (80) Junam (50)
Private: (360)	Ehwa W., (90) *Josun (50)	Sungsin W., (60) *Sejong, (40) *Sangji, (40)
		Chungju W., (40) Heosung W. (40)

( ) Number of freshmen permitted in 1978 academic year by the Ministry of Education in Korea.

*Sample college or university for this study.

For the stratified sampling, the sixteen colleges and universities which have a science education department are divided into two by two classification: national and private, old and new.

The sample of this study is selected from each category consisting of at least one institute. Seoul National University is selected especially because the university has performed a central function in science teacher education, and influenced the curriculum and faculties of other institutes as the oldest one in Korea.

TABLE 2. --Population and sample

College group	Population	Sample (%)	Others
a. Special *Seoul	480	180 (37.5)	178
b. Old-national *Kongju, *Kyongbuk, Kyongsang	1040	396 (38.1)	86
c. New-national *Pusan, *Chungbuk, Junbuk, Junam, Jeju	1280	459 (35.9)	26
d. Old-private *Ehwa W., Josun	560	209 (37.3)	89
e. New-private *Sungsin W., *Sejong, Heosung, W., Chungju W., Sangji	880	332 (37.7)	37
Total	4240	1576 (37.2)	416

*Sample college or university for this study.

The estimated population was 4,240 students, which was a number obtained by multiplying four by the number of freshmen permitted in the 1978 academic year. The sample was 1,576 students which was 37.2 percent of the population as shown in Table 2. Others in Table 2 included students of the Natural Science College of Seoul National University, the liberal arts college of Chungbuk and Ehwa Women University, and the graduate school of Seoul and Kyongbuk National University.

Development of the Instrument

Previous researchers developed scales or inventories for attitudes toward science of elementary, secondary and college students including elementary education majors and teachers. Few of these studied the attitudes of science education majors. Some researchers developed scales for attitudes toward science teaching for elementary education majors and teachers, but very few for science education majors. Those already developed are written in English and mainly in the educational background of the United States of America.

It became necessary to develop a pair of measuring instruments of attitudes toward science and science teaching of science education majors for the specific purpose of this study.

In order to be usable in this study, scales had to:

1. ascertain the students' attitudes toward science and science teaching,
2. be aimed toward students at the four-year college level, where students are not expected to have studied either courses of philosophy or history of science.
3. be sensitive enough to detect difference of attitudes toward science and attitudes toward science teaching of science education majors,

4. require less than fifty minutes to administer both scales,
5. have a rather simple format which can be responded to easily,
6. be quantitative in scoring, and
7. be valid and reliable.

According to the above criteria, the style of scale was selected of nondisguised-structured direct type rather than an indirect one for this study. Two Likert-type scales were developed. Edwards and Kenney (1946) compared Likert and Thurstone techniques of building attitude scales. They reported that Likert scales yield higher reliability coefficients with fewer items, than scales constructed by the Thurstone method. They indicated that Likert scales are less time consuming to prepare and to administer.

The model of scale construction for this study adapted mainly the method of Moore and Sutman (1970) which has been used by other researchers such as Bratt and DeVito (1978).

The attitudes to be assessed were derived from literature published about philosophy and the history of science, and contemporary science education. After the categories of each scale were decided, both positive and negative position statements were written for each category. More than six attitude statements (Appendix A), which became actual questionnaire items, were designed for each position statement to be used as a Likert-type scale, according to Shrigley's recommendation (1974) of writing of attitude statements.

The second step involved soliciting panel members' advice concerning content validity of the prepared materials.

The third step consisted of pre-testing the materials with Korean students in Colorado and some students in Korea to establish better validity and reliability.

After analysis of the pre-test and consideration of the panel's comments, final scales were formed and administered to a sample of science education majors in Korea.

Description of the Instruments

Developed scales are described as follows.

Kinds of Scales

1. The Attitudes Toward Science Scale (abbr. the AS scale)
2. The Attitudes Toward Science Teaching Scale (abbr. the AT scale)

Components of Each Scale

The AS and AT scales are subscaled into five categories each. Some categories are more intellectually related (categories 1, 2 and 3) and others are more emotionally related (categories 4 and 5).

Each category contains two position statements. One is a positive attitude, and the other is a negative attitude. There are ten position statements. Each position statement of either a positive or a negative attitude is related to four attitude statements which are the questionnaire items. There are forty attitude statements for each scale. Item numbers which belong to each subscale are set forth in Table 3.

TABLE 3.--Item numbers belonging to each subscale

Scale	Subscale	Direction	Subscale Item Numbers			
AS	1	P	1	10	14	29
		N	3	8	20	31
	2	P	18	19	26	40
		N	5	24	32	34
	3	P	7	9	22	37
		N	2	15	27	36
	4	P	4	23	30	35
		N	12	16	21	39
	5	P	11	13	28	38
		N	6	17	25	33
AT	1	P	9	12	18	37
		N	4	19	21	39
	2	P	6	15	20	29
		N	5	8	11	34
	3	P	1	25	27	31
		N	16	23	26	32
	4	P	7	35	36	40
		N	2	22	28	38
	5	P	3	13	17	24
		N	10	14	30	33

Style and Quantification of Scales

A four-choice Likert-type scale was scored in the following manner for quantification of the responses. In the case of a five-choice Likert-type, at the preliminary stage, the neutral part was scored as numeral three.

	SA	A	(N)	D	SD
Positive attitude statement item:	5	4	(3)	2	1
Negative attitude statement item:	1	2	(3)	4	5

A four- or six-choice response, excluding the "neutral," is a recent trend and has been selected in this study. It is difficult to understand and interpret a "neutral" attitude in value judgement. In their study, Bratt and DeVito (1978, p. 552) said,

> A Likert-type, forced choice scale was used to assess agreement with each statement.

Also, according to Krajkovick and Smith (1979, p. 4)

> It was felt, however, a dichotomous format did force a judgement and therefore, a true attitude would be expressed. In order to address this concern, the neutral choice found in most Likert scales was omitted.

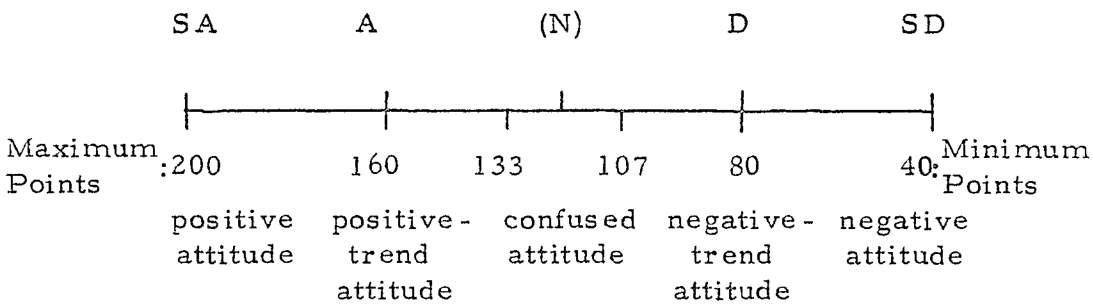
The pre-test tried a five-choice Likert-type response and the results were analyzed to decide upon a final form.

Total Score Points

AS scale: minimum 40 points, maximum 200 points

AT scale: minimum 40 points, maximum 200 points

Classification of Attitudes Toward
Science and Science Teaching



Question Items for Background Information

The question items were sex distinction, grade level, specialty, college, religion, army service, location of birth place and high school attended, career goal, and self-estimation of academic achievement. The format of the questions consisted of less than five-choice multiple type, except for the item relating to attending college.

Attitudes to be Assessed

Position Statements of the Attitudes Toward Science

Category 1.--the goals and values of science. *P: Science, as a continuing inquiry of humans, has as its important goals discovering laws and constructing theories by observation and experiment. Science is a valuable human activity and should be allowed to develop.

---

*P: Positive attitude position statement.

**N: The goal of science is to realize materialism. Important activities of scientists are for the purpose of facilitating convenient material life. Scientists work hard to earn a better salary. Science has no value for humans. Science will make our life poorer so that we should not continue to support scientific research.

Category 2.--scientific knowledge and the view of nature.

P: The accumulated knowledge of science has increased rapidly, but it has limitations and conditions that are subject to change. A new scientific theory is more acceptable if it can be shown to explain natural phenomena better than preceding theories and coincide with experimental results. Science is only one view of nature. There are many views of nature, even among the various fields of science. However, we believe that we can gradually understand nature better through scientific progress.

N: Scientific knowledge representing unchangeable truths has been discovered entirely by modern scientists. Scientific knowledge is trivial and worthless. Human beings cannot understand the holy secrets of nature.

**N: Negative attitude position statement.

Category 3.--processes and methods of science. P: Careful observation, controlled experiments, creative invention and open-mindedness are important bases of "sciencing" and scientific explanations. Scientific methods have limitations in that they can only answer questions about natural phenomena under certain controlled conditions, and sometimes they are not able to do that.

N: Every scientist is required to remember all the scientific truths and follow mechanically formal steps of a fixed scientific method. A scientific method can deal with all problems and provide correct answers to all questions.

Category 4.--social and cultural aspects of science. P: Science influences every culture and all aspects of modern society: ways of thinking, philosophy, national policy, moral problems, and modernization of countries. There are both positive and negative influences resulting from the applications of scientific knowledge and methods. In return, society strongly influences the development of science. There are good and bad aspects of the cultural and social influences on science.

N: There is no relation between science and society. There are only negative aspects to the mutual influences of science and society.

Category 5.--scientists and a career in science. P: Being a scientist or working in a job requiring scientific knowledge and methods should be a very interesting, challenging, and rewarding way of life.

N: Being a scientist or working in a job requiring scientific knowledge and methods would be dull and uninteresting. Such work is only for highly intelligent people who are willing to spend most of their time in a laboratory. Artistic men, religious people, and females should not and cannot become good scientists.

Position Statements of the Attitudes Toward Science Teaching

Category 1.--the goals and values of science teaching. P: Science teaching at the elementary and secondary school level is aimed toward providing scientific literacy among people; this includes understanding of basic concepts and the nature of science, scientific process skills, good attitudes concerning science, and orientation toward professions in science. Learning science by all children is valuable to their development of cognitive, affective, and psychomotor domains.

N: The immediate objective of science education at any level is for students to pass the entrance examination of a higher level school, and the long-range goal of science education is mainly to produce the required professional manpower for science and technology. Teaching science to all elementary and secondary school students is useless, except for those who will become either scientists or engineers.

Category 2.--the content of science teaching. P: The content of science curricula should be selected and structured to help students learn basic concepts and to stimulate their intellectual interests.

N: The content and sequence of science curricula should be limited to selected textbooks, and should contain only as many new facts of modern science and/or as many various techniques of repairing machines as possible.

Category 3.--the learning process and teaching methods in science. P: Students should be involved in active inquiry as much as possible. Teachers should take the role of resource person for guiding or facilitating learning by asking many inquiry questions based on students' intellectual levels.

N: Students should remember as many facts and formulas of modern science as possible. Science teachers should direct strictly what students do and inform them correctly as to what results will come from the experiments. Use of audio-visual materials or allowing students' discussion are a waste of time in teaching science.

Category 4.--social aspects of science teaching. P: General education of science in the elementary and secondary schools contributes to the modernization of a country and the progress of science. The importance of good science teaching and professional research in science education should be recognized and supported.

N: Teaching science does not contribute to the modernization of a country. Only high level professional education and research work in science should be supported for the development of science and industrialization of our society. There is no professional status in science education, and no need to establish special courses, departments, degrees or institutions.

Category 5.--science educators and a career in science education. P: Science educators should have as much pride and prestige in their work as practicing scientists. Jobs related to science education are valuable and attractive.

N: Science educators are neither scientists nor educators. They are the people who wanted to become scientists but could not. Jobs related to science education are neither worthwhile nor interesting, because they are easy work.

Validity and Reliability of the Scales

For validity and reliability, a few strategies have been pursued: panel member's contribution for content validity, preliminary trials, comparison with Moore's scale for concurrent validity, comparison with three different groups for construct validity as suggested by Kerlinger (1964), computer run calculation of the correlation coefficient of each item with total scores, and coefficient alpha for internal consistence according to the Cronbach's theory (1951).

Content Validity by Panel Members

For content validity, a panel of thirty resource persons was selected from Korean and American faculties and researchers in philosophy, history and education of science, and a small number of master science teachers from elementary and secondary schools in Korea. They responded to the questionnaire concerning development of scales, and discussed the research in general. The panel members' responses were accumulated in frequency distribution form so as to learn the most favored items of the attitude statements.

Their names are listed below with degree, profession and institution. The first sixteen members are Korean and the next fourteen members are American.

Chun, Sang-guen (Ph.D.) History of Science Professor of Sungsin Women Teachers College. Chung, Wan-ho (M.S.) Biology Education Researcher of the Ministry of Education. Han, Bok-soo (M.S.) Science Teacher of Junior High Laboratory School of Seoul National University, Han, Jong-ha (Ph.D.) Science Education Researcher of the Korean Educational Development Institute. Hong, Sang-hi (Ph.D.) Professor of Nuclear Energy of Seoul National University. Jo, Wang-soo (M.S.) Wild Animal Researcher of the Agriculture and Forestry Research Institute. Kim, Dong-pil (M.S.) Physics Teacher of Kwanak High School. Kim, Heun-jae (M.S.) Science Education Professor of Inchun Teachers College. Kim, Yong-soo (B.S.) Teacher of Elementary Laboratory School of Seoul National University, Kwon, Jae-sool (M.S.) Science Education Researcher of the Korean Educational Development Institute. Lee, Don-hee (Ph.D.) Philosophy of Education Professor of Seoul National University. Lee, Gye-choo (M.S.) Science Education Professor of Kwangju Teachers College. Moon, Chan-ho (M.S.) Physical Science Education Researcher of the Ministry of Education. Pack, Soon-dal (B.S.) Teacher of Elementary Laboratory School of Chungang University. So, Heung-yel (Ph.D.) Philosophy of Science Professor of Ehwa Women University. Woo, Chong-chun (Ph.D.) Professor of Physics of Seoul National University.

Allison, R. D. (Ed.D.) Chemistry Professor of Bakersfield College. Arntson, W. W. (Ed.D.) Chemistry Professor of University of Wisconsin Center-Barron County. Bratt, M. (Ph.D.) Science Education Professor of Ohio State University. Crockett, G. L. (Ed.D.) Science Education Professor of University of Northern Colorado. Dech, J. (Ed.D.) Director of Science/Math Council of University of Northern Colorado. Downs, G. E. (Ed.D.) Physics and Math teacher of Rich Township High School. Dunn, S. K. (Ed.D.) Science Education Professor of Washington State University. Fellers, W. O. (Ed.D.) Engineering Professor of American River College. Olson, K. (Ph.D.) Science Education Professor of University of Northern Colorado. Simmons, J. B. (Ed.D.) Science Education Professor of Illinois State University. Stollberg, R. (Ph.D.) Physics Professor of San Francisco State University. Sund, R. B. (Ed.D.) Science Education Professor of University of Northern Colorado. Trowbridge, L. W. (Ph.D.) Science Education Professor of University of Northern Colorado. Unruh, R. (Ed.D.) Science Education Professor of University of Northern Iowa.

Preliminary Trials

The first trial form of the scales was administered to twelve Korean students in Colorado and 350 students of Kongju and Kwangju Teachers College in Korea in December 1978. The purpose was to discover and eliminate any procedural problems, to eliminate the least discriminating questions from the scales, and to gather data which would help establish better validity and reliability of the scales.

The first computer analysis gave the results as the Run 1 in the following Table 4. The second run was done after having omitted the items whose correlation coefficient (r) is less than 0.20 so that coefficient alpha was achieved 0.70 in AS scale and 0.86 in AT scale.

It was found that the response percentage of "neutral" was an average of 18 percent on the AS scale and 14 percent on the AT scale, and the maximum case was 49 percent on the AS scale.

This researcher's decision was to omit the "neutral" response category and made a special effort to rewrite the ambiguous items.

TABLE 4.--Item parameters of the preliminary trials

Run	Scale	Cases	No. Items	Mean	Sigma	Alpha	Range of r
1	AS	362	40	100.8	9.7	0.62	-0.03~+0.51
	AT	362	40	90.5	13.2	0.83	-0.35~+0.59
2	AS	362	30	72.8	9.4	0.70	0.20~+0.55
	AT	362	35	75.5	13.3	0.86	0.20~+0.60

Concurrent Validity by Comparison with Moore's Scale

For concurrent validity, Moore's scale (1973) was translated into Korean with permission of the author (Appendix B) and administered to a limited number of Korean students of the Junior Teachers College to compare with the AS and AT scale.

It was difficult to obtain one or a pair of scales for measurement of both attitudes toward science and science teaching except Moore's and Bratt's. However, their scales are for elementary education majors or teachers so that Junior Teacher College students were selected to take both scales.

A correlation coefficient between the scores of the Moore's scale and the scales developed by this researcher (called Pak's) was calculated for concurrent validity by computing the Pearson product-moment correlation coefficient (r). As shown in Table 5, the correlation coefficient is 0.60.

TABLE 5.--Comparison of results measured by two different scales

Scale	Cases	No. Items	Mean (%)	Sigma	r
Moore's	80	70	236.5 (67.6)	14.6	0.60*
Pak's	80	80	319.1 (79.8)	15.3	

*Significant at the 0.05 level.

Construct Validity by Comparisons of Different Groups

Kerlinger (1964, p. 451) said:

> One can manipulate communications, for example, in order to change attitude. If attitude scores change according

> to theoretical prediction, this would be evidence of the construct validity of the attitude measure, since the scores would probably not change according to the prediction if the measure were not measuring the construct.

Using the above theory, multiple comparisons of the mean scores measured by the AS scale were carried out, with students majoring in science education, physics, and humanity; comparisons of the mean scores measured by the AT scale were carried out, with students majoring in science education at the undergraduate level, graduate level, and medicine.

TABLE 6.--Three groups' mean scores measured by the AS scale

Group	Cases	Mean	Sigma
Science Education	1576	159.5	10.9
Physics	90	166.1	10.9
Humanity	34	154.6	13.3

TABLE 7.--Three groups' mean scores measured by the AT scale

Group	Cases	Mean	Sigma
Science Education	1576	163.0	12.4
Graduates Sci. Edu.	21	172.2	13.3
Medicine	41	159.4	14.1

The research data analysis shows that the mean score of attitudes toward science of science education majors is significantly less positive than physics students, but more positive than humanity majors at the 0.05 level; the mean score of attitudes toward science teaching of science education majors at the undergraduate level is significantly less positive than graduate science education majors but more positive than those of medical students at the 0.05 level. These results exhibit the construct validity of the developed scales.

Reliability

For the investigation of reliability of the scales, a few strategies were used.

As in the preliminary trial case, computation was made of the correlation coefficient between the scores of each item and the subscale score (${}_ir_{sub}$) and between the score of each item and the total score (${}_ir_{tot}$). The results show that the range of ${}_ir_{sub}$ is 0.29 ~ 0.59 and ${}_ir_{tot}$ is 0.11 ~ 0.52 in the attitudes toward science, 0.38 ~ 0.61 and 0.08 ~ 0.56 in the attitudes toward science teaching (Appendix D). There is no negative correlation coefficient as in the preliminary case.

The computer was also run to calculate scale parameters as shown in Table 8.

The coefficient alpha of the AS and AT scale is 0.73 and 0.82, respectively.

TABLE 8.--Parameters of the AS and AT scale

Scale	Scores/Subscale	1	2	3	4	5	Total
AS	No. of Item	8	8	8	8	8	40
	Mean	33.08	30.84	30.98	32.10	32.48	159.49
	Sigma	3.35	3.08	3.02	3.18	3.64	10.90
	Alpha	0.53	0.15	0.28	0.37	0.55	0.73
AT	No. of Item	8	8	8	8	8	40
	Mean	33.47	31.56	31.89	32.48	33.60	163.00
	Sigma	3.21	3.00	3.15	3.59	3.29	12.29
	Alpha	0.54	0.31	0.41	0.55	0.62	0.82

The correlation coefficient between the total scores and the scores of positive attitude-related items is 0.78 in AS and 0.81 in AT scale. The correlation coefficient between the total scores and the scores of the negative attitude-related items is 0.83 in AS and 0.84 in AT scale.

These results show good internal consistency and reliability of the scales.

Data Gathering and Statistical Treatment

Final Korean versions of the AS and AT scale were printed in Korea (Appendix C) and administered by the faculties of the science education department of each sample institute and the response sheets were mailed to this researcher.

All of the response sheets were checked by this investigator, as to whether they were properly marked to be analyzed by computer, and a total of 1,576 sample responses by science education majors were finally fixed for computer analysis. Others were scored and calculated directly by this researcher for more detailed observation and treatment.

The responses of 1,576 samples from eight institutes were scored to tabulate the absolute and relative frequencies for each variable, and to discover the distribution of scores. Basic data, such as number of subjects, means, standard deviations, and standard errors of the AS, AT, AS+AT, AS-AT scores were calculated. Analysis of variance of each group by each variable and multiple comparisons by the Scheffe's method with the 0.05 level were done by computer. Correlation coefficients between the AS and AT scores, and other AS and AT scores which were added and subtracted, such as ${}_{s}r_{t}$, ${}_{s}r_{s+t}$, ${}_{s}r_{s-t}$, ${}_{t}r_{s+t}$, and ${}_{t}r_{s-t}$ were calculated.

CHAPTER IV

ANALYSIS OF DATA

Introduction

In this chapter, data pertinent to the five hypotheses dealing with the scores measured by the AS and AT scale are tabulated. The analysis of variance was done using F ratio to be tested for significance at the five percent (0.05) level, including multiple comparisons by the Sheffe's method. Following the summary of the findings, the results are interpreted.

Research Data for Attitudes Toward Science

The mean score of the 1,576 sample students' attitudes toward science, measured by the AS scale, is 159.5; the standard deviation is 10.9; and the standard error is 0.3 points.

The classified scores distribution of the attitude toward science is shown in Table 9.

TABLE 9.--Classified scores distribution of the Attitudes Toward Science

Attitude	Score Range	Absolute Frequency	Relative Frequency (%)
Negative	40 - 80	0	0
Negative-trend	81 - 106	1	0.1
Confused	107 - 133	32	2.0
Positive-trend	134 - 159	734	46.6
Positive	160 - 200	809	51.3
Total		1576	100.0

Hypothesis 1. There are no significant differences among the mean scores of science education majors on attitudes toward science as measured by the AS scale when analyzed with respect to (a) sex, (b) grade level, (c) specialty, (d) college, (e) birth place, (f) high school attended, (h) religion, (h) army service, (i) career goal and (j) self-estimation of academic achievement.

(a) The F ratio with respect to sex distinction is not significant at the 0.05 level as shown in Table 10. Hypothesis 1.a is accepted.

TABLE 10.--Statistical data for the AS score (sex)

Group	Cases	Mean	Sigma	Results of Anova	
Male	656	160.0	11.6	F ratio	2.68
Female	918	159.1	10.5	P value	0.102
Total	1574	159.5	11.0		

(b) The F ratio with respect to grade level is not significant at the 0.05 level as shown in Table 11. Hypothesis 1.b is accepted.

TABLE 11.--Statistical data for the AS score (grade level)

Group	Cases	Mean	Sigma	Results of Anova	
Freshman	517	158.9	11.3	F ratio	1.60
Sophomore	365	160.1	10.4	P value	0.186
Junior	358	159.0	11.3		
Senior	325	160.3	10.7		
Total	1565	159.5	11.0		

(c) The F ratio with respect to specialty is significant at the 0.05 level as shown in Table 12. Hypothesis 1.c is rejected. Multiple comparisons show that the physics teaching majors' mean score is significantly greater than biology teaching majors at the 0.05 level.

TABLE 12.--Statistical data for the AS scores (specialty)

Group	Cases	Mean	Sigma	Results of Anova	
Physics	319	161.5	10.3	F ratio	4.60
Chemistry	541	159.5	11.2	P value	0.004
Biology	297	158.2	11.6		
Earth Science	187	159.8	10.5		
Total	1344	159.5	11.0		

(d) The F ratio with respect to college group is significant at the 0.05 level as shown in Table 13. Hypothesis 1.d is rejected. Multiple comparisons show that the mean score of special college students is significantly greater than that of the students of the new national and private colleges at the 0.05 level, and the measure of attitudes toward science of the students of the old national colleges is significantly greater than that of the students of the new private colleges at the 0.06 level.

TABLE 13.--Statistical data for the As scores (college)

Group	Cases	Mean	Sigma	Results of Anova	
Special	180	162.6	10.9	F ratio	6.87
Old national	395	160.3	10.8	P value	0.000
New national	459	158.5	10.9		
Old private	209	160.1	10.5		
New private	330	157.9	11.2		
Total	1573	159.5	11.0		

(e) The F ratio with respect to birth place is not significant at the 0.05 level as shown in Table 14. Hypothesis 1.e is accepted.

TABLE 14.--Statistical data for the AS score (birth place)

Group	Cases	Mean	Sigma	Results of Anova	
Large city	773	159.5	10.9	F ratio	0.20
Small city	297	159.4	11.4	P value	0.937
Factory village	8	156.8	4.7		
Fishing village	21	161.2	6.7		
Farm village	470	159.5	11.0		
Total	1569	159.5	11.0		

(f) The F ratio with respect to location of the high school attended is significant at the 0.05 level as shown in Table 15. Hypothesis 1.f is rejected.

TABLE 15.--Statistical data for the AS score (high school attended)

Group	Cases	Mean	Sigma	Results of Anova	
Large city	1199	159.4	10.8	F ratio	2.90
Small city	321	159.9	11.0	P value	0.021
Factory village	11	154.9	13.7		
Fishing village	5	147.8	21.8		
Farm village	32	163.1	9.0		
Total	1568	159.5	11.0		

Multiple comparisons show that no pair of mean scores of the groups is significantly different at the 0.05 level. The mean score of farm village high school graduates is significantly greater than the mean score of graduates from fishing villages at the 0.07 level.

(g) The F ratio with respect to religion is not significant at the 0.05 level as shown in Table 16. Hypothesis 1.g is accepted.

TABLE 16. --Statistical data for the As scores (religion)

Group	Cases	Mean	Sigma	Results of Anova	
Buddhism	213	159.3	10.3	F ratio	1.07
Confucianism	16	156.4	12.4	P value	0.371
Christianity	453	160.3	11.6		
Other religion	73	159.3	11.3		
No religion	812	159.3	10.7		
Total	1567	159.5	11.0		

(h) The F ratio with respect to army service is significant at the 0.05 level as shown in Table 17. Hypothesis 1.h is rejected. However, multiple comparisons show that no pair of the mean scores of the groups is significantly different from the other at the 0.05 level.

TABLE 17. --Statistical data for the AS scores (army service)

Group	Cases	Mean	Sigma	Results of Anova	
Before college	12	153.8	19.3	F ratio	2.66
First two-year	83	157.3	12.6	P value	0.031
Last two-year	61	158.1	12.9		
After college	240	160.8	12.8		
Not relevant	1111	159.7	10.0		
Total	1507	159.5	11.0		

(i) The F ratio with respect to career goal is significant at the 0.05 level as shown in Table 18. Hypothesis 1.i is rejected. Multiple comparisons show that the mean score of the students who intended to become a scientist or an educator is significantly greater than other groups. However, neither of the groups are significantly different from each other at the 0.05 level.

TABLE 18.--Statistical data for the AS scores (career goal)

Group	Cases	Mean	Sigma	Results of Anova	
Educator	520	158.2	10.4	F ratio	12.95
Scientist	294	162.3	10.4	P value	0.000
Either sci. or edu.	396	161.2	10.9		
Neither	173	158.6	11.6		
No special	157	156.3	11.4		
Total	1540	159.5	11.0		

(j) The F ratio with respect to self-estimation of academic achievement is significant at the 0.05 level as shown in Table 19. Hypothesis 1.j is rejected. However, multiple comparisons show that no pair of mean scores of the groups is significantly different from the other at the 0.05 level.

TABLE 19.--Statistical data for the AS scores (self-estimation of academic achievement)

Group	Cases	Mean	Sigma	Results of Anova	
Self-est. A	158	157.9	11.8	F ratio	2.86
Self-est. B	833	160.1	10.7	P value	0.022
Self-est. C	420	159.2	10.4		
Self-est. D	54	156.8	14.1		
Self-est. E	33	156.6	13.9		
Total	1498	159.5	11.0		

Findings for Attitudes Toward Science

The mean score of the 1,576 students measured by the AS scale is 159.5 when minimum and maximum scores are 40 and 200. The standard deviation is 10.9 points. Even though the range of scores is from 84 to 192 points, the majority of the students have either positive (51%) or positive-trend (47%) attitudes toward science.

Detailed investigations show the following:

1. There are no significant differences in attitudes toward science of the science education majors when analyzed with respect to sex, grade level, birth place and religion at the 0.05 level.

2. There are significant differences in attitudes toward science of the science education majors when analyzed with respect to location

of high school attended, army service and self-estimation of academic achievement. However, multiple comparisons show that no pairs of the groups are significantly different from each other at 0.05 level.

3. There are significant differences in attitudes toward science of the science education majors when analyzed with respect to specialty, college and career goal. Multiple comparisons which show the significant differences at the 0.05 level can be summarized as follows:

a. The mean score of physics teaching majors is greater than that of biology teaching majors.

b. The mean score of the students of special college is greater than that of the students of new national and private colleges.

c. The mean score of the students who intended to become either a scientist or an educator is greater than the mean score of the other groups.

Research Data for Attitudes Toward Science Teaching

The mean score of the 1,576 sample students' attitude toward science teaching, measured by the AT scale, is 163.0. The standard deviation is 12.4, and the standard error is 0.3 points.

The classified scores distribution of the attitudes toward science teaching is shown in Table 20.

TABLE 20. --Classified scores distribution of the AT scores

Attitude	Score Range	Absolute Frequency	Relative Frequency (%)
Negative	40 - 80	0	0
Negative-trend	81 - 106	2	0.1
Confused	107 - 133	41	2.6
Positive-trend	134 - 159	521	33.2
Positive	160 - 200	1010	64.1
Total	40 - 200	1576	100.0

Hypothesis 2. There are no significant differences among the mean scores of science education majors on attitudes toward science teaching as measured by the AT scale when analyzed with respect to (a) sex, (b) grade level, (c) specialty, (d) college, (e) birth place, (f) high school attended, (g) religion, (h) army service, (i) career goal, (j) self-estimation of academic achievement.

(a) The F ratio with respect to sex distinction is not significant at the 0.05 level as shown in Table 21. Hypothesis 2.a is accepted.

TABLE 21.--Statistical data for the AT scores (sex)

Group	Cases	Mean	Sigma	Results of Anova	
Male	656	163.7	12.9	F ratio	3.73
Female	918	162.5	11.9	P value	0.054
Total	1574	163.0	12.3		

(b) The F ratio with respect to grades is not significant at the 0.05 level as shown in Table 21. Hypothesis 2.b is accepted.

TABLE 22.--Statistical data for the AT scores (grade level)

Group	Cases	Mean	Sigma	Results of Anova	
Freshman	517	162.8	12.0	F ratio	1.12
Sophomore	365	163.1	11.2	P value	0.338
Junior	358	162.3	12.8		
Senior	325	164.0	13.4		
Total	1565	163.0	12.3		

(c) The F ratio with respect to specialty is significant at the 0.05 level as shown in Table 23. Hypothesis 2.c is rejected. Multiple comparisons show that the mean score of physics teaching majors is significantly greater than that of chemistry and biology teaching majors at the 0.05 level.

TABLE 23. --Statistical data for the AT scores (specialty)

Group	Cases	Mean	Sigma	Results of Anova	
Physics	319	165.1	12.4	F ratio	3.77
Chemistry	541	162.6	12.6	P value	0.011
Biology	297	162.1	10.8		
Earth Science	187	162.4	14.5		
Total	1344	163.0	12.5		

(d) The F ratio with respect to college group is significant at the 0.05 level as shown in Table 24. Hypothesis 2.d is rejected. Multiple comparisons show that the mean score of the science education majors of old national colleges is significantly greater than that of students of new private colleges at the 0.05 level.

TABLE 24. --Statistical data for the AT scores (college)

Group	Cases	Mean	Sigma	Results of Anova	
Special	180	163.2	13.0	F ratio	3.04
Old national	395	164.4	12.2	P value	0.016
New national	459	163.4	12.1		
Old private	209	162.2	12.4		
New private	330	161.4	12.3		
Total	1573	163.0	12.4		

(e) The F ratio with respect to birth place is not significant at the 0.05 level as shown in Table 25. Hypothesis 2.e is accepted.

TABLE 25.--Statistical data for the AT scores (birth place)

Group	Cases	Mean	Sigma	Results of Anova	
Large city	773	162.4	12.9	F ratio	1.95
Small city	297	162.0	12.1	P value	0.100
Factory village	8	158.8	13.7		
Fishing village	21	161.8	14.9		
Farm village	470	163.5	11.2		
Total	1569	163.0	12.3		

(f) The F ratio with respect to the location of the attended high school is not significant at the 0.05 level as shown in Table 26. Hypothesis 2.f is accepted.

TABLE 26.--Statistical data for the AT score (high school)

Group	Cases	Mean	Sigma	Results of Anova	
Large city	1199	162.7	12.4	F ratio	2.02
Small city	321	164.3	11.9	P value	0.088
Factory village	11	158.7	13.5		
Fishing village	5	155.8	23.1		
Farm village	32	165.0	9.6		
Total	1568	163.0	12.3		

(g) The F ratio with respect to religion is not significant at the 0.05 level as shown in Table 27. Hypothesis 2.g is accepted.

TABLE 27.--Statistical data for the AT scores (religion)

Group	Cases	Mean	Sigma	Results of Anova	
Buddhism	213	163.1	13.7	F ratio	1.00
Confucianism	16	163.0	12.3	P value	0.406
Christianity	453	163.9	12.3		
Other religion	73	163.6	11.5		
No religion	812	162.5	12.0		
Total	1567	163.0	12.3		

(h) The F ratio with respect to army service is not significant at the 0.05 level as shown in Table 28. Hypothesis 2.h is accepted.

TABLE 28.--Statistical data for the AT scores (army service)

Group	Cases	Mean	Sigma	Results of Anova	
Before college	12	158.3	19.0	F ratio	0.61
First two-year	83	162.2	13.8	P value	0.662
Last two-year	61	163.2	12.4		
After college	240	163.5	14.9		
Not relevant	1111	163.1	11.5		
Total	1507	163.0	12.4		

(i) The F ratio with respect to career goal is significant at the 0.05 level as shown in Table 29. Hypothesis 2.i is rejected. Multiple comparisons show that the mean score of the students who intended to become an educator or a scientist, or either one, is significantly greater than the mean score of those who had no such special intention at the 0.05 level.

TABLE 29.--Statistical data for the AT scores (career goal)

Group	Cases	Mean	Sigma	Results of Anova	
Educator	520	162.7	11.6	F ratio	7.03
Scientist	294	163.5	12.1	P value	0.000
Either sci. or edu.	396	165.0	11.8		
Neither sci. nor edu.	173	162.4	14.2		
No special intention	157	159.0	13.3		
Total	1540	163.0	12.3		

(j) The F ratio with respect to self-estimation of academic achievement is significant at the 0.05 level as shown in Table 30. Hypothesis 2.j is rejected. Multiple comparisons show that the mean score of the students who self-estimated their academic achievement at a grade of B is significantly greater than the mean score of those who estimated themselves at a grade of A at the 0.05 level.

TABLE 30.--Statistical data for the AT scores (self-estimation of academic achievement)

Group	Cases	Mean	Sigma	Results of Anova	
Estimat. A	158	160.2	13.0	F ratio	4.41
Estimat. B	833	163.8	11.8	P value	0.002
Estimat. C	420	162.9	11.8		
Estimat. D	54	159.8	16.4		
Estimat. E	33	159.4	16.6		
Total	1498	163.0	12.3		

Findings for Attitudes Toward Science Teaching

The mean score of the 1,576 students measured by the AT scale is 163.0 when minimum and maximum are 40 and 200 points each. The standard deviation is 12.4 points. Even though the range of scores is from 73 to 197 points, the majority of the students have either positive (64%) or positive-trend (33%) attitudes toward science teaching.

Detailed investigations show the following:

1. There are no significant differences in the attitudes toward science teaching of the science education majors when analyzed with respect to sex, grade level, birth place, high school attended, religion and army service.

2. There are significant differences in attitudes toward science teaching of science education majors when analyzed with respect to

specialty, college, career goal, and self-estimation of academic achievement. Multiple comparisons which show the significant differences at the 0.05 level can be summarized as follows:

a. The mean score of physics teaching majors is greater than that of chemistry and biology teaching majors.

b. The mean score of the students of old national colleges is greater than that of the students of new private colleges.

c. The mean score of the students who intended to become either an educator or a scientist is greater than that of the students who had no special intention.

d. The mean score of the students who self-estimated themselves at a grade of B is greater than that of the students who self-estimated themselves at a grade of A.

Research Data for Total Attitudes Toward Science and Science Teaching

The mean score of the 1,576 sample students' total attitudes toward science and science teaching, measured by the AS and AT scale, is 322.5. The standard deviation is 20.8 and the standard error is 0.5 points.

The classified scores distribution of the total attitudes is as shown in Table 31.

TABLE 31. --Classified scores distribution of the total attitudes toward science and science teaching

Attitude	Score Range	Absolute Frequency	Relative Frequency (%)
Negative	80 - 160	1	0.1
Negative-trend	161 - 213	0	0.0
Confused	214 - 266	26	1.6
Positive-trend	267 - 319	638	40.5
Positive	320 - 400	911	57.8
Total	80 - 400	1576	100.0

Hypothesis 3. There are no significant differences among the total mean scores of science education majors on attitudes toward science and science teaching as measured by the AS and AT scale when analyzed with respect to (a) sex, (b) grade level, (c) specialty, (d) college, (e) birth place, (f) high school attended, (g) religion, (h) army service, (i) career goal and (j) self-estimation of academic achievement.

(a) The F ratio with respect to sex distinction is significant at the 0.05 level as shown in Table 32. Hypothesis 3.a is rejected.

TABLE 32.--Statistical data for the AS plus AT score (sex)

Group	Cases	Mean	Sigma	Results of Anova	
Male	656	323.8	22.2	F ratio	3.90
Female	918	321.6	19.6	P value	0.049
Total	1574	322.5	20.7		

(b) The F ratio with respect to grade level is not significant at the 0.05 level as shown in Table 33. Hypothesis 3.b is accepted.

TABLE 33.--Statistical data for the AS plus AT score (grade level)

Group	Cases	Mean	Sigma	Results of Anova	
Freshman	517	321.7	20.8	F ratio	1.59
Sophomore	365	323.2	18.6	P value	0.187
Junior	358	321.3	21.9		
Senior	325	324.3	21.4		
Total	1565	322.5	20.8		

(c) The F ratio with respect to specialty is significant at the 0.05 level as shown in Table 34. Hypothesis 3.c is rejected. Multiple comparisons show that the mean score of the AS plus AT of the physics teaching majors is significantly greater than that of biology and chemistry teaching majors at the 0.05 level.

TABLE 34.--Statistical data for the AS plus AT (specialty)

Group	Cases	Mean	Sigma	Results of Anova	
Physics	319	326.6	19.9	F ratio	5.16
Chemistry	541	322.1	21.7	P value	0.002
Biology	297	320.3	19.5		
Earth Science	187	322.2	21.8		
Total	1344	322.5	21.0		

(d) The F ratio with respect to college group is significant at the 0.05 level as shown in Table 35. Hypothesis 3.d is rejected. Multiple comparisons show that the mean score of the AS plus AT of students in special and old national colleges is significantly greater than that of students in new private colleges at the 0.05 level.

TABLE 35.--Statistical data for the AS plus AT (college)

Group	Cases	Mean	Sigma	Results of Anova	
Special	180	325.8	21.7	F ratio	4.38
Old national	395	324.7	20.2	P value	0.002
New national	459	321.9	20.5		
Old private	209	322.2	19.9		
New private	330	319.3	21.1		
Total	1573	322.5	20.8		

(e) The F ratio with respect to birth place is not significant at the 0.05 level as shown in Table 36. Hypothesis 3.e is accepted.

TABLE 36.--Statistical data for the AS plus AT scores (birth place)

Group	Cases	Mean	Sigma	Results of Anova	
Large city	773	322.0	21.4	F ratio	1.59
Small city	297	321.9	20.7	P value	0.173
Factory village	8	315.5	12.4		
Fishing village	21	331.1	10.4		
Farm village	470	323.6	19.9		
Total	1569	322.5	20.8		

(f) The F ratio with respect to location of the high school attended is significant at the 0.05 level as shown in Table 37. Hypothesis 3.f is rejected. However, multiple comparisons show that no pairs of the groups are significantly different from each other at the 0.05 level.

TABLE 37.--Statistical data for the AS plus AT scores (high school attended)

Group	Cases	Mean	Sigma	Results of Anova	
Large city	1199	322.1	20.8	F ratio	2.83
Small city	321	324.2	20.1	P value	0.023
Factory village	11	313.6	23.5		
Fishing village	5	303.6	43.2		
Farm village	32	328.1	15.6		
Total	1568	322.5	20.8		

(g) The F ratio with respect to religion is not significant at the 0.05 level as shown in Table 38. Hypothesis 3.g is accepted.

TABLE 38.--Statistical data for the AS plus AT scores (religion)

Group	Cases	Mean	Sigma	Results of Anova	
Buddhism	213	322.4	21.1	F ratio	1.19
Confucianism	16	319.4	23.5	P value	0.314
Christianity	453	324.2	21.1		
Other religion	73	322.9	21.0		
No religion	812	321.7	20.3		
Total	1567	322.5	20.7		

(h) The F ratio with respect to army service is not significant at the 0.05 level as shown in Table 39. Hypothesis 3.h is accepted.

TABLE 39.--Statistical data for the AS plus AT scores (army service)

Group	Cases	Mean	Sigma	Results of Anova	
Before college	12	312.2	37.3	F ratio	1.64
First two-year	83	319.5	23.7	P value	0.160
Last two-year	61	321.4	23.5		
After college	240	324.3	25.1		
Not relevant	1111	322.8	18.9		
Total	1507	322.5	20.8		

(i) The F ratio with respect to career goal is significant at the 0.05 level as shown in Table 40. Hypothesis 3.i is rejected. Multiple comparisons show that the mean score of the AS plus AT of the students who intended to become a scientist or either scientist or educator is significantly greater at the 0.05 level than the mean score of those who had the intention to become an educator. The mean score of students intending to become an educator is significantly greater than that of the students who had no special intention at the 0.07 level.

TABLE 40.--Statistical data for the AS plus AT scores (career goal)

Group	Cases	Mean	Sigma	Results of Anova	
Educator	520	320.9	19.4	F ratio	11.02
Scientist	294	325.8	19.4	P value	0.000
Either edu or sci	396	326.2	20.2		
Neither ed nor sc	173	320.9	23.3		
No special intent.	157	315.4	22.2		
Total	1540	322.5	20.7		

(j) The F ratio with respect to self-estimation of academic achievement is significant at the 0.05 level as shown in Table 41. Hypothesis 3.j is rejected. Multiple comparisons show that the mean score of the students who self-estimated their academic achievement at a grade of B is significantly greater than that of those who estimated at a grade of A at the 0.05 level.

TABLE 41.--Statistical data for the AS plus AT scores (self-estimation of academic achievement)

Group	Cases	Mean	Sigma	Results of Anova	
Estimated A	158	318.2	22.4	F ratio	4.62
Estimated B	833	323.9	20.1	P value	0.001
Estimated C	420	322.1	19.5		
Estimated D	54	316.6	27.2		
Estimated E	33	315.9	27.0		
Total	1498	322.5	20.8		

Findings for Total Attitude Toward Science and Science Teaching

The mean score of the 1,576 sample students measured by the AS and AT scale is 322.5 points when minimum and maximum scores are 80 and 400 respectively. The standard deviation is 20.8 points. Even though the range of scores is from 157 to 381, the majority of the students have either positive (58%) or positive-trend (41%) attitudes toward science and science teaching.

Detailed investigations show the following:

1. There are no significant differences in total attitude toward science and science teaching of science education majors when analyzed with respect to grade level, birth place, religion and army service at the 0.05 level.

2. There are significant differences in attitudes toward science and science teaching of science education majors when analyzed with respect to high school attended. However, multiple comparisons show that no pairs of the groups are significantly different from each other at the 0.05 level.

3. There are significant differences in total attitude toward science and science teaching of the science education majors when analyzed with respect to sex, specialty, college, career goal and self-estimation of academic achievement. Multiple comparisons which show the significant differences at the 0.05 level can be summarized as follows:

a. The mean score of male students is greater than that of female students.

b. The mean score of physics teaching majors is greater than that of chemistry and biology teaching majors.

c. The mean score of the students of special and old national colleges is greater than that of the students of new private colleges.

d. The mean score of the students who had no special intention is less than that of the others.

e. The mean score of the students who estimated their academic achievement at a grade of B is greater than that of the students who estimated at a grade of A.

Research Data for Difference Between the Attitudes Toward Science and Science Teaching

The mean score of the differences between the attitudes toward science and science teaching of the 1,576 sample students, measured by the AS and AT scale, is -3.5. The standard deviation is 10.9 and the standard error is 0.3 points when the minimum and maximum are -160 and 160 points each.

The classification of the two attitudes differences are illustrated in the following score range in Table 42, and the score difference distribution is tabulated.

TABLE 42.--Classified scores distribution of the difference between the attitudes toward science and science teaching

Attitude	Score Range	Absolute Frequency	Relative Frequency (%)
Education-biased	-160 - -31	14	0.9
Education-trend	-30 - -11	339	21.5
Balanced	-10 - 10	1117	70.9
Science-trend	11 - 30	96	6.1
Science-biased	31 - 160	10	0.6
Total	-160 - 160	1576	100.0

Hypothesis 4. There are no significant differences between the mean scores of science education majors on attitudes toward science and science teaching measured by the AS and AT scale when analyzed with respect to (a) sex, (b) grade level, (c) specialty, (d) college, (e) birth place, (f) high school attended, (g) religion, (h) army service, (i) career goal, (j) self-estimation of academic achievement.

(a) The F ratio with respect to sex distinction is not significant at the 0.05 level as shown in Table 43. Hypothesis 4.a is accepted.

TABLE 43.--Statistical data for the AS minus AT scores (sex)

Group	Cases	Mean	Sigma	Results of Anova	
Male	656	-3.69	10.5	F ratio	0.30
Female	918	-3.39	10.8	P value	0.582
Total	1574	-3.51	10.7		

(b) The F ratio with respect to grade level is not significant at the 0.05 level as shown in Table 44. Hypothesis 4.b is accepted.

TABLE 44.--Statistical data for the AS minus AT scores (grade level)

Group	Cases	Mean	Sigma	Results of Anova	
Freshman	517	-3.87	10.5	F ratio	0.59
Sophomore	365	-2.97	10.9	P value	0.624
Junior	358	-3.31	9.9		
Senior	325	-3.72	11.4		
Total	1565	-3.50	10.7		

(c) The F ratio with respect to specialty is not significant at the 0.05 level as shown in Table 45. Hypothesis 4.c is accepted.

TABLE 45.--Statistical data for the AS minus AT scores (specialty)

Group	Cases	Mean	Sigma	Results of Anova	
Physics	319	-3.59	11.0	F ratio	0.56
Chemistry	541	-3.17	10.0	P value	0.643
Biology	298	-3.81	10.8		
Earth Science	187	-2.61	12.9		
Total	1345	-3.50	10.9		

(d) The F ratio with respect to college is significant at the 0.05 level as shown in Table 46. Hypothesis 4.d is rejected. Multiple comparisons show that the difference of mean score of the science education majors in special college is much smaller than that of those in old and new national colleges at the 0.05 level, and the difference of the mean score of the students of the old private colleges is smaller than that of the new national colleges at the 0.05 level.

TABLE 46.--Statistical data for the AS minus AT scores (college)

Group	Cases	Mean	Sigma	Results of Anova	
Special	180	-0.65	10.1	F ratio	6.19
Old national	395	-4.06	10.8	P value	0.000
New national	459	-4.81	10.3		
Old private	209	-2.10	11.5		
New private	330	-3.46	10.5		
Total	1573	-3.51	10.6		

(e) The F ratio with respect to birth place is not significant at the 0.05 level as shown in Table 47. Hypothesis 4.e is accepted.

TABLE 47.--Statistical data for the AS minus AT scores (birth place)

Group	Cases	Mean	Sigma	Results of Anova	
Large city	773	-3.04	10.8	F ratio	1.48
Small city	297	-3.44	10.2	P value	0.205
Factory village	8	-0.88	11.8		
Fishing village	21	-2.00	14.2		
Farm village	470	-4.43	10.6		
Total	1569	-3.51	10.7		

(f) The F ratio with respect to location of the high school attended is not significant at the 0.05 level as shown in Table 48. Hypothesis 4.f is accepted.

TABLE 48.--Statistical data for the AS minus AT scores (high school attended)

Group	Cases	Mean	Sigma	Results of Anova	
Large city	1199	-3.33	10.6	F ratio	1.01
Small city	321	-4.36	10.8	P value	0.401
Factory village	11	-3.82	13.8		
Fishing village	5	-8.00	12.5		
Farm village	32	-1.88	10.1		
Total	1568	-3.51	10.7		

(g) The F ratio with respect to religion is not significant at the 0.05 level as shown in Table 49. Hypothesis 4.g is accepted.

TABLE 49.--Statistical data for the AS minus AT scores (religion)

Group	Cases	Mean	Sigma	Results of Anova	
Buddhism	213	-3.86	11.8	F ratio	0.65
Confucianism	16	-6.56	7.3	P value	0.633
Christianity	453	-3.56	11.1		
Other religion	73	-4.33	8.9		
No religion	812	-3.22	10.3		
Total	1567	-3.49	10.7		

(h) The F ratio with respect to army service is not significant at the 0.05 level as shown in Table 50. Hypothesis 4.h is accepted.

TABLE 50.--Statistical data for the AS minus AT scores (army service)

Group	Cases	Mean	Sigma	Results of Anova	
Before college	12	-4.50	9.1	F ratio	1.00
First two-year	83	-4.86	11.7	P value	0.406
Last two-year	61	-5.10	9.5		
After college	240	-2.77	11.7		
No relevant	1111	-3.39	10.5		
Total	1567	-3.49	10.7		

(i) The F ratio with respect to career goal is significant at the 0.05 level as shown in Table 51. Hypothesis 4.i is rejected. Multiple comparisons show that the difference of the mean score of science education majors who intended to become a scientist is significantly smaller at the 0.05 level than the difference between mean scores of the students who intended to become an educator or either an educator or a scientist.

TABLE 51.--Statistical data for the AS minus AT scores (career goal)

Group	Cases	Mean	Sigma	Results of Anova	
Educator	520	-4.49	10.2	F ratio	4.74
Scientist	294	-1.22	11.3	P value	0.001
Either edu or sci	396	-3.82	10.4		
Neither edu nor sci	173	-3.77	11.3		
No special intent.	157	-2.71	11.0		
Total	1540	-3.51	10.7		

(j) The F ratio with respect to self-estimation of academic achievement is not significant at the 0.05 level as shown in Table 52. Hypothesis 4.j is accepted.

TABLE 52.--Statistical data for the AS minus AT scores (self-estimation of academic achievement)

Group	Cases	Mean	Sigma	Results of Anova	
Estimated A	158	-2.29	10.7	F ratio	0.64
Estimated B	833	-3.67	10.3	P value	0.634
Estimated C	420	-3.71	10.8		
Estimated D	54	-3.07	14.0		
Estimated E	33	-2.82	14.3		
Total	1498	-3.49	10.7		

Findings for Difference Between Attitudes Toward Science and Science Teaching

The mean score of the difference of the 1,576 sample students' attitudes toward science and science teaching measured by the AS and AT scale is -3.5 when minimum and maximum are -160 and 160 points each. The standard deviation is 10.9 points. Even though the range of scores is from -52 to 58, 71 percent of science education majors have balanced attitudes toward science and science teaching, 22 percent have education tending attitudes, and 7 percent have science tending attitudes.

Detailed investigations show the following:

1. There are no significant differences in attitudes toward science and science teaching when analyzed with respect to sex, grade

level, specialty, birth place, high school attended, religion, army service and self-estimation of academic achievement.

2. There are significant differences in attitudes toward science and science teaching when analyzed with respect to college and career goal. Multiple comparisons which show the significant differences at the 0.05 level can be summarized as follows:

a. The mean score of the difference in attitudes toward science and science teaching of the students of new and old national colleges is greater than that of the students of special college. The mean score of the students of new national colleges is greater than that of the students of old private colleges.

b. The mean score of the difference in attitudes toward science and science teaching of the students who intended to become an educator or either an educator or a scientist is greater than that of the students who intended to become a scientist.

Research Data for Correlations Between the Attitudes Toward Science and Science Teaching

If the classification of correlation coefficient range is done as shown in Table 53, the results for hypothesis 5 related to the correlation between attitudes toward science and science teaching can be described as follows:

TABLE 53. --Classification of correlation coefficients range

Correlation Coefficient Range	Description
0.80 - 1.00	strong correlation
0.50 - 0.79	moderate correlation
0.20 - 0.49	weak correlation
-0.19 - 0.19	no correlation
-0.20 - -0.49	negative weak correlation
-0.50 - -0.79	negative moderate correlation
-0.80 - -1.00	negative strong correlation

Hypothesis 5. There is no significant correlation between the scores of science education majors on attitudes toward science and science teaching as measured by the AS and AT scale when analyzed with respect to the scores of (a) the AS and AT, (b) the AS and AS+AT, (c) the AS and AS-AT, (d) the AT and AS+AT, (e) the AT and AS-AT.

TABLE 54. --Correlation coefficients among the scores measured by the AS and AT scale (number of subjects: N = 1,576)

Case	$_{s}r_{t}$	$_{s}r_{s+t}$	$_{s}r_{s-t}$	$_{t}r_{s+t}$	$_{t}r_{s-t}$
Correlation	0.59*	0.88*	0.35*	0.90*	-0.55*

*Significant at the 0.05 level.

(a) The correlation coefficient between the scores of the AS and AT ($_s r_t$) is 0.59 at the 0.05 level as shown in Table 54. Hypothesis 5.a is rejected.

(b) The correlation coefficient between the scores of the AS and AS+AT ($_s r_{s+t}$) is 0.88 at the 0.05 level as shown in Table 54. Hypothesis 5.b is rejected.

(c) The correlation coefficient between the scores of the AS and AS-AT ($_s r_{s-t}$) is 0.35 at the 0.005 level as shown in Table 54. Hypothesis 5.c is rejected.

(d) The correlation coefficient between the scores of the AT and AS+AT ($_t r_{s+t}$) is 0.90 at the 0.05 level as shown in Table 54. Hypothesis 5.d is rejected.

(e) The correlation coefficient between the scores of the AT and AS-AT ($_t r_{s-t}$) is -0.55 at the 0.05 level as shown in Table 54. Hypothesis 5.e is rejected.

Findings for Correlation Between the Attitudes Toward Science and Science Teaching

(a) There is a moderate correlation ($_s r_t = 0.59$) between the attitudes toward science and science teaching of science education majors.

(b) There is a strong correlation ($_s r_{s+t}$ = 0.88) between the attitudes toward science and total attitudes toward science and science teaching of science education majors.

(c) There is a weak correlation ($_s r_{s-t}$ = 0.35) between the attitudes toward science and the difference of attitudes toward science and science teaching of science education majors.

(d) There is a strong correlation ($_t r_{s+t}$ = 0.90) between the attitudes toward science teaching and total attitudes toward science and science teaching of science education majors.

(e) There is a negative moderate correlation ($_t r_{s-t}$ = -0.55) between the attitudes toward science teaching and the difference of attitudes toward science and science teaching of science education majors.

Summary of Findings

TABLE 55.--Summary table of findings (mean and range of scores)

Scale	Cases	Mean	Sigma	Score Range
AS	1,576	159	10	84 - 192
AT	1,576	163	12	73 - 197
AS+AT	1,576	322	21	157 - 381
AS-AT	1,576	-4	11	-52 - 58

TABLE 56.--Summary table of findings (attitudes of majority)

AS: Positive	51 percent,	Positive-trend	47 percent
AT: Positive	64 percent,	Positive-trend	33 percent
AS+AT: Positive	58 percent,	Positive-trend	41 percent
AS-AT: Balanced	71 percent,	Science-tending	7 percent
		Education-tending	22 percent

TABLE 57.--Summary table of findings (correlation coefficients)

Case:	$_{s}r_{t}$	$_{s}r_{s+t}$	$_{s}r_{s-t}$	$_{t}r_{s+t}$	$_{t}r_{s-t}$
Correla. coeff.:	0.59	0.88	0.35	0.90	-0.55
Decision:	moderate	strong	weak	strong	neg. mod.

TABLE 58.--Summary table of findings (analysis of variance and multiple comparison)

Variable	AS	AT	AS+AT	AS-AT
a. Sex	N.S.	N.S.	S (male > female)*	N.S.
b. Grade level	N.S.	N.S.	N.S.	N.S.
c. Specialty	S (phys. > bio.)	S (phys. > chem., bio.)	S (phys. > chem., bio.)	N.S.
d. College-group	S (spec. > new nat. & pri.)	S (old nat. > new pri.)	S (spec., old nat.> new pri.)	S (new & old nat. < spe. new nat. < old pri.)
e. Birth place	N.S.	N.S.	N.S.	N.S.
f. High school	S'	N.S.	S'	N.S.
g. Religion	N.S.	N.S.	N.S.	N.S.
h. Army service	S'	N.S.	N.S.	N.S.
i. Career goal	S (sci., eith. > edu., nei., no)	S (edu., sci. > eith. > no)	S (eith., sci. > edu., no)	S (edu., eith.<sci.)
j. Self-estimation of academic achievement	S'	S (esti. B > A)	S (esti. B > A)	N.S.

N.S.: no significant difference at the 0.05 level.
S': significant at the 0.05 level, there are no results of multiple comparisons.
S: significant at the 0.05 level, there are results of multiple comparisons.

* read (<) as mean score of male students total attitudes toward science and science teaching is greater than that of female students' total attitudes.

Interpretation of the Findings

Interpretations of the findings from the research data are discussed in this section, including some aspects of response choice distributions. The first part deals with general aspects of attitudes toward science and science teaching. The second part is concerned with the difference between attitudes toward science and science teaching, and correlations between them. The third part interprets the relationships of grade level, birth place, religion and army service on attitudes toward science and science teaching. The fourth part characterizes the dependence of sex, specialty, college group, high school attended, career goal, and self-estimation of academic achievement on attitudes toward science and science teaching. The last part discusses some special aspects of response choice distributions.

Attitudes Toward Science and Science Teaching

Traditionally science and technology were not only ignored but frequently discouraged in Korea. After the Korean war, Korean people and the government recognized the importance of scientific development for the national defense and modernization of the country. As discussed in Chapter I, many incentives for science-related jobs may be a factor in stimulating and encouraging students' positive attitudes toward science.

Because of their cultural and historical background, Korean people have had a strong enthusiasm for education and a respectful attitude toward teachers, whose job was recognized as a mission. In spite of the fact that an improvement of treatment for teachers has lagged behind inflation and scientific research and development work, the students of the teachers colleges seem to have positive attitudes toward science and science teaching. However, there seems to have begun some deviation from the tradition of teaching as an honored profession as discussed at the following sections.

It can be inferred from the positive attitudes toward science and science teaching that the total attitude of science education majors is positive.

Relationship Between Attitudes Toward Science and Science Teaching

Ideally, science teachers should have broad knowledge of both science and education. In addition, they should have the skills required for scientific approaches to solving problems and of handling children, and positive attitudes concerning both science and teaching.

It is probable that science teachers can do a better job if they have more knowledge and a good attitude toward science. These are necessary but not sufficient attributes. Logically, the direct goal of a science teacher is good teaching. The profession of the science teacher is science teaching, not research in science.

On the other hand, a science teacher who has a poor understanding of science, minimal ability to experiment and has negative attitudes toward science, is not a desirable model for science teaching.

The fact that 29 percent of science education majors are inclined toward either science or education and the correlation coefficient between the attitudes toward science and science teaching is 0.58 might signify a shifting away from balanced positive attitudes. It will be crucial if the correlation continues to decrease and students become polarized toward either science or education only.

The high correlation coefficients of ${}_{s}r_{s+t}$ and ${}_{t}r_{s+t}$ can be inferred because the total attitudes contain both the scores of attitudes toward science and science teaching.

The sign of ${}_{s}r_{s-t}$ is minus and its absolute value is greater than ${}_{t}r_{s-t}$ because the mean score of the AS is less than that of the AT.

Lack of Dependence on Grade Level, Birth Place, Religion and Army Service

That there are no significant differences of attitudes toward science and science teaching among freshmen, sophomores, juniors and seniors implies that science teacher education does not bring about an attitude change. Attitudes might be formed during pre-college education. Previous attitudes toward science and teaching are strongly held and not changed easily as shown by Kane's study (1968). Hein's study (1973) concerning the under-graduate preparation of chemistry-physics teachers revealed that students' affective behavior toward science and teaching were not significantly changed during the four years of college study, and concluded the program did not succeed in producing such change. However, Nance (1972) concluded in his study that there was a significantly positive attitude change in those students enrolled in the course of modern physics while no change of attitudes toward science occurred in those students enrolled in the course using traditional content. DeProspo (1958) also found that there was an effect of audio visual materials on the attitudes of general science and biology students. Teaching and measurement of attitude change seem to be difficult but not impossible to bring about.

Contrary to the common belief in Korea that the majority of teachers college students are of local birth and graduates of local high schools, only 33 percent of the sample students was of local birth and 3 percent were graduates of local high schools. "Local" refers to the areas of factories, fishing and farm villages. Lack of dependence on birth place but dependence on graduation from a local high school might mean that there has been a substantial movement of population in general and student movement to the city in particular and also that attitude change may have been accomplished by pre-college education.

Lack of dependence on religion might be either due to insufficient reasons for differences of attitude by religion generally or to the lack of an effect produced by the religious life of the students. Traditionally, Buddhism has been the dominant religion in Korea but the majority of the students do not understand the religious documents and do not practice religious behavior strictly. Christianity has been introduced rather recently in Korea so that it is neither understood well nor practiced fully. Therefore, the attitudes of the non-religious students (51.5%) and students with professed religions (48.5%) are not too different from each other.

A complicated military system and difficult experiences in army service were expected to affect the attitudes of students, but research data show no significant differences among them except in attitudes toward science. Although no pairs of groups are significantly different from each other at the 0.05 level, the mean score of the students who finished army service before college is lower than others. Lack of opportunity to study during the years of army service might cause some difficulty in following courses of science and engender negative attitudes toward science.

Dependence on Sex, Specialty, College, High School Attended, Career Goal and Self-estimation of Academic Achievement

The total attitude toward science and science teaching of the sample male students is slightly more (2.2 points) positive than that of the female students as shown in Shrigley and Johnson's study (1974). Female students who decided to study and teach science and passed the entrance examination apparently had positive attitudes toward science and science teaching. This might reduce the traditional "masculine bias" and narrow the gap of attitude differences between males and females.

Because of the commonly recognized difficulty in studying physics caused by its abstract, mathematical and experimental aspects, students who decide to study and teach physics must have strong positive attitudes toward science and science teaching.

The students who challenged the difficult entrance examination of the special university have somewhat more science-biased attitudes. This might mean that excellent students tend more toward science than teaching. A long tradition of a stimulating environment in education in old teachers colleges and guaranteed jobs for national teachers college graduates might affect their students' attitudes toward science teaching. As indicated in Chapter III, the new private colleges are mainly women's colleges. Their students are presumed to have passed the national examination with low scores and have had less competitive college tests. Those factors have probably affected the results of differences among the groups in colleges.

It is usually difficult for local high school graduates to pass the national and college entrance examination. Students who graduated from local high schools and passed the entrance examination, should have high potential for college study with strong motivation and resolution. The significantly higher mean scores of graduates from farm village high schools may be understandable, but factory and fishing village cases are not easily explained. It might be due to the small numbers in the sample.

It is an undesirable situation that ten percent of the science education majors had no specific intention of selecting science education as their major area when they became freshmen in the college. It is even more discouraging that forty percent of the science education majors did not intend to become educators when they entered college as freshmen. The fact that this group has a less positive attitude toward science teaching than other groups reflects the natural results. The fact also supports the finding that there is no significant effect of college education on attitude change and no difference of attitudes by grade. These results may be related to some little understood policy and system of higher education, and the transitional differences between tradition and enforced modernization in Korea.

The students who estimated themselves at the A level might be inclined more toward science as discussed earlier so that their attitudes toward science teaching are more negative than those of students who estimated themselves at a grade of B.

Some Aspects of Response Choice Distribution

A few attitude statements are listed below with the respective percentages of opposite response, which express a negative attitude.

Group 1

\# 2. Scientists can provide the correct answers to any question (20%).

19. Scientific laws have limitations (29%).

24. Knowledge of science consists of absolute truths which have been proven by experiment (30%).

27. The job of a scientist should be to follow fixed steps of a scientific method (24%).

Group 2

\#20. The first important goal of science is to produce a better material life (30%).

Group 3

\# 3. Human beings might be better off without the advance of science (21%).

#21. The progress of science reduces us to poverty in our spiritual life (36%).

It can be inferred that the items of group 1 suggest that more than one-fifth of the sample have a feeling or belief in the absoluteness of science. By interpretation, items of group 2 suggest that about one-third of the sample have confused attitudes about science and technology even though the definition of "science" is given at the first line of the AS scale as "basic natural science." By interpretation, the items of group 3 suggest that more than one-fifth of the sample have a pessimistic view with respect to the development of science.

As with some responses to the AS scale, some attitude statements of the AT scale are listed below with percentages of opposite response in the parentheses:

<u>Group 4</u>

#23. Science teachers should direct with authority what the students must do in the study of science (55%).

16. More complete knowledge of science automatically makes a science teacher more effective (20%).

<u>Group 5</u>

#11. The main activity of school science should be to study many techniques of using machines for daily life (29%).

Group 6

#10. Excellent students should become scientists, but inferior ones are good enough to become science educators (12%).

22. There should be no need to establish a separate department of science education (13%).

38. There is no professional status in science education (18%).

Interpretation of the items of group 4 suggest that more than half of science education majors hold to an authoritative role for teachers. Interpretation of the item of group 5 implies that one-third of the students confused about the main goals of education of science and technical skills. Interpretation of the items of group 6 suggest respondents' negative attitudes toward their own major subject and profession.

These results might be due to an authoritative tradition, the short history of scientific research and development, and the lack of a teaching philosophy of science and proper orientation for the profession of science education.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to investigate the status of the attitudes toward science and science teaching among science education majors in Korea by analyzing according to sex, grade level, specialty, birth place, high school attended, religion, army service, career goal and self-estimation of academic achievement.

After a review of related literature including ERIC search a research plan was established. Following this the researcher developed two scales by adaptation of Moore's model of scale construction (1970) for measurement of attitudes toward science and science teaching. Position and attitude statements for science and science teaching were written by the researcher and scrutinized by panel members. A trial test was carried out and followed by computer analysis. The final form of the Korean version was printed in Korea and administered to sample students of the eight selected colleges by the faculties of the science education departments. The response sheets were returned to the researcher in the United States of America. The responses of a total of 1,576 respondents were tabulated. Absolute and relative frequencies for each variable were recorded. Basic data, such as number of subjects, mean, standard deviation, and standard error of the AS, AT, AS+AT, AS-AT scores were calculated. Analysis of variance of each group for each variable, multiple comparisons by the Sheffe's method and correlation coefficients between the AS and AT scores were determined by computer. Five hypotheses were tested at the 0.05 level.

The Attitudes Toward Science Scale (AS scale) and the Attitudes Toward Science Teaching Scale (AT scale) are subscaled into five categories each. Categories 1, 2, and 3 are intellectually related. Categories 4 and 5 are emotionally related. Each category contains two position statements; one positive and the other negative. Each position statement is related to four attitude statements which became the questionnaire items. The four-choice Likert type scales, which excluded the "neutral" position, were scored with the numerals 5, 4, 2, 1 points representing Strongly Agree, Agree, Disagree, Strongly Disagree responses to the positive attitude statements. The quantification was reversed for the negative attitude statements. Question items for background information consisted mainly of a five choice multiple type.

For content validity, a panel of 14 American and 16 Korean faculty members and researcher in philosophy, history and education in science contributed by responding to the questionnaire and holding direct discussions with the researcher. The first trial form of the scales was administered to 12 Koreans in Colorado and 350 students of Knogju and Kwangju teachers college in Korea in December 1978. The trial responses were analyzed to find the range of correlation coefficients of each item. These were -0.03$\sim$ +0.51 and -0.35$\sim$+0.59 respectively. Values of coefficient alpha of 0.62 and 0.83 were found for the AS and AT scales respectively. For concurrent validity, Moore's scale (1973) and the scale developed by the researcher were administered to 80 students of a teachers college in Kwangju. A correlation coefficient 0.60 was obtained. Mean scores of five different groups (undergraduate science education, graduate science education, physics, medicine, humanity) were compared to find construct validity according to Kerlinger's theory (1964).

For the investigation of the reliability of the scales, correlation coefficients between the scores of each item and the total scores were obtained. These were 0.11$\sim$ 0.52 and 0.38$\sim$0.61 each in the AS and AT scales. Coefficient alpha of 0.73 and 0.82 were obtained. The correlation coefficient between the total scores and the scores on the positive attitude-related items are 0.78 and 0.81 respectively in the AS and AT scales. For negative attitude-related items the correlations were 0.83 and 0.84 respectively.

These results show good internal consistency and reliability for the scales.

Findings

1. The mean score and standard deviation of the attitudes toward science of the students measured by the AS scale are 159 and 10 points respectively when the minimum and maximum scores are 40 and 200 points. The score range measured by the AS scale is from 84 to 194 points. The students who have positive or positive-trend attitudes toward science are 51 and 47 percent respectively.

2. The mean score and standard deviation of the attitudes toward science teaching of the students measured by the AT scale are 163 and 12 points when the minimum and maximum scores are 40 and 200 points. The score range measured by the AT scale is from 73 to 197 points. The students who have positive or positive-trend attitudes toward science teaching are 64 and 34 percent respectively.

3. The mean score and standard deviation of the total attitude toward science and science teaching of the students measured by the AS and AT scale are 322 and 21 points respectively when the minimum and maximum scores are 80 and 400 points. Their score range measured by the AS and AT scale is from 157 to 381 points. The students who have positive or positive-trend total

attitudes toward science and science teaching are 58 and 41 percent respectively.

4. The mean score and standard deviation of the difference between the attitudes toward science and science teaching of the students measured by the AS and AT scale are -4 and 11 points when the minimum and maximum score are -160 and 160 points. The score range measured by the AS and AT scale is from -52 to +58 points. The students who have a balanced attitude toward science and science teaching are 71 percent. The students inclining to science are 7 percent, and the students inclining to education are 22 percent.

5. The correlation coefficients among the scores of attitudes toward science (s), science teaching (t), science and science teaching (s+t) and difference between science and science teaching (s-t) are: ${}_sr_t=0.59$, ${}_sr_{s+t}=0.88$, ${}_sr_{s-t}=0.35$, ${}_tr_{s+t}=0.90$, ${}_tr_{s-t}=$ -0.55.

6. There are no significant differences at the 0.05 level among the groups with respect to grade level, birth place and religion in attitudes toward science and science teaching of the students measured by the AS and AT scale.

7. There are significant differences at the 0.05 level among the groups with respect to the location of high school attended and army service in attitudes toward science and science

teaching of the students measured by the AS and AT scale. However, multiple comparisons show that no pairs of the groups are significantly different from each other at the 0.05 level.

8. There are significant differences at the 0.05 level among the groups with respect to sex, specialty, college, career goal, and self-estimation of academic achievement in attitudes toward science and science teaching of the students measured by the AS and AT scale. Multiple comparisons show that some pairs of the groups are significantly different at the 0.05 level. Specifically,

a. Male students' total attitudes toward science and science teaching are slightly more positive than those for female students.

b. Physics teaching majors' attitudes toward science and science teaching are more positive than attitudes of biology and chemistry teaching majors.

c. Special and old national college students' attitudes toward science and science teaching are more positive than attitudes of the students in new colleges, but the attitude differences of new college students are greater than those of the students in special and old colleges.

d. The attitudes toward science of the students who intended to become either a scientist or an educator are more positive than other groups. The attitudes toward science teaching of the students who had no special career intentions are more negative than the other groups.

e. The attitudes toward science teaching and total attitudes of the students who estimated their academic achievement at a grade of B were more positive than those who estimated themselves as being at the A level.

9. Among the students in the sample 40 percent had no specific intention to become educators when they passed the entrance examination and became freshmen in the college.

10. Among the students in the sample 32 percent estimated their academic achievement at a grade of C or lower.

11. Among the students in the sample 26 percent had an opinion or belief in the absoluteness of science, 30 percent were confused about the main goals of science and technology, and 29 percent had a pessimistic view of scientific development.

12. Among the students in the sample 38 percent had an authoritative attitude toward the role of teachers, 29 percent were confused about the main goals of general education in science and technician skills, and 14 percent expressed negative views about the profession of science education.

Conclusions

1. The majority of science education majors have tendencies toward positive attitudes toward science and science teaching.

2. Two-thirds of science education majors have a balanced attitude toward science and science teaching. One-third of science education majors have tendencies toward biased attitudes about either science or education.

3. The attitudes toward science of science education majors are moderately correlated with their attitudes toward science teaching. The total attitude toward science and science teaching of science education majors are strongly correlated with their attitudes toward science, and also with their attitudes toward science teaching respectively. The differences between the attitudes toward science and science teaching of science education majors are weakly correlated with their attitudes toward science, but moderately correlated in a negative way with their attitudes toward science teaching.

4. There are no differences among the groups with respect to grade level, birth place and religion for science education majors in their attitudes toward science and science teaching.

5. There are differences among the groups with respect to high school attended and army service for science education majors in their attitudes toward science and science teaching.

However, no pairs of the groups are significantly different from each other.

6. There are differences among the groups with respect to sex, specialty, college, career goal and self-estimation of academic achievement for science education majors in attitudes toward science and science teaching. Specifically,

a. Male students' total attitudes toward science and science teaching are slightly more positive than those of female students.

b. Physics teaching majors' attitudes toward science and science teaching are more positive than those of biology and chemistry teaching majors.

c. Attitudes of special and old national college science education majors toward science and science teaching are more positive than attitudes of the students in new colleges, but the attitude differences of new college students are greater than those of the students in special and old colleges.

d. The attitudes toward science of the students who intend to become either a scientist or an educator are more positive than other groups, while the attitudes toward science teaching of the students who have no special intention are more negative than the other groups.

e. The attitudes toward science teaching and total attitudes of the students who estimate their academic achievement at a grade of B are more positive than those who estimate themselves as being at the A level.

7. More than one-third of science education majors had no specific intention to become an educator when they passed the entrance examination of the college.

8. One-third of science education majors self estimate their academic achievement at a grade of C or lower.

9. More than one-fourth of science education majors have an opinion or belief in the absoluteness of science and the authoritative role of teachers, are confused about the main goals of science and technology, and have a pessimistic view of scientific development and their profession of science education.

Recommendations

The study seems to suggest that the quantity and quality of science teachers in Korea will become serious problems unless measures for improvement of internal and external factors in the education and treatment of science teachers are implemented.

Personnel in the science education bureau and teacher education section of the Ministry of Education, the science education departments of teachers colleges, and supervisors of each provincial board of education are encouraged to scrutinize the results of this research and develop mechanisms for continuing study, revised national education policies and an improved program of instruction for pre- and in-service education for science teachers in Korea.

Suggestions for Further Research

1. More detailed subscale-level investigations of the attitudes toward science and science teaching, and the correlated effects produced by students' specialty, college attended, and career goals are needed. Such research would supply data on status and possible ideas for education related to attitude change.

2. Replication of the survey study after a certain time interval will provide needed comparisons, and an understanding of the potential trends of attitude change.

3. A modified version of these scales should be developed for the study of attitudes toward science and science teaching of secondary school science teachers, elementary education majors and teachers in the field.

4. It will be worthwhile to study the relation between the cognitive achievements of the science or education related courses and attitudes toward science and/or science teaching.

5. Theoretical and experimental studies of attitude changes toward science and science teaching by science education majors using the developed scales should be made.

APPENDICES

APPENDIX A

POSITION AND ATTITUDE STATEMENTS

* A LETTER TO PANEL MEMBERS IN ENGLISH
* POSITION STATEMENTS AND QUESTION ITEMS OF ATTITUDES TOWARD SCIENCE AND SCIENCE TEACHING (ENGLISH VERSION)
* A LETTER TO PANEL MEMBERS IN KOREAN
* POSITION STATEMENTS AND QUESTION ITEMS OF ATTITUDES TOWARD SCIENCE AND SCIENCE TEACHING (KOREAN VERSION)

January 14, 1979

Dear Sir:

For the study of the attitudes toward science and science teaching held by science education majors in Korea, I am developing a suitable test. Enclosed is a copy of the proposed test which includes position statements and question items.

I hope you will agree to serve on a panel to assist me in developing this test, and I will appreciate it if you do the following:

1. My plan is to select four items from six questions of each position statement. Would you judge each item according to the range of category and position statement? Write your choice in the parenthesis according to the following classification:

   excellent (A), good (B), fair (C), poor (D), inappropriate (F)

2. If you want to recommend a new question item, please do so on line 7.

3. If you wish to correct English and comment or have other ideas about the terminology, categorization, or positive and negative position statements, please modify words or sentences, and write your opinion.

I will appreciate it if you do. Thank you.

Sincerely yours,

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POSITION STATEMENTS AND QUESTION ITEMS OF ATTITUDES TOWARD SCIENCE*

Category 1. The Goals and Values of Science

Position Statements on Positive Attitudes

Science, as a continuing inquiry of humans, has as its important goals discovering regularities and constructing theories by observation and experiment. (a)

Science is a valuable activity of humans and should be allowed to develop. (b)

(Examples of Question Items)

( ) 1a. Science is a continuing inquiry of humans to understand its nature.

( ) 2a. One of the important goals of science is to explain various events of nature.

( ) 3a. Showing evidence is an important factor in science.

( ) 4b. Scientific research is a valuable activity of humans.

( ) 5b. Science has helped more than it has hindered men.

( ) 6b. We should continue to develop science.

( ) 7 .

Position Statements on Negative Attitude

The goal of science is to produce materialism. Important activities of scientists are for the purpose of facilitating convenient material life. Scientists work hard to earn a better salary. (a)

Science has no value for humans. Science will make our life poorer so that we should not continue to support scientific research.(b)

*Here "science" means basic natural science.

( ) 1a. The goal of science is only to produce a convenient material life.

( ) 2a. The main purpose of science is to produce various electrical appliances.

( ) 3a. Scientists work hard to earn a better salary.

( ) 4b. Science has no value and should not be developed.

( ) 5b. Human beings might be better off without the advances of science.

( ) 6b. We should not support scientists' work.

7.

Category 2. Scientific Knowledge and the View of Nature

Position Statements on Positive Attitude

The accumulated knowledge of science has increased rapidly, but has limitations and conditions that are subject to change. A new scientific theory is more acceptable if it can be shown to explain natural phenomena better than preceding theories and coincides with experimental results. (a)

Science is only one view of nature. There are many views of nature, even among the various fields of science. However we believe that we can gradually understand nature better by the progress of science. (b)

( ) 1a. Even though scientific knowledge has increased rapidly, it has conditions that are subject to change.

( ) 2a. Scientific laws have limitations.

( ) 3a. A new theory is more acceptable if it can be shown to explain natural phenomena better than preceding theories.

( ) 4b. Scientists are interested in improving their explanations of nature.

( ) 5b. We can gradually understand nature better by the progress of science.

( ) 6b. Science is only one view of nature.

7.

Position Statements on Negative Attitude

Scientific knowledge representing unchangable truths has been discovered entirely by modern scientists. (a)

Scientific knowledge is trivial and worthless. Human beings cannot understand the holy secrets of nature. (b)

( ) 1a. Knowledge of science consists of absolute truths which have been proven by experiment.

( ) 2a. The important scientific theories have been constructed entirely by the scientists of the twentieth century.

( ) 3a. Einstein's theory of relativity is a perfect theory.

( ) 4b. Scientific knowledge is trivial.

( ) 5b. Knowledge of science is worthless.

( ) 6b. Man cannot understand the secrets of nature.

7.

Category 3. Processes and Methods of Science

Position Statements on Positive Attitudes

Careful observation, controlled experiments, creative invention and openmindedness are important bases of "sciencing" and scientific explanations. (a)

Scientific methods have limitations in that they can only answer questions about natural phenomena under certain controlled conditions. (b)

( ) 1a. Scientists should control wisely the variables in an experiment.

( ) 2a. Our senses are important tools for investigating nature.

( ) 3a. Willingness to alter one's position on the basis of sufficient evidence is a necessary attitude of scientists.

( ) 4b. Scientific inquiry makes limited explanations of natural phenomena.

( ) 5b. Scientific approaches can be applied under certain conditions.

( ) 6b. Scientific methods give very limited answers.

7.

Position Statements on Negative Attitudes

Every scientist is required to remember all the scientific truths and follow formal steps of a scientific method. (a)

A scientific method can deal with all problems and provide correct answers to all questions. (b)

( ) 1a. There is only one scientific method.

( ) 2a. The job of a scientist is to follow the scientific method according to its formal steps.

( ) 3a. If a Nobel scientist says a new theory is true, other scientists believe him.

( ) 4b. The scientific method can deal with any issues of mankind.

( ) 5b. Scientists can provide the correct answers to any question.

( ) 6b. We have come to know completely the secrets of the universe by the scientific method.

7.

Category 4. Social and Cultural Aspects of Science

Position Statements on Positive Attitudes

Science has influenced every culture and all aspects of modern society; ways of thinking, philosophy, national policy, moral problems, and modernization of our country. There are positive and negative aspects to the influences of the results and applications of scientific knowledge and methods. (a)

In return, society strongly influences the development of science. There are good and bad aspects of the cultural and social influences to science. (b)

( ) 1a. Science has been interwoven with many aspects of our society.

( ) 2a. Science has strongly influenced our ways of thinking.

( ) 3a. The application of science has been changing our life.

( ) 4b. Progress in science requires public support.

( ) 5b. National policy influences strongly scientists' research work.

( ) 6b. There are positive and negative aspects to the mutual influences of science and society.

7.

Position Statements on Negative Attitudes

There is no relation between science and society. (a)

There are only negative aspects to the mutual influences of science and society. (b)

( ) 1a. Science activities are matters only for scientists.

( ) 2a. It is foolish to spend such huge amounts of money for science.

( ) 3a. The public should not support science research.

( ) 4b. Scientists are mainly responsible for pollution.

( ) 5b. The progress of science has reduced us to poverty in our spiritual life.

( ) 6b. Policy makers have utilized scientists in unfair ways.

7.

Category 5. Scientists and A Career in Science

Position Statements on Positive Attitudes

Being a scientist or working in a job requiring scientific knowledge and methods should be a very interesting, challenging, and rewarding way of life.

( ) 1. It is challenging for me to study science.

( ) 2. Being a scientist should be a very rewarding way of life.

( ) 3. Working in a job requiring scientific knowledge should be very interesting.

( ) 4. I enjoy reading the articles on science reported in newspapers.

( ) 5. If capable students want to become scientists, I will strongly support them.

( ) 6. I want to become a scientist.

7.

Position Statements on Negative Attitudes

Being a scientist or working in a job requiring scientific knowledge and methods would be dull and uninteresting. Such work is only for highly intelligent people who are willing to spend most of their time in a laboratory. (a)

Artistic, religious people, and females should not and cannot become good scientists. (b)

( ) 1a. I do not like to study science.

( ) 2a. Scientists have to work in uninteresting laboratories so that I would not want to be one for this reason.

( ) 3a. Conversations related to science are boring to me.

( ) 4b. Scientists cannot appreciate arts.

( ) 5b. A true scientist does not believe in God.

( ) 6b. Women cannot be good scientists.

7.

General comment:

POSITION STATEMENTS AND QUESTION ITEMS OF ATTITUDES TOWARD SCIENCE TEACHING

Category 1. The Goals and Values of Science Teaching

Position Statements on Positive Attitudes

Science teaching at the elementary and secondary school levels is aimed toward providing scientific literacy among people: this includes understanding of basic concepts and the nature of science, scientific process skills, good attitudes concerning science, and orientation toward professions in science. (a)

Learning science by all children is valuable to their development of cognitive, affective, and psychomotor domains. (b)

( ) 1a. Science teaching at the elementary school level aims at scientific literacy of the people.

( ) 2a. Inquiry process skills are important objectives of science teaching in general education.

( ) 3a. People need to understand the nature of science because science has a great effect upon their lives.

( ) 4b. Development of scientific attitudes is one of the important values of education.

( ) 5b. Learning science contributes to the intellectual development of children.

( ) 6b. Science education for all people is valuable in modern society.

7.

Position Statements on Negative Attitudes

The immediate objective of science education at any level is for students to pass the entrance examination of higher level schools, and the sole long range goal of science education is to produce the required professional manpower for science and technology. (a)

Teaching science to all elementary and secondary school students is useless except for those who will become either scientists or engineers. (b)

( ) 1a. Science teaching at secondary school is for the students who will continue to study at the college of natural sciences.

( ) 2a. The criteria of good teaching of science should be judged by the passing ratio on entrance examination for higher level schools.

( ) 4b. Science teaching is useful only for excellent students who will become scientists.

( ) 5b. Teaching science at the elementary school level does not contribute to general education.

( ) 6b. Teaching science to girls is entirely useless.

7.

Category 2. The Content of Science Teaching

Position Statements on Positive Attitudes

The contents of science teaching should be selected and structured to help students learn basic concepts and to be stimulated in intellectual interests.

( ) 1. It is important for students to understand the basic concept of science such as "conservation of energy."

( ) 2. The selected basic concepts in science curriculum should be structured to be related meaningfully to each other.

( ) 3. Secondary school science curriculum should be constructed to have articulation with elementary science.

( ) 4. The content of science courses should be selected to demonstrate the greatness of science.

( ) 5. The content of science courses should be selected to produce intellectual pleasure.

( ) 6. Science subjects in high school might be separated into physics, chemistry, biology, or earth science, but integration among them should be considered.

7.

Position Statements on Negative Attitudes

The content and sequence of science teaching should be limited in selected textbooks, and should contain as many new facts of modern science and/or many various techniques of repairing machines as possible.

( ) 1. Once a text is selected for a science course, the content of teaching should be limited to the book.

( ) 2. The learning sequence of science courses should follow the same order in a selected textbook.

( ) 3. Graduates of elementary school should be able to name all the plants around the area.

( ) 4. If a new elementary particle is discovered, it should be discussed immediately in elementary school textbooks.

( ) 5. Graduates of high school should know the number of chromosomes in a human cell.

( ) 6. The main activity of school science should be to study many techniques of using machines for daily life.

Category 3. The Learning Process and Teaching Methods in Science

Position Statements on Positive Attitudes

Students should be involved in active inquiry as much as possible. (a)

Teachers should take the role of resource persons for guiding or facilitating learning by asking more meaningful questions considering students intellectual levels. (b)

( ) 1a. Students should be involved in inquiry activities more than in listening to teachers talk.

( ) 2a. Equipment for science teaching should be designed mainly for students to do inquiry activities.

( ) 3a. Textbooks should contain many challenging inquiry questions.

( ) 4b. Science teaching should be guided by considering the level of intellectual development of the students.

( ) 5b. A science teacher should ask more meaningful questions instead of merely giving simple information.

( ) 6b. Science teachers should take the role of resource persons facilitating learning.

7.

Position Statements on Negative Attitudes

Students should remember as much knowledge of modern science as possible, therefore learning science requires a very knowledgable teacher. (a)

Science teachers should carefully direct what students do and inform them correctly as to what results will come from the experiments. Use of AV materials or allowing students' discussion are a waste of time in teaching science. (b)

( ) 1a. It is most important for students to remember many formulas in learning science.

( ) 2a. More complete knowledge of science automatically make a science teacher more effective.

( ) 3a. Science teachers should direct with authority what the student must do in the study of science.

( ) 4b. Use of AV materials is a waste of time in teaching science.

( ) 5b. Students' discussion is a waste of time in learning science.

( ) 6b. If the correct result of an experiment does not appear immediately, the teacher should tell students the correct answer at once.

7.

Category 4. Social Aspects of Science Teaching

Positive Statements on Positive Attitudes

General education science in elementary and secondary schools contributes to the modernization of our country and progress of science. (a)

We should recognize the importance of good science teaching and the professional nature of research in science education, and support them. (b)

( ) 1a. Science teaching in the elementary school contributes to modernization of our country.

( ) 2a. Science teaching in the secondary school contributes to the progress of science.

( ) 3a. General education in science contributes to breaking down the superstitious beliefs of laymen.

( ) 4b. We should recognize the importance of good science teaching in the elementary school.

( ) 5b. Science education should be studied in more comprehensive ways by professional science educators.

( ) 6b. Doctoral programs of science education should be established at Korean universities.

7.

Position Statements on Negative Attitudes

Teaching science does not contribute to the modernization of our country. Only high level professional education and research work in science should be supported for the development of science and industrialization of our society. (a)

There is no professional status in science education, and no need to establish special courses, departments, degrees, or institutions. (b)

( ) 1a. Learning science does not contribute favorably to our individual life.

( ) 2a. Teaching science does not contribute to modernization of our country.

( ) 3a. Higher level professional education is enough for the development of science.

( ) 4b. Professional status is not required for the secondary school teaching of science.

( ) 5b. A well established system of producing the required manpower of science will come with production of science educators.

( ) 6b. For the training of science educators, it is unnecessary to establish an institute with special programs.

7.

Category 5. Science Educators and A Career in Science Education

Position Statements on Positive Attitudes

Science educators should have as much pride and prestige in their work as scientists.

Jobs related to science education are valuable and attractive to me. (b)

( ) 1a. Science educators are as important as scientists.

( ) 2a. Science education students must have pride in their major.

( ) 3a. It is as rewarding to do research in science education as to do research in science.

( ) 4b. Jobs related to science education are valuable.

( ) 5b. I enjoy teaching science.

( ) 6b. I plan to continue my professional work in science education.

7.

Positive Statements on Negative Attitudes

Science educators are neither scientists nor educators. They are the people who wanted to become scientists but could not. (a)

Jobs related to science education are neither worthwhile nor interesting because they are easy work. (b)

( ) 1a. Science educators are neither scientists nor educators.

( ) 2a. Excellent students should become scientists, but inferior ones are good enough to become science educators.

( ) 3a. There will be no progress in the job of science education.

( ) 4b. Teaching science is easy work.

( ) 5b. I would not recommend that my children become science educators.

( ) 6b. I do not like to teach science.

7.

General Comment:

______________ 귀하

안녕 하셨읍니까?

과학과 과학 교육에 대한 태도를 연구 하고자 별첨과 같이 10 페이지에 걸쳐 각 범주(範疇)마다 준거 진술(準據陳述)과 질의 항목(質疑項目)을 마련해 보았읍니다.

1. 귀하를 자문 인사로 모실 수 있게 허락해 주시고 다음 사항을 하여 주시면 대단히 감사하겠읍니다.
2. 각 준거 진술마다 4개의 질의 항목을 선택하려는 것이오니 각 질의 사항에 대해 준거 진술에 비추어 보아 좋은 질의 항목인가의 여부를 5단계로 점수화하여 괄호 (   ) 속에 써 넣어 주십시요.

   아주 좋음(5), 좋음(4), 보통임(3), 좀 부적당함(2), 부적당함(1).

3. 만일 좋은 질의 항목을 추천 하시려면 7번 빈칸에 써 넣어주시고 여백이 부족하면 뒷면에 써 주십시요.
4. 5가지의 범주와, 각 범주의 긍정적 및 부정적 태도의 준거 진술, 또 전체적인 내용이나 용어 등에 대하여 좋으신 의견이 있으시면 직접해당되는 곳에 줄을 긋고 수정하시거나 첨가해 주십시요.
5. 죄송하오나 곧 보내 주시기 바라오며 늦어도 1979년 1월 31일까지 아래 주소로 [illegible] 항공편을 이용하여 우송해 주시면 대단히 감사하겠읍니다. (소요 우표는 따로 우송해 드리도록 하겠읍니다).

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이것은 아직 연구 단계에 있는 것이오니 외부에 공개하거나 본인과 상의없이 다른 목적으로 사용하지 않게 하여 주십시요. 작은 저의 연구가 일단계 완료되면 과학교육학회지에 발표하고 귀하에게 복사하여 한 부를 보내드리겠읍니다. 감사합니다.

1979년 1월 8일

서울 대학교 사범대학 과학교육과
조교수 박 승 재

과학에 대한 태도의 준거 진술과 문의 항목

범주 1. 과학의 목적과 가치에 대한 태도

긍정적 태도의 준거 진술

과학은 인간의 자연에 대한 끊임없는 탐구 활동으로 그 중요한 목적은 자연을 관찰하고 실험하여 규칙성을 찾고 그 현상들을 설명할 이론을 세우는 것인데, 그 활동은 창의성과 실증성으로 특징지워진다. 합리성, 보편성, 공리성 및 발전성 등은 과학의 중요한 가치들이다.

(문의 항목의 예)

1. 과학은 자연의 규칙성을 찾고 그 현상을 설명할 이론을 세우는 계속적 탐구 과정이다. (　　)
2. 실제적 증거를 보이는 것은 과학 활동의 한가지 중요한 특징이다 (　　)
3. 과학의 중요한 목적은 자연 현상을 서술하고 설명하는 것이다. (　　)
4. 과학자들의 한가지 중요한 활동 동기는 자연에 대한 그들의 지적 호기심을 만족시키려는 것이다. (　　)
5. 합리성과 보편성은 과학의 중요한 가치들이다. (　　)
6. 과학은 인간을 해롭게 한 것보다 이익되게 한 것이 더 많다. (　　)
7.

부정적 태도의 준거 진술

과학은 인간의 모든 문제를 해결할 수 있는 방법을 지닌 완전한 지식 체계이다. 과학의 중요한 목적은 일상 물품의 증산과 산업 기술의 개발인데, 그 활동은 복잡하고 묘한 기계와 절대 권위로 특징지워진다. 결국 과학의 가치는 즉각적 실용성과 경제적 발전에 있다.

1. 과학은 인간의 모든 문제를 해결할 수 있다. (　　)
2. 많은 기계들과 다양한 물품의 생산이야말로 현대 과학의 특징을 가장 잘 나타내준다. (　　)
3. 과학자들이 열심히 일하는 것은 더 많은 보수를 받기 위해서이다. (　　)
4. 빠른 교통 수단과 여러 편리한 전기 제품들이야 말로 과학의 가치를 가장 잘 나타내 준다. (　　)
5. 과학의 보람은 결국 얼마나 산업을 발전 시키고 경제를 부흥 시키는 가에 달려 있다. (　　)
6. 과학과 과학자들은 인간의 생활을 타락시켰다. (　　)
7.

범주 2. 과학의 지식에 대한 태도

긍정적 태도의 준거 진술

과학의 지식은 근래에 급격히 증가하였으나 그것은 완전한 것이 아니라 계속 발전하는 것이다. 따라서 인간은 점진적으로 자연을 좀 더 이해할 것이다.

1. 과학의 지식은 근래에 급격히 증가하였으나 그것은 조건과 한계를 지닌 것으로 계속 발전한다. ( )
2. 어떤 과학의 법칙은 완전히 옳다고 증명해 보일 수 없다. ( )
3. 과학에서 새 이론은 그 전의 이론보다 더 잘 설명하고 실험 사실과 부합하면 받아들여진다. ( )
4. 과학자들은 항상 자연에 대한 그들의 설명을 발전시키려는 데 관심이 있다. ( )
5. 현대 과학은 자연에 대한 절대적 진술의 한 고정된 뉴톤적 기계관을 부인한다. ( )
6. 과학은 자연을 보는 유일한 방법이 아니라 한가지 방법이며 과학 분야에 따라 서로 다른 견해가 있을 수 있다. ( )
7.

부정적 태도의 준거 진술

불변의 절대 진리인 과학의 지식은 근래에 과학적 방법에 의해 모두 발견되었고 현대 과학은 우주의 현상을 완전히 서술하고 설명할 수 있게 발전하였다. 과학의 지식은 모두 가치없는 헛된 것으로 인간은 아무리해도 오묘한 자연을 전연 이해할 수 없다.

1. 과학의 지식은 실험적으로 증명된 의심할 여지가 없는 진리이다. ( )
2. 중요한 과학의 법칙들은 20세기 과학자들에 의하여 모두 발견되었다. ( )
3. 뉴톤의 운동 법칙은 낡은 것으로 틀리는 나쁜 것이고, 아인슈타인의 상대성 원리는 새로운 것으로 틀림이 없는 좋은 것이다. ( )
4. 현대 과학의 발전으로 우리는 우주의 모든 신비를 알게 되었다. ( )
5. 과학의 지식은 모두 가치 없는 헛된 것이다. ( )
6. 인간은 아무리해도 신비한 자연의 이치를 전혀 알아낼 수 없다. ( )
7.

범주 3. 과학 활동의 방법에 대한 태도

긍정적 태도의 준거 진술

객관적 관찰, 주의 깊은 실험, 창의적 발견 그리고 개방적 태도 등은 과학을 형성하고 과학적 설명을 하는 중요한 바탕이다. 과학 활동은 한계가 있는 것으로, 단지 어떤 일정한 조절된 조건 하에서 자연에 대한 질문에 답하려고 하지만 때로는 그것도 못 할 수가 있다.

1. 과학 활동의 중요한 한가지는 주의 깊게 현상을 관찰하고 정확히 서술하는 것이다. (　　　)
2. 자연을 탐구하는데 모든 과학자들이 좇는 한가지 고정된 과학적 방법의 단계는 없다. (　　　)
3. 충분한 근거 하에서는 견해나 입장을 바꿀 용의를 갖고 있는 것이 과학자의 필요한 태도이다. (　　　)
4. 과학적 탐구는 자연 현상을 설명하고 예언하는 일이지만 때로는 그 일에도 한계가 있다. (　　　)
5. 우리의 감각은 자연을 탐구하는데 사용되는 중요한 도구이다. (　　　)
6. 과학자들은 자유로운 탐구 활동을 통해 창의적 연구를 수행해야 한다. (　　　)
7.

부정적 태도의 준거 진술

과학 지식의 축적과 과학적 설명은 절대 진리와 전통의 권위에 의존한다. 과학자가 되려면 모든 과학 지식을 기억해야하고 과학적 방법의 형식적 단계를 좇아야 한다. 과학은 모든 문제를 해결할 수 있으며 모든 질문에 항상 옳은 답 만을 제공해 준다.

1. 과학자들의 일은 모든 과학 지식을 기억하고 과학적 방법의 형식적 단계를 좇는 것이다. (　　　)
2. 과학자들은 모든 질문에 언제나 옳은 답만을 제공해 준다. (　　　)
3. 과학은 인간의 모든 문제를 해결할 수 있다. (　　　)
4. 과학적 방법은 어떤 문제나 상황에도 적용될 수 있다. (　　　)
5. 과학은 신(神)이 없음을 증명하였다. (　　　)
6. 만일 한 노벨 수상 과학자가 이 이론이 옳다고 하면 모든 다른 과학자들은 그를 믿는다. (　　　)
7.

범주 4. 과학의 사회 문화적 측면에 대한 태도

긍정적 태도의 준거 진술

과학은 각 문화와 사회의 거의 모든 국면, 즉, 사고 방식, 철학, 국가 정책, 도덕 문제, 우리 나라의 현대화 등에 영향을 끼쳐왔고, 또한 사회도 과학 발전에 지대한 영향을 끼쳐왔다. 과학과 사회의 상호 영향은 좋고 나쁜 양 국면이 다 있다.

1. 과학은 우리 사회의 거의 모든 국면과 밀접한 관계를 맺고 있다. (   )
2. 우리 정부와 국민은 과학을 계속 발전 시키도록 지원해야 한다. (   )
3. 과학의 시대에 살고 있는 모든 국민은 과학을 이해해야 한다. (   )
4. 과학의 발전은 모든 국민의 지원을 필요로 한다. (   )
5. 과학은 인간의 사고 방식과 물질 생활에 크게 영향을 끼쳐 왔다. (   )
6. 과학과 사회의 상호 영향은 좋은 국면도 있었고 나쁜 국면도 있었다. (   )
7.

부정적 태도의 준거 진술

과학 활동은 오로지 과학자들만의 일로 사회는 과학 활동에 관여할 필요가 없다. 일반인은 과학을 이해할 수 없으므로 전문적 과학 활동과 아무런 관계도 가질 수 없고 가져서는 안된다. 역사적으로 보면 사회는 항상 과학자들을 부당하게 대한 반면, 과학 발전의 결과는 인간 사회를 나쁘게 만들었다.

1. 과학 활동은 오로지 과학자들 만의 일이다. (   )
2. 과학의 연구를 위하여 거액의 돈과 에너지를 소비함은 어리석은 것이다. (   )
3. 과학과 종교는 항상 대립되어 있는데, 과학자들은 언제나 박해를 받았다. (   )
4. 오염, 핵 전쟁 및 물질 만능 주의 등은 과학자들에게 책임이 있다. (   )
5. 과학의 발전은 물질 생활의 풍요를 누리게 하였지만, 정신 생활의 빈곤을 초래하였다. (   )
6. 인간은 과학의 발전이 없었으면 더욱 행복했을 것이다. (   )
7.

범주 5. 과학자와 과학 관계 직업에 대한 태도

긍정적 태도의 준거 진술

과학자가 되거나 과학의 지식과 사고 방식을 필요로 하는 일은 매우 흥미롭고 보람있는 생활이다.

1. 과학자로서의 생활은 매우 보람있는 생애이다. (　　)
2. 과학자들도 가족이나 친구와 잘 어울려 생활한다. (　　)
3. 과학의 지식이나 사고 방식을 필요로 하는 일은 매우 흥미롭다. (　　)
4. 과학을 공부하는 것이 쉽지는 않지만 도전할 만 하다. (　　)
5. 나는 자질있는 후배나 제자들이 과학자가 되려고 하면 적극 권고하고 협조 하겠다. (　　)
6. 나는 신문이나 잡지에 게재된 과학 관계 기사를 즐겨 읽는다. (　　)
7.

부정적 태도의 준거 진술

과학자가 되거나 과학의 지식과 사고 방식을 필요로 하는 일은 흥미롭지 못하고 보람없는 일이다. 그런 일은 대부분의 시간을 실험실에서 보내야 하는 특수 기인(奇人)이나 할 일이다.

1. 과학자들은 너무나 많은 시간을 재미없는 실험실에서 보내야만 하기 때문에 나는 과학자가 되기 싫다. (　　)
2. 과학자들은 미술이나 음악에 둔하고 마음이 좁아 가정이나 사회 생활에 서툴다. (　　)
3. 대다수 과학자는 종교를 믿지 않는다. (　　)
4. 여자는 훌륭한 과학자가 될 수 없다. (　　)
5. 나는 과학을 이해하지도 못하며 흥미도 없다. (　　)
6. 과학과 관계된 대화나 오락은 항상 나를 지루하게 만든다. (　　)
7.

과학교육에 대한 준거진술과 질의 항목

범주 1. 과학교육에 대한 목적과 가치에 대한 태도

<u>긍정적 태도의 준거 진술</u>

초 중등 과학교육은 모든국민의 과학교양, 즉 과학의 기본 개념과 본성의 이해, 과학적 탐구능력의 습득, 과학에 대한 좋은 태도의 함양, 과학관계 직업에 대한 안내등을 목적으로 한다. 모든 국민의 과학 학습은 개개인의 지적, 정의적, 신체적 발달을 통해 과학의 발전과 우리나라 근대화에 공헌한다.

(질의 항목의 예)

1. 초 중등과학교육은 모든국민의 과학교양을 함양시킬 것을 목적으로 한다. (　　)
2. 과학적 사고능력과 탐구태도의 함양은 일반 과학교육의 중요한 목표이다. (　　)
3. 일반인들도 과학이 그들 생활에 지대한 영향을 끼치므로 과학을 이해 해야 한다. (　　)
4. 과학 학습은 학생들 개개인의 지적, 정의적 및 신체적 발달에 대단히 중요하다. (　　)
5. 모든 국민에 대한 과학교육은 과학발전과 우리나라 근대화에 공헌한다. (　　)
6. 대부분의 학생들은 초등과학을 공부할 수 있으며 그 공부는 누구에게나 보람있는 일이다. (　　)
7.

<u>부정적 태도의 준거진술</u>

어느 수준이던 과학교육의 목적은 과학자와 기술자등 필요한 전문적 인력을 양성하기 위함이다. 모든 초중등 학생에게 과학을 가르칠 필요가 없다.

1. 초 중등 과학교육은 일반 인간교육이나 전문적 과학교육에 아무런 도움이 되지 못한다. (　　)
2. 중등과학교육은 자연과학대학이나 공과대학에 진학할 학생을 위한 것이다. (　　)
3. 여자에게 과학을 가르치는 것은 전혀 무용한 일이다. (　　)
4. 과학교육의 잘 잘못의 판단기준은 상급학교 입시 합격률에 달려 있다. (　　)
5. 과학교육은 과학자나 공학자가 될 우수한 학생들에게만 가능하고 유용하지 그렇지 못한 학생들에게는 가르쳐야 오히려 나쁜 태도만 길러진다. (　　)
6. 일반인들이 과학을 공부하는 것은 과학 발전에 아무런 도움이 되지 못한다. (　　)
7.

범주 2. 과학 교육 내용에 대한 태도

긍정적 태도의 준거진술

과학의 내용은 학생들이 과학의 기본개념을 학습하고 지적 흥미를 갖도록 선택되고 구조화 되어야 한다.

1. 교양과학교육은 "에너지의 보존"과 같은 과학의 기본개념을 선택해서 철저히 이해하도록 해야 한다. (　　)
2. 과학교육을 위해서 선택된 개념들은 서로 의미있게 관련지어 학습 하도록 구조화 해야 한다. (　　)
3. 중등 과학 교육 과정은 초등 과학교육과 잘 연관지어 구성해야 한다. (　　)
4. 중등교육이수자는 적어도 실험에 있어서 변이(變異)를 통제 할 줄 알아야 한다. (　　)
5. 과학과정의 내용은 지적수준에 적합하게 과학의 위대함을 보이고 지적 즐거움을 맛볼 수 있게 제시되어야 한다. (　　)
6. 고등학교 과학은 물리, 화학, 생물 및 지구과학등으로 분과 될 수 있겠으나 통합성을 고려해야 한다. (　　)
7

부정적 태도의 준거진술

과학 교육의 내용은 가능한 많은 현대과학의 새 정보들과 기계 수리 기술을 포함해야 한다.

1. 과학과정의 내용은 가능한 많은 현대과학의 새 정보들만을 포함해야 한다. (　　)
2. 과학교육의 주활동내용은 기구사용과 기계수선 기술을 습득하는 것이라야 한다. (　　)
3. 초등과학 교육은 보잘 것 없는 것으로 거의 무용한 일이다. (　　)
4. 중등과학 교육은 대학 과학교육을 잘 준비하는 것이라야 한다. (　　)
5. 고등학교 졸업생은 인간세포속에 염색체 수가 몇개 있는지 정도는 알아야 한다. (　　)
6. 과학 학습내용은 오로지 선택한 교과서의 내용만 포함해야 한다. (　　)
7.

범주 3. 과학의 학습과정과 교수방법에 대한 태도

긍정적 태도의 준거진술

학생들은 가능한 적극적으로 탐구활동에 참여해야 한다. 교사는 의미 있는 질문들을 통해 학습을 안내하거나 협조하는 자원인사의 역할을 해야 한다.

1. 학생들은 교사의 말을 듣기만 하는 것보다 적극적인 탐구활동에 참가해야 한다. (　　)
2. 과학교육은 학생들의 지적 발달 수준을 고려하여 계획되고 지도되어야 한다 (　　)
3. 과학교사는 단순히 정보를 제공해 주는 것보다 의미있는 수렴적 및 발산적 질문을 해야 한다. (　　)
4. 과학교사는 학습을 안내하거나 협조하는 자원인사의 역할을 해야 한다. (　　)
5. 과학교육 평가의 한 기능은 학생의 과학학습 결과를 진단하고 부족한 점을 보충하도록 돕는 것이다. (　　)
6. 과학교육의 기구는 교사가 복잡하고 비싼 기구로 시범하기 위한 것 보다 학생들이 탐구 활동을 하도록 고안되어야 한다. (　　)
7.

부정적 태도의 준거진술

학생들은 가능한 현대과학의 많은 정보를 기억하고 여러 기재 수선 기술을 습득해야 한다. 교사는 학생들이 무엇을 해야하고 시험을 어떻게 치루어야 하는가 등을 말해주고 평가해 주어야 한다.

1. 학생들은 현대과학의 여러 공식과 사실들을 기억해야 한다. (　　)
2. 국민학교 아동들을 위해서는 지적 발달을 고려하는 것이 도움이 될 것이지만 중등 학생들에게는 아무 도움이 되지 않는다. (　　)
3. 과학교사는 학생들이 무엇을 기억해야 되는가를 말해주고 칠판에 적어 베끼도록 해야 한다. (　　)
4. 과학교육의 내용은 빼거나 추가할 것 없이 선택한 교과서의 계열을 따르기만 해야 한다. (　　)
5. 과학교육에서 시청각 자료를 사용하는 것은 시간 낭비에 지나지 않는다. (　　)
6. 만일 학생실험에 있어서 정확한 결과가 곧 나오지 않으면, 과학 교사는 곧 옳은 답을 말해 주어야 한다. (　　)
7.

범주 4. 과학교육의 사회적 측면에 대한 태도

<u>긍정적 태도의 준거진술</u>

과거에는 과학교육이 경시되고 전문성이 확립되지 않아 사회로부터의 지원이나 사회에의 공헌이 미약하였으나 근래에 이르러 우리사회와 과학교육은 점점 깊은 관계를 맺어가고 있다.

1. 과거에 과학교육은 경시되었으나 근래에 이르러 중요함을 인식하게 되었다.(   )
2. 과학교육의 전문성을 인정하고 과학교육 전문가를 양성할 체제가 확립되어야 한다. (   )
3 과학교육 박사학위과정이 한국 대학교에 설정되어야 한다. (   )
4. 과학교육은 과학교육 전문가에 의해 종합적이고 체계적으로 연구되어야 한다. (   )
5. 과학교육관계직업은 과학연구관계 직업 못지 않게 중요시 되어야 한다.(   )
6. 과학교육은 학생들 개개인의 발달에 공헌하고 우리나라 과학과 근대화에 이바지 해야 한다. (   )
7.

<u>부정적 태도의 준거진술</u>

일반인의 생활이나 우리나라 근대화에 초중등 교양과학교육은 아무런 관계가 없다. 우리나라의 과학발전이나 근대화를 위해서는 전문적 고등 과학교육만을 육성해야 한다.

1. 일반인의 생활이나 우리나라 근대화에 초중등 교양과학교육은 아무런 관계가 없다.( )
2. 과학교육의 전문직은 필요없으며 전문성이란 있을 수 없다.(   )
3. 과학 인력 양성체제만 잘 되면 과학교육인력은 부수적으로 다 해결된다.( )
4. 과학교육은 연구할 것도 없고 연구해도 소용없다. (   )
5. 과학교사는 과학지식만 많이 알면 알수록 잘 가르칠 수 있다. (   )
6. 과학 교육자 양성을 위해 특별 과목이나 과정 또는 독립된 과를 설정할 필요가 없다. (   )
7.

범주 5. 과학교육자와 과학교육 관계 직업에 대한 태도

<u>긍정적 태도의 준거진술</u>

과학교육자는 과학자 못지 않게 그들 직업에 대해 긍지를 가질수 있고 가져야 한다. 과학교육 관계 직업은 보람있는 일이다.

1. 과학교사, 과학장학사, 과학교육연구자들은 과학자, 공학자, 기술자 못지 않게 중요하다.( )
2. 과학교육을 연구하는 것은 과학을 연구하는 것과 마찬가지로 가치 있는 일이다.( )
3. 과학교육 전공 학생이나 전문가들은 자기들 전공과 직업에 긍지를 느낄 만 하다.( )
4. 나는 과학 가르치기를 좋아 한다.( )
5. 나는 과학을 잘 가르칠 수 있다.( )
6. 나는 과학교육과 관계된 직업을 계속 갖겠다.( )
7.

<u>부정적 태도의 준거진술</u>

과학교육자들은 과학자가 되려고 하다 못된 사람들이다. 과학교육과 관계된 직업은 흥미도 없고 보람도 없는 일이다.

1. 우수한 학생은 과학자가 되고 열등한 학생은 과학교육자가 되어도 충분하다.( )
2. 과학교육은 연구할 것이 없고 전문성도 없어 그 방면으로 진출하면 발전의 여지가 없다.( )
3. 과학을 가르치는 일은 과학을 연구하는 일보다 보람이 없는 일이다.( )
4. 어쩌다 과학교육이 내 전공이 되었다면, 가능한 한 전공을 다른 것으로 바꾸겠다.( )
5. 과학을 가르치는 것은 귀찮고 (은 일이) 싫다.( )
6. 나는 자녀와 후배들에게 과학교육자가 되라고 권고 하지 않겠다.( )

APPENDIX B

MOORE'S SCALE: WHAT IS YOUR ATTITUDE TOWARD SCIENCE AND SCIENCE TEACHING?

* A LETTER FROM DR. MOORE PERMITTING TRANSLATION AND USE

* WHAT IS YOUR ATTITUDE TOWARD SCIENCE AND SCIENCE TEACHING? (ENGLISH VERSION)

* ATTITUDES ASSESSED BY "WHAT IS YOUR ATTITUDE TOWARD SCIENCE AND SCIENCE TEACHING?"

* WHAT IS YOUR ATTITUDE TOWARD SCIENCE AND SCIENCE TEACHING? (KOREAN VERSION)

MIAMI UNIVERSITY
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DEPARTMENT OF TEACHER EDUCATION
301 McGuffey Hall

Telephone (513) 529-6443

November 3, 1978

Sung-Jae Pak
13-G
North Aggie Village
Ft Collins, Colo. 80526

Dear Sung-Jae Pak,

Thank you for your letter of October 31, 1978. I am enclosing a copy of the Science Teaching Attitude Scales. I hereby grant you permission to make as many copies as you need for your present work. I also grant you permission to translate the S.T.A.S. into Korean for your research. If you decide to make the translation, I would appreciate receiving two copies of the translation.

Good luck with your work.

Sincerely,

Richard W. Moore

Richard W. Moore

WHAT IS YOUR ATTITUDE TOWARD SCIENCE AND SCIENCE TEACHING?

There are some statements about science and science teaching on the next few pages. Some statements are about a person's feeling about science. Some of these statements describe views about how science should be taught. You may agree with some of the statements and you may disagree with others. That is exactly what you are asked to do. By doing this, you will show your attitudes toward science and science teaching.

After you have carefully read a statement, decide whether you agree or disagree with it. If you agree, decide whether you agree mildly or strongly. If you disagree, decide whether you disagree mildly or strongly. Then, find the number of that statement on the answer sheet, and blacken the space by the

1 if you agree strongly.

2 if you agree mildly.

3 if you disagree mildly.

4 if you disagree strongly.

Example:

00. I would like to have many friends.

00. 1 ▬ 2 = 3 = 4 =

(The person who marked this example agrees strongly with the statement, "I would like to have many friends.")

Please respond to each statement and blacken only one space for each statement.

Please do not make any marks on this test booklet.

WHAT IS YOUR ATTITUDE TOWARD SCIENCE AND SCIENCE TEACHING?

1. It is important for children to learn that the air is approximately 20% oxygen--at least by the sixth grade.
2. There is no need for the public to understand science in order for scientific progress to occur.
3. Most children should be able to design experiments--at least by the sixth grade.
4. Most people are not able to understand the work of science.
5. When something is explained well, there is no reason to look for another explanation.
6. A teacher should be a resource person rather than an information-given in science.
7. The products of scientific work are mainly useful to scientists; they are not very useful to the average person.
8. I do not understand science, and I do not want to teach it.
9. A scientist must be imaginative in developing ideas which explain natural events.
10. After all is said and done, it is really the teacher who tells the children what they have to learn and know.
11. Some questions cannot be answered by science.
12. In teaching science, a teacher might spend more time listening to the children than talking to them.
13. Before one can do anything in science, he must study the writings of the great scientists.
14. Rapid progress in science requires public support.
15. Process skills are very important things to be developed in science.
16. Scientists believe that nothing is known to be true with absolute certainty.
17. A major purpose of science is to help man live more comfortably.
18. A new theory may be accepted when it can be shown to explain things as well as another theory.

19. Children must learn certain basic facts in elementary science so they can do well in science in junior high.

20. Scientists do not need public support, they can get along quite well without it.

21. I understand science and I want to teach it.

22. Every citizen should understand science because we are living in an age of science.

23. Children must be told what they are to learn if they are to make progress in science.

24. Science is so difficult that only highly trained scientists can understand it.

25. A teacher has a responsibility to teach the basic processes of science.

26. His senses are one of the most important tools a scientist has.

27. Science may be described as being primarily an idea-generating activity.

28. Ideas are one of the more important products of science.

29. As children experiment, a teacher may give helpful hints, but not the answer to a problem.

30. Science is pretty easy to understand.

31. The value of science lies in its theoretical products.

32. Process skills are the most important things to be developed by children in science.

33. A major purpose of science is to produce new drugs and save lives.

34. I like science, and I probably will be (am) a better science teacher than most other teachers.

35. Science is devoted to describing how things happen.

36. I am afraid to teach science because I can't do the experiments myself.

37. Public understanding of science is necessary because scientific research requires financial support through the government.

38. I just never will understand science.

39. People need to understand the nature of science because it has such a great affect upon their lives.

40. A teacher has a responsibility to teach the basic facts of science.

41. Scientists discover laws which tell us exactly what is going on in nature.

42. The idea of teaching science scares me.

43. Demonstrations should be used frequently so the children will understand what their teacher tells them.

44. Scientists believe that they can find explanations for what they observe by looking at natural phenomena.

45. Scientific laws cannot be changed.

46. If an experiment does not come out right, the teacher should tell the children the answer so they will not be lost.

47. There are some things which are known by science to be absolutely true.

48. It is a teacher's responsibility to tell children which things are important for them to know.

49. I do (will) not teach very much science.

50. An important purpose of science is to help man to live longer.

51. A useful scientific theory may not be entirely correct, but it is the best idea scientists have been able to think up.

52. Today's electric appliances are examples of the really valuable products of science.

53. It is important for children to learn how to control variables in an experiment--at least by the sixth grade.

54. I am well-prepared to teach science.

55. The teacher should arrange things so that children spend more time experimenting than listening to her in science.

56. Scientists are always interested in improving their explanations of natural events.

57. The value of science lies in its usefulness in solving practical problems.

58. I think I understand the nature of science and science teaching pretty well.

59. Most people are able to understand the work of science.

60. Scientific explanations can be made only by scientists.

61. Most children should know that the blood carries oxygen to the cells--at least by the sixth grade.

62. We can always get answers to our questions by asking a scientist.

63. Scientific laws have been proven beyond all possible doubt.

64. Looking at natural phenomena is a most important source of scientific information.

65. A major function of the teacher in teaching science is to help children identify problems.

66. If a scientist cannot answer a question, all he has to do is to ask another scientist.

67. Anything we need to know can be found out through science.

68. It is important for children to know why iron rusts--at least by the sixth grade.

69. Scientific ideas may be said to undergo a process of evolution in their development.

70. Scientists cannot always find the answers to their questions.

Scale	Attitudes Assessed by "What is Your Attitude Toward Science and Science Teaching?"	Items used to assess each attitude
1-P	The laws and/or theories of science are approximations of truth and are subject to change.	16, 18, 51, 56, 69
1-N	The laws and/or theories of science represent unchangeable truths discovered through science.	5, 41, 45, 47, 63
2-P	Observation of natural phenomena is the basis of scientific explanation. Science is limited in that it can only answer questions about natural phenomena and sometimes it is not able to do that.	11, 26, 44, 64, 70
2-N	The basis of scientific explanation is in authority. Science deals with all problems and it can provide correct answers to all questions.	13, 60, 62, 66, 67
3-P	Science is an idea-generating activity. It is devoted to providing explanations of natural phenomena. Its value lies in its theoretical aspects.	9, 27, 28, 31, 35
3-N	Science is a technology-developing activity. It is devoted to serving mankind. Its value lies in its practical uses.	17, 33, 50, 52, 57
4-P	Progress in science requires public support in this age of science, therefore, the public should be made aware of the nature of science and what it attempts to do. The public can understand science and it ultimately benefits from scientific work.	14, 22, 37, 39, 59
4-N	Public understanding of science would contribute nothing to the advancement of science or to human welfare, therefore, the public has no need to understand the nature of science. They cannot understand it, and it does not affect them.	2, 4, 7, 20, 24

Scale	Attitudes Assessed by "What is Your Attitude Toward Science and Science Teaching?"	Items used to assess each attitude
5-P	The idea of teaching science is attractive to me; I understand science and I can teach it.	21, 30, 34, 54, 58
5-N	I do not like the thought of teaching science.	8, 36, 38, 42, 49
6-P	There are certain processes in science which children should know, i.e., children should know how to do certain things	3, 15, 25, 32, 53
6-N	There are certain facts in science that children should know.	1, 19, 40, 61, 68
7-P	Science teaching should be guiding or facilitating of learning. The teacher becomes a resource person.	6, 12, 29, 55, 65
7-N	Science teaching should be a matter of telling children what they are to learn.	10, 23, 43, 46, 48

과학과 과학교육에 대한 태도

과학과 과학교육에 대한 진술이 다음 4 페이지에 걸쳐 기재되어 있읍니다. 그중 어떤 것은 과학에 대한 느낌의 진술이고, 또 다른 어떤것은 과학을 어떻게 교육시켜야 되는가에 대한 것입니다. 아마도 여러분은 그중 어느것에 대하여는 찬성하실 것이고 어떤 다른 것에 대하여는 반대하실텐데 바로 그러한 여러분의 느낌을 묻는 것입니다. 이것을 통해 여러분은 과학과 과학교육에 대한 태도를 나타내게 될 것입니다.

각 진술 항목을 잘 읽으시고 찬 반을 결정하십시오.
만일 찬성하면 적극 찬성하는지 약간 찬성하는지 결정하시고, 반대하면 적극 반대하는지 약간 반대하는지 결정하십시오.
그리고는 아래 예와 같이 응답서에 표시해 주십시오.

예

	적극 찬성	약간 찬성	약간 반대	적극 반대
00. 나는 친구를 많이 갖기 원한다.	ㅁ	=	=	=

(이 예와 같이 표시한 사람은 많은 친구 갖기를 적극 찬성하는 것입니다.)

각 진술 항목마다 한 곳에만 표시해 주시고, 설문서에는 아무것도 쓰지 말아 주십시오.

과학과 과학교육에 대한 태도

1. 어린이들은 적어도 국민학교 6 학년때까지는 공기의 약 20 % 가 산소임을 알아야 한다
2. 과학의 발전을 위해서 일반인이 과학을 이해할 필요가 없다
3. 대부분의 어린이들은 적어도 국민학교 6 학년때까지는 실험을 설계할 수 있어야 한다.
4. 대부분의 사람들은 과학을 이해할 수 없다.
5. 어떤 현상이 잘 설명되면 또 다른 설명을 추구할 이유가 없다
6. 교사는 과학의 정보 전달자이기 보다는 자원인사이어야 한다.
7. 과학의 결과는 주로 과학자들에게 유용하지 일반인에게는 그렇게 유용하지 않다.
8. 나는 과학을 이해하지도 못하며 가르치기도 싫다.
9. 과학자는 자연현상을 설명할 이론을 세움에 상상력이 풍부해야 한다
10. 어떤 단계에 결국은 어린이들이 무엇을 배워야 하고 알아야 되는가를 말해주어야 할 사람은 교사이다.
11. 어떤 질문들은 과학에 의해 대답될 수 없다
12. 과학교육에서 교사는 어린이들에게 말해주는 것 보다 그들의 말을 더 들어야 한다.
13. 과학과 관계하여 무엇인가 연구할 수 있기 전에 우선은 위대한 과학자들의 저술들을 공부해야 된다.
14. 과학의 급진적 발전은 일반인의 지원이 필요하다
15. 탐구과정의 능력은 과학공부에서 함양되어야 할 중요한 목표이다.
16. 과학자들은 어떤 것도 절대로 완전하게 진리라고 믿지 않는다.
17. 과학의 중요목적은 인간이 더 편하게 살도록 돕는 것이다.
18. 하나의 새로운 이론은 그것이 다른이론과 마찬가지로 사물현상을 설명할 수 있으면 받아들여진다.
17. 어린이들은 중학교에서 과학을 잘 공부하도록 국민학교에서 얼마간의 기본사실을 배워야 한다.

- 2 -

20. 과학자들은 일반인의 지원이 필요없다. 그들은 지원 없이도 잘 해낼 수 있다.

21. 나는 과학을 이해하며 과학 가르치기를 원한다.

22. 우리는 과학의 시대에 살고 있으므로 모든 국민은 과학을 이해해야 한다

23. 어린이들에게 과학공부를 잘 시키려면 그들이 무엇을 배워야 할지 말해주어야 한다.

24. 과학은 대단히 어려워 단지 특별하게 훈련된 과학자들만이 이해할 수 있다

25. 국민학교 교사는 어린이들에게 과학의 기본적인 탐구과정을 가르칠 의무가 있다.

26. 감각은 과학자들이 지닌 가장 중요한 도구중에 한가지이다

27. 과학은 기본적으로 아이디어 개발 활동이라고 말할 수 있다.

28. 아이디어들은 과학의 보다 중요한 결과중에 하나이다.

29. 교사는 어린이들이 실험을 할 때 암시는 주어도 문제의 해답을 주어서는 안된다.

30. 과학은 이해하기 쉽다.

31. 과학의 가치는 이론적인 결과에 있다.

32. 탐구능력은 어린이들의 과학공부에서 개발되어야 할 가장 중요한 것이다.

33. 과학의 주 목적은 새 약들을 제조하고 우리의 생명을 구하는 것이다

34. 나는 과학을 좋아함으로 아마도 다른사람보다 더 훌륭한 과학교사가 될 것이다.

35. 과학은 어떻게 자연현상이 벌어지는가를 서술한다.

36. 나는 직접 실험을 할 줄 몰라 과학가르치기가 겁난다.

37. 과학자들의 연구는 정부로부터의 경제적 지원을 필요로 함으로 일반인의 과학에 대한 이해가 필요하다.

38. 나는 결코 과학을 이해하지 못할 것이다.

39. 사람들은 과학이 그들의 생활에 크게 영향을 미치므로 과학의 본성을 이해할 필요가 있다.

40. 교사는 어린이들에게 과학의 기초적인 사실들을 가르칠 의무가 있다.

41. 과학자들은 자연현상이 어떻게 해서 그런지 우리에게 정확하게 설명해 주는 법칙들을 발견한다.

42. 과학을 가르치게 되면 어떻게 가르쳐야 할런지 걱정 근심이 된다.
43. 교사는 자기가 어린이들에게 말하는 것이 무엇인가를 잘 이해하도록 시범을 자주 해 보여야 한다.
44. 과학자들은 자연현상들을 관찰함으로써 설명할 수 있다고 믿는다.
45. 과학적 법칙들은 변경될 수 없다.
46. 만일 어떤 실험이 곧 잘 안되면 교사는 어린이들이 당황하지 않게 그 해답을 말해 주어야 한다.
47. 어떤 것은 과학에 의해서 절대 진리인 것으로 밝혀졌다.
48. 교사는 어린이들이 무엇을 아는 것이 중요한지 말해 줄 의무가 있다.
49. 내가 국민학교 교사라면 어린이들에게 과학을 많이 가르치지 않겠다.
50. 과학의 중요한 목적은 인간이 보다 오래 살도록 돕는 것이다.
51. 유용한 과학적 이론은 완전히 옳지 않을 수도 있지만 그것은 과학자들이 생각해 낸 가장 좋은 아이디어이다.
52. 현대의 전기제품들이야말로 과학의 진실로 가치있는 결과의 예들이다.
53. 적어도 국민학교 6학년때까지는 어린이들이 실험에 있어서 변인들을 어떻게 조절하는지 배우는 것이 중요하다.
54. 나는 과학을 잘 가르칠 수 있다.
55. 교사는 과학교육에 있어서 어린이들이 교사의 말을 듣는 것 보다 실험을 하는데 더 시간을 보내도록 주선해야 한다.
56. 과학자들은 항상 자연현상을 더 잘 설명하려는데 관심이 있다.
57. 과학의 가치는 실제적 문제들을 해결하는데 그 유용성이 있다.
58. 나는 과학의 본성과 과학교육에 대하여 잘 이해하고 있다.
59. 대부분의 사람들은 과학을 이해할 수 있다.
60. 과학적 설명은 단지 과학자들만이 할 수 있다.

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61. 적어도 국민학교 6학년 때까지 대부분의 어린이들은 피가 산소를 세포들에게 운반 한다는 것을 알아야 한다.

62. 우리는 과학자들에게 질문하면 항상 모든 문제의 답을 얻을 수 있다.

63. 과학적 법칙들은 의심할 여지가 없게 증명된 것이다.

64. 자연현상을 관찰하는 것이 과학적 정보의 가장 중요한 원천이다.

65. 과학교육에서 교사의 한가지 중요기능은 어린이들로 하여금 문제를 확인하게 돕는 것이다.

66. 과학자들이 어떤 질문에 답할 수 없으면 그가 할 수 있는 것은 오로지 다른 과학자들에게 물어보는 것이다.

67. 우리가 알 필요가 있는 것은 무엇이나 과학을 통해 발견될 수 있다.

68. 국민학교 6학년생이면 적어도 왜 쇠가 녹스는지 알아야 한다.

69. 과학의 이론들은 계속 발전하고 있다.

70. 과학자들은 무슨 질문에나 항상 답할 수 있는 것은 아니다.

APPENDIX C

THE ATTITUDE TOWARD SCIENCE SCALE AND THE ATTITUDES TOWARD SCIENCE TEACHING SCALE

* WHAT ARE YOUR ATTITUDES TOWARD SCIENCE AND SCIENCE TEACHING? (ENGLISH VERSION)

* RESPONSE SHEET OF ATTITUDES TOWARD SCIENCE AND SCIENCE TEACHING (ENGLISH VERSION)

* WHAT ARE YOUR ATTITUDES TOWARD SCIENCE AND SCIENCE TEACHING? (KOREAN VERSION)

* RESPONSE SHEET OF ATTITUDES TOWARD SCIENCE AND SCIENCE TEACHING (KOREAN VERSION)

WHAT ARE YOUR ATTITUDES TOWARD SCIENCE AND SCIENCE TEACHING?

On the next few pages, there are some statements about science and science teaching. You may agree with some of the statements and you may disagree with others.

After you read each statement, decide whether you agree or disagree with it. Find the space on the response sheet that coincides with your opinion or feeling and blacken one for each statement.

Example:

	Strongly Agree	Agree	Disagree	Strongly Disagree
1. Elementary school curricula should contain health education subjects.	==	==	==	==
2. Everyone should have only one small meal a day for the best diet.	==	==	==	==

On the second part, there are some questions about your background. These are for the purpose of studying tendencies of the attitudes toward science and science teaching as a whole. Individual background will be held in confidence.

Please do not mark in the statements booklet. Return it with your response sheet when you finish.

What Are Your Opinions And How Do You Feel About Science?

S 1. We should continue to develop science.

2. Scientists can provide the correct answers to any questions.

3. Human beings might be better off without the advance of science.

4. Science strongly influences our ways of thinking.

5. Scientific knowledge is trivial.

6. Artistic men could not be good scientists.

7. Scientific approaches can be applied under certain conditions.

8. Scientists work hard to earn a better salary.

9. Scientific inquiry makes limited explanations of natural phenomena.

10. Scientific research should be a valuable activity of mankind.

11. Reading articles on science in newspapers is enjoyable.

12. The public should not comment about science research.

13. Working in a job requiring scientific knowledge should be very interesting.

14. Obtaining evidence should be an important factor in science.

15. The scientific method can deal with any issues of mankind.

16. Science activities are matters only for scientists.

17. Scientists work in dull and uninteresting laboratories.

18. Science expresses only one view of nature.

19. Scientific laws have limitations.

20. The first important goal of science is to produce a better material life.

21. The progress of science reduces us to poverty in our spiritual life.

22. Willingness to alter one's position on the basis of sufficient evidence is an attitude of scientists.

23. National policy strongly influences scientists' work.

S24. Knowledge of science consists of absolute truths which have been proven by experiment.

25. Men who believe in God cannot be good scientists.

26. Even though scientific knowledge has increased rapidly, it contains elements that are subject to change.

27. The job of a scientist should be to follow the fixed steps of a scientific method.

28. Being a scientist should be a very rewarding way of life.

29. Science is a continuing inquiry of humans to understand natural phenomena.

30. The application of science has been changing our lives.

31. We should not support the work of scientists.

32. Man cannot understand the secrets of nature.

33. Women cannot be good scientists.

34. The important scientific theories have been constructed entirely by modern scientists.

35. There are both positive and negative aspects to the mutual influences of science and society.

36. There is only one scientific method.

37. Scientists should wisely control the variables in an experiment.

38. It would be challenging to study science.

39. Scientists are mainly responsible for pollution.

40. We can gradually understand nature better by progress made in science.

What Are Your Opinions And How Do You Feel About Science Teaching?

T 1. Students should be involved in inquiry activities more than in listening to teachers talk.

2. Teaching science does not contribute to modernization of a country.

3. Jobs related to science education are valuable.

T4. Science teaching is useful only for excellent students who will become scientists.

5. Once a text is selected for a science course, the content of teaching should be limited to the book.

6. The selected basic concepts in a science curriculum should be structured to be related meaningfully to each other.

7. We should recognize the importance of good science teaching in the elementary school.

8. If any kind of new theory is announced by a scientist, it should be discussed immediately in elementary school text-books.

9. Inquiry process skills are important objectives of science teaching in general education.

10. Excellent students should become scientists, but inferior ones are good enough to become science educators.

11. The main activity of school science should be to study many techniques of using machines for daily life.

12. Learning science contributes to the intellectual development of children.

13. Science education students should take pride in their major field.

14. Teaching science is easy work.

15. Secondary school science curricula should be constructed to have articulation with elementary science rather than preparation of college study.

16. More complete knowledge of science automatically makes a science teacher more effective.

17. Science educators are as important as scientists.

18. Development of scientific attitudes should be one of the important values of education.

19. The criteria of good science teaching should be judged by the passing ratio on entrance examinations for higher level schools.

20. It is important for students to understand the basic concepts of science.

T21. Science teaching in the secondary school should be for the students who will continue to study at the colleges of natural sciences.

22. There should be no need to establish a separate department of science education.

23. Science teachers should direct with authority what the students must do in the study of science.

24. Teaching science is enjoyable.

25. Science teaching should be guided by considering the level of intellectual development of the students.

26. Use of audio-visual materials is a waste of time in teaching science.

27. A science teacher should ask more meaningful questions instead of merely giving simple information.

28. Learning science does not contribute to our individual lives.

29. The content of science courses should be selected to produce intellectual pleasure.

30. Science teachers should not be scientists.

31. Science teachers should take the role of resource persons facilitating learning.

32. Students' discussion is a waste of time in learning science.

33. Students should not strive to become science educators because science education has little worth.

34. The learning sequence of a science course should follow the same order in a selected textbook.

35. Science teaching in the secondary school contributes to the progress of science.

36. General education in science should contribute to breaking down the superstitious beliefs of laymen.

37. Science teaching at the elementary school level should aim at the scientific literacy of the students.

38. There is no professional status in science education.

39. Teaching science to girls is entirely useless.

40. Doctoral programs of science education should be established at our universities.

Background Information of Respondent

R1. Sex distinction

a. male

b. female

2. Grade

a. freshman

b. sophomore

c. junior

d. senior

e. graduate or teacher

3. Specialty or major

a. physics or physics education

b. chemistry or chemistry education

c. biology or biology education

d. earth science or earth science education

e. math, math education, elementary or junior high education

4. Birth-place

a. a large city

b. a small city

c. a factory village

d. a fishing village

e. a farm village

5. Location of attended high school

a. a large city

b. a small city

c. a factory village

d. a fishing village

e. a farm village

6. Religion

a. Buddhism

b. Confucianism

c. Christianity

d. Other religion

e. No religion

7. Army service

a. finished before college

b. finished during first two years of college

c. finished during last two years of college

d. finished after college

e. not finished or not relevant

8. When I entered college, I had

a. the intention to become an educator

b. the intention to become a scientist

c. a dual intention to become either an educator or scientist, or both

d. no intention to become an educator or a scientist

e. no special intention

9. If I self-estimate my academic achievement of college study as a whole, I am (was)

   a. an A level student

   b. a B level student

   c. a C level student

   d. a D level student

   e. an E level student

10. Name of attending (attended) college and university.

11. Name

RESPONSE SHEET OF ATTITUDES TOWARD SCIENCE AND SCIENCE TEACHING

Toward Science (S)

	SA	A	D	SD
S 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	==	==	==	==

Toward Science Teaching (T)

	SA	A	D	SD
T 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	==	==	==	==

Background of Respondent (R)

	a	b	c	d	e
R 1	==	==	==	==	==
2	==	==	==	==	==
3	==	==	==	==	==
4	==	==	==	==	==
5	==	==	==	==	==
6	==	==	==	==	==
7	==	==	==	==	==
8	==	==	==	==	==
9	==	==	==	==	==

10 ____________________

11 ____________________

Abbr.
- SA : Strongly Agree
- A : Agree
- D : Disagree
- SD : Strongly Disagree

과학과 과학교육에 대한 설문서

과학과 과학교육에 대한 진술항목이 다음 2페이지에 걸쳐 기재되어 있읍니다. 아마도 여러분은 그중 어떤 진술항목에 대하여는 찬성을 하실 것이고 또 다른 어떤 것에 대하여는 반대하실텐데, 이 설문서는 바로 그러한 여러분의 의견 또는 느낌을 답해 주실 것을 요청하는 것입니다.

각 항목을 읽으시고 그 진술에 대하여 찬성하시는지 또는 반대하시는지를 응답서의 적합한 칸을 아래 예와 같이 표시해 주십시오.

〈예〉

1. 국민학교 교육과정에 국어과목이 반드시 포함되어야 한다.
2. 날씬한 몸매를 위해 하루에 한끼만 조금 먹어야 한다.

	적극 찬성	찬성	반대	적극 반대
1	▭	=	=	=
2	=	=	=	▭

끝 부분에는 설문 응답자의 배경사항을 묻는 항목이 있는데, 이것은 일반적인 경향을 연구하는 자료로서만 사용될 것입니다.

본 진술서에는 아무것도 쓰지 말아주시고 다 끝나시면 응답서와 함께 설문서도 꼭 제출해 주시기 바랍니다.

과학*에 대한 의견과 느낌

(*여기서 과학은 기초자연과학을 뜻함)

S 1. 우리는 과학을 계속 발전시켜야 한다.
2. 과학자들은 무슨 질문에도 옳은 답을 제공해 줄 수 있다.
3. 인간은 과학의 발전이 없었으면 더욱 행복했을 것이다.
4. 과학은 인간의 사고방식에 크게 영향을 미친다.
5. 과학은 보잘 것 없는 것이다.
6. 예술적인 사람은 훌륭한 과학자가 될 수 없다.
7. 과학적 방법은 일정한 조건하에서 적용될 수 있다.
8. 과학자들은 더 많은 보수를 받기 위해서 열심히 일한다.
9. 과학은 자연현상을 일정한 한계 내에서 설명한다.
10. 과학을 연구하는 것은 인간의 가치있는 일이다.
11. 신문에 보도된 과학 관계기사는 흥미있다.
12. 우리 나라에서는 과학연구를 지지할 처지가 못된다.
13. 과학지식을 필요로 하는 직업은 흥미롭다.
14. 증거를 찾는 것은 과학활동의 한가지 중요한 요인이다.
15. 과학자들은 인간의 모든 문제를 해결할 수 있다.
16. 과학활동은 단지 과학자들만의 일이다.
17. 과학자들은 지리하게 재미없는 실험실에서 일을 한다.
18. 과학은 인간이 자연을 보는 유일한 방법이 아니다.
19. 과학적 법칙은 한계를 지니고 있다.
20. 과학의 첫째 목적은 편리한 생활품을 생산하는데 있다.
21. 과학의 발전은 인간의 정신생활에 빈곤을 초래한다.
22. 충분한 근거하에서는 자기의 견해를 바꿀 용의를 갖는 것이 과학자의 태도이다.
23. 국가정책은 과학자들의 일에 크게 영향을 미친다.
24. 과학의 지식은 실험적으로 증명된 절대 진리이다.
25. 하느님을 믿는 자는 훌륭한 과학자 일 수 없다.
26. 과학지식은 근래에 급격히 증가하였으나 그것은 변경될 수 있는 조건을 지니고 있다.
27. 과학자의 연구활동은 일정한 형식단계를 따르는 기계적인 일이다.
28. 과학자로서의 생애는 매우 보람있는 것이다.
29. 과학은 자연현상을 이해하려는 인간의 계속적인 탐구과정이다.
30. 과학의 응용은 우리의 생활을 크게 변화시킨다.
31. 우리는 과학자들의 일을 지원해서는 안된다.
32. 인간은 자연의 신비를 이해할 수 없다.
33. 여자는 훌륭한 과학자가 될 수 없다.
34. 중요한 과학이론들은 현대과학자들에 의해 모두 밝혀졌다.
35. 과학과 사회의 상호 영향에는 좋고 나쁜 두 국면이 있다.
36. 과학적 방법은 단 한가지 고정되어 있다.
37. 과학자들은 실험에 있어서 변인(變因)들을 현명하게 조절해야 한다.
38. 과학은 공부할 만 하다.
39. 공해는 주로 과학자들에게 책임이 있다.
40. 우리는 과학이 발전함에 따라 점점 더 자연을 이해하게 된다.

과학교육에 대한 의견과 느낌

T 1. 학생들은 교사의 설명만을 듣는 것보다 탐구활동에 더 직접 참가해야 한다.
2. 과학교육은 국가 현대화에 공헌하지 못한다.
3. 과학교육과 관게된 직업은 가치있는 일이다.
4. 과학교육은 과학자가 될 우수한 학생들에게만 유용하다.
5. 과학교육 내용은 선택한 교과서에 국한해야 한다.
6. 과학교육과정에 있어서 선택된 기본개념들은 서로 의미있게 구조화되어야 한다.
7. 국민학교에서도 과학교육을 잘 시켜야 한다.
8. 과학자들이 어떤 이론이든 새로운 것을 발표하면, 그 내용을 곧 국민학교 교과서에 포함시켜야 한다.
9. 탐구과정의 능력 배양은 인반과학교육의 한가지 중요한 목표이다.
10. 탁월한 학생들은 과학자가 되어야 하고 열등한 학생들은 과학교육자가 되어도 충분하다.
11. 학교 과학교육의 중요활동은 일상생활에 필요한 기계들의 사용기술을 습득하는 것이라야 한다.
12. 과학학습은 어린이의 지적 발달에 공헌한다.
13. 과학교육 전공학생들은 자기전공에 긍지를 가져야 한다.
14. 과학을 가르치는 것은 쉬운 일이다.
15. 중등 과학교육과정은 대학보다 국민학교 과학교육과 관련지워 구성해야 한다.
16. 과학교사는 과학지식만 많으면 많을수록 더 효과적으로 가르친다.
17. 과학교육자들은 과학자들과 마찬가지로 중요하다.
18. 과학적 태도의 함양은 일반교육의 중요한 가치 중의 한 가지이다.
19. 과학교육의 성과는 상급학교 진학률로 판단되어야 한다.
20. 학생들은 여러 정보만 듣는 것보다 기본개념을 이해하는 것이 중요하다.
21. 중등과학교육은 이공대학에 진학할 학생들을 위한 것이라야 한다.
22. 대학교에 따로이 과학교육과를 설치할 필요가 없다.
23. 과학교사는 학생들이 과학공부에 있어서 무엇을 해야만 하는지 권위를 가지고 지시해야 한다.
24. 과학을 가르치는 것은 보람있는 일이다.
25. 과학교육은 학생들의 지적 발달수준을 고려해서 지도해야 한다.
26. 과학교육에서 시청각자료를 사용하는 것은 시간낭비이다.
27. 과학교사는 단순히 지식을 설명해 주는 것보다 의미있는 질문을 더 잘해야 한다.
28. 과학학습은 우리 일상생활에 아무런 도움이 되지 않는다.
29. 과학과목의 내용은 학생들의 지적 흥미를 돋구도록 선택해야 한다.
30. 과학교사는 과학자도 아니고 교육자도 아니다.
31. 과학교사는 학습을 안내하는 자원인사의 역할을 해야 한다.
32. 과학공부에 있어서 학생들끼리 토의하는 것은 시간낭비이다.
33. 과학교육 관계직업은 권장할만한 것이 못된다.
34. 과학학습내용의 계열은 선택한 교과서의 순서만을 따르는 것이라야 한다.
35. 중등 과학교육은 과학발전에 공헌한다.
36. 교양과학교육은 일반인의 미신행위를 근절하는데 도움이 된다.
37. 국민학교 과학교육은 온국민의 과학교양을 목적으로 해야 한다.
38. 과학교육에는 전문성이 없다.
39. 여학생들에게 과학을 가르치는 것은 전혀 쓸데 없는 일이다.
40. 과학교육의 박사학위 과정이 우리나라 대학교에도 설정되어야 한다.

응답자의 배경사항

R 1. 성 별
- a. 남
- b. 여

2. 대학 학년
- a. 1학년생
- b. 2학년생
- c. 3학년생
- d. 4학년생
- e. 대학원생 또는 교사

3. 전공(계열별 학생은 앞으로 전공하려는 것)
- a. 물리학, 응용물리학, 물리학교육
- b. 화학, 응용화학, 화학교육
- c. 생물학, 응용생물학, 생물학교육
- d. 기상학, 지질학, 천문학, 해양학, 또는 지구과학교육
- e. 수학, 수학교육, 초등교육 등 기타

4. 출생지
- a. 큰 도시
- b. 작은 도시
- c. 공장지대
- d. 어촌
- e. 농촌

5. 출신 고등학교의 위치
- a. 큰 도시
- b. 작은 도시
- c. 공장지대
- d. 어촌
- e. 농촌

6. 종 교
- a. 불교
- b. 유교
- c. 기독교
- d. 기타 종교
- e. 무종교

7. 군복무
- a. 대학입학전 완수
- b. 대학 1, 2학년중 완수
- c. 대학 3, 4학년중 완수
- d. 대학졸업후 완수
- e. 미필 또는 해당안됨

8. 대학에 입학했을 당시, 소망했던 직업은
- a. 교육자
- b. 과학자
- c. 교육자나 과학자 또는 그 이중직
- d. 교육자와 과학자 이외의 직업
- e. 확실하지 않았음

9. 나의 대학 성적을 평균해서 어림해 보면, 나는
- a. A급학생
- b. B급학생
- c. C급학생
- d. D급학생
- e. E급학생

10. 다니는(졸업한) 대학명

11. 이름

과학과 과학교육에 대한 응답서

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응답자 배경사항(R)

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APPENDIX D

RESPONSE CHOICE DISTRIBUTIONS (%) AND ITEM PARAMETERS

* RESPONSE CHOICE DISTRIBUTIONS (%) AND ITEM PARAMETERS OF THE AS SCALE

* RESPONSE CHOICE DISTRIBUTIONS (%) AND ITEM PARAMETERS OF THE AT SCALE

RESPONSE CHOICE DISTRIBUTIONS (%) AND ITEM PARAMETERS OF THE AS SCALE

Item	Scale	SA	A	D	SD	Mean	Sigma	r(Total)	r(Scale)
1	1P	69	28	2	1	4.63	0.66	0.35	0.48
2	3N	2	18	69	10	3.68	0.95	0.14	0.45
3	1N	3	18	60	19	3.75	1.05	0.37	0.54
4	4P	35	58	5	2	4.20	0.80	0.37	0.45
5	2N	1	2	38	59	4.52	0.70	0.42	0.29
6	5N	2	12	58	28	3.98	0.98	0.30	0.43
7	3P	12	67	19	3	3.67	1.00	0.11	0.42
8	1N	2	15	61	22	3.85	1.00	0.28	0.45
9	3P	11	60	24	5	3.49	1.11	0.11	0.45
10	1P	41	54	4	1	4.29	0.76	0.49	0.59
11	5P	21	61	15	2	3.84	1.00	0.36	0.52
12	4N	2	7	46	45	4.26	0.90	0.40	0.52
13	5P	21	65	12	1	3.92	0.91	0.41	0.57
14	1P	28	65	5	2	4.13	0.79	0.33	0.42
15	3N	1	7	60	32	4.15	0.83	0.14	0.44
16	4N	1	3	60	37	4.29	0.68	0.39	0.41
17	5N	2	12	61	24	3.94	0.96	0.45	0.52
18	2P	18	66	13	3	3.82	0.98	0.12	0.41
19	2P	14	59	21	6	3.54	1.15	0.14	0.39
20	1N	4	26	56	14	3.51	1.13	0.24	0.45
21	4N	7	29	45	19	3.40	1.27	0.36	0.49
22	3P	39	53	7	2	4.20	0.88	0.33	0.42
23	4P	15	61	20	3	3.64	1.07	0.23	0.44

Item	Scale	SA	A	D	SD	Mean	Sigma	r(Total)	r(Scale)
24	2N	6	24	57	13	3.48	1.15	0.15	0.42
25	5N	3	7	51	39	4.15	0.97	0.33	0.44
26	2P	21	69	8	2	3.98	0.84	0.27	0.40
27	3N	2	22	61	15	3.65	1.04	0.30	0.36
28	5P	30	59	9	1	4.07	0.89	0.43	0.55
29	1P	46	51	3	1	4.38	0.70	0.47	0.51
30	4P	37	59	3	1	4.27	0.73	0.41	0.49
31	1N	1	2	36	61	4.53	0.71	0.52	0.53
32	2N	4	15	52	28	3.85	1.11	0.34	0.42
33	5N	4	4	33	58	4.38	0.99	0.27	0.42
34	2N	2	14	64	20	3.86	0.96	0.24	0.39
35	4P	22	67	9	2	3.99	0.85	0.15	0.26
36	3N	1	6	64	28	4.13	0.79	0.38	0.37
37	3P	20	71	7	1	4.02	0.77	0.33	0.36
38	5P	30	66	3	1	4.21	0.67	0.46	0.53
39	4N	2	10	56	32	4.04	0.96	0.29	0.42
40	2P	25	54	18	3	3.79	1.10	0.31	0.32

RESPONSE CHOICE DISTRIBUTIONS (%) AND ITEM PARAMETERS OF THE AT SCALE

Item	Scale	SA	A	D	SD	Mean	Sigma	r(Total)	r(Scale)
1	3P	58	39	3	0	4.51	0.68	0.35	0.38
2	4N	1	2	51	47	4.41	0.64	0.47	0.51
3	5P	20	72	6	1	4.04	0.74	0.42	0.54
4	1N	3	7	58	32	4.09	0.92	0.35	0.52
5	2N	1	3	52	43	4.33	0.74	0.40	0.45
6	2P	36	62	2	1	4.30	0.62	0.45	0.45
7	4P	48	47	3	1	4.39	0.73	0.47	0.48
8	2N	4	14	66	17	3.77	1.00	0.17	0.40
9	1P	38	58	2	1	4.31	0.69	0.45	0.47
10	5N	2	10	45	43	4.16	1.01	0.29	0.44
11	2N	4	25	57	13	3.50	1.12	0.21	0.44
12	1P	34	61	4	1	4.25	0.70	0.45	0.49
13	5P	47	49	3	1	4.37	0.74	0.55	0.61
14	5N	2	7	71	20	3.99	0.81	0.25	0.38
15	2P	13	45	38	4	3.24	1.20	0.14	0.38
16	3N	4	16	64	16	3.74	1.03	0.21	0.42
17	5P	43	53	3	1	4.35	0.70	0.52	0.58
18	1P	38	59	3	1	4.30	0.67	0.51	0.52
19	1N	3	7	57	33	4.11	0.91	0.41	0.50
20	2P	42	50	7	1	4.25	0.85	0.38	0.47
21	1N	2	6	66	25	4.07	0.83	0.41	0.51
22	4N	3	10	51	36	4.06	1.02	0.40	0.52
23	3N	12	43	37	8	2.84	1.25	0.08	0.39

Item	Scale	SA	A	D	SD	Mean	Sigma	r(Total)	r(Scale)
24	5P	29	66	3	1	4.19	0.68	0.51	0.58
25	3P	26	68	5	1	4.13	0.73	0.46	0.46
26	3N	1	2	44	53	4.45	0.73	0.56	0.53
27	3P	27	65	7	1	4.09	0.79	0.39	0.48
28	4N	1	3	45	51	4.43	0.72	0.57	0.55
29	2P	27	66	7	1	4.11	0.77	0.37	0.39
30	5N	2	5	52	41	4.25	0.84	0.46	0.58
31	3P	15	67	15	3	3.78	0.97	0.31	0.46
32	3N	1	4	48	47	4.35	0.79	0.56	0.55
33	5N	1	4	58	36	4.24	0.75	0.48	0.54
34	2N	1	6	69	23	4.06	0.78	0.43	0.44
35	4P	14	63	20	2	3.65	1.02	0.34	0.52
36	4P	6	59	30	4	3.35	1.09	0.19	0.41
37	1P	21	63	14	1	3.89	0.94	0.23	0.42
38	4N	2	16	54	27	3.88	1.05	0.37	0.52
39	1N	3	3	32	62	4.46	0.89	0.39	0.50
40	4P	49	42	6	3	4.30	0.94	0.37	0.49

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