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ABSTRACT

Dimensions of scientific literacy with regard to a theoretical definition were inferred for a group of science oriented persons, a group of nonscience oriented persons, and the two groups combined. Comparisons of the strength of agreement of the two groups, and of subgroups of the two groups, with the inferred dimensions were made. The sample consisted of five subgroups comprised of 37 university pure science, 38 university applied science, 75 university nonscience, 100 public science, and 100 public nonscience persons. A theoretical model of scientific literacy was developed and used to develop a 45 statement Q-set. Each person was asked to sort the Q-set in terms of "What should be expected of most high school graduates with regard to science?" A forced sort, five cards per nine piles, was required, representing a continuum from +4, MOST IMPORTANT, to -4, LEAST IMPORTANT. A questionnaire was administered to collect predictor variable data. Relationships between the inferred dimensions and the predictor variables, (a) educational level, (b) amount of science education, (c) educational level of parents, (d) age, and (e) sex, were investigated. It was found, among other things, that membership in subgroups was more related to respondents' perception of scientific literacy than was membership in the two groups; and, in general, that an inverse relationship existed between educational level and valuing of inferred dimensions. (Author/SH)

THE DEVELOPMENT OF A MODEL TO DETERMINE PERCEPTIONS OF SCIENTIFIC LITERACY

By

Lawrence Lee Gabel, Ph.D.

The Ohio State University, 1976

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One purpose for teaching science is to provide an aspect of an individual's general education which will promote effective citizenship. This has been described as educating for a scientifically literate citizenry.

This study sought to infer dimensions of scientific literacy with regard to a theoretical definition for a group of science oriented persons, for a group of nonscience oriented persons, and for the two groups combined. Comparisons of the strength of agreement of the two orientation groups, and of subgroups of the two groups, with the inferred dimensions were made. Relationships between the inferred dimensions and the predictor variables (a) educational level, (b) amount of science education, (c) educational level of parents, (d) age, and (e) sex were investigated.

A Theoretical Model of Scientific Literacy was developed and used to develop a 45 statement Q-set, the Scientific Literacy Q-set (SLQ). A questionnaire, the INFORMATION SHEET (IS) was developed to collect predictor variable data. Both instruments were piloted and refined until they were at an eighth grade reading level. Pearson's r was used to calculate intercorrelation coefficients after the SLQ was sorted in a test-retest situation; the average coefficient was 0.49.

The sample consisted of five subgroups. There were thirty-seven university pure science persons, thirty-eight university applied science persons, seventy-five university nonscience persons, one hundred public science persons, and one hundred public nonscience persons. These persons were randomly selected from The Ohio State University faculty and from Franklin County, Ohio residents.

The SLQ, the IS, and ancillary materials were mailed without prior consent to the selected persons. The instructions asked them to sort the SLQ in terms of "What should be expected of most high school graduates with regard to science?" A forced sort, five cards per nine piles, was required. The nine piles represented a continuum from +4 MOST IMPORTANT to -4 LEAST IMPORTANT. It was determined that forty persons did not receive the materials; 185 persons responded producing a 60% response.

Descriptive statistics, correlations, factor analysis, analysis of variance, and regression analysis were used to analyze the data and/or test the null hypotheses. Seven inferred dimensions of scientific literacy were developed. I. Scientific Inquiry - producing new knowledge through a synthesizing activity. II. Maintaining Current Awareness - valuing people keeping abreast of new developments in science and technology. III. Valuing Methods of Science - valuing methods which scientists use in their work. IV. Personal Application of Science - applying scientific knowledge and methods of science in daily lives. V. Distinguishing Between Science and Technology - making the distinction in terms of goals and results, also understanding how science and technology affect each other. VI. Utilizing Factual Knowledge - knowing and using factual knowledge about nature. VII. Mutual Involvement of Science and Society - science providing mankind with new capabilities, also society providing supportive conditions for science.

In addition to the inferred dimensions of scientific literacy several generalizations were developed from the data analysis results. Membership in subgroups was more related to respondents' perceptions of scientific literacy than was membership in the two orientation groups. The subgroups valued the inferred dimensions differently. Individual characteristics of respondents were related to their perceptions of scientific literacy. Sex and age were weakly related usually in combination with other variables. In general an inverse relationship existed between respondents' educational levels and their valuing of the inferred dimensions. Also, respondents with lower educational levels whose parents had lower educational levels tended to value more practical aspects of the inferred dimensions. Science courses which respondents had taken were related to their perceptions of scientific literacy. In particular, high school science courses which the public nonscience respondents had studied were positively related to their perceptions of scientific literacy.

THE DEVELOPMENT OF A MODEL TO DETERMINE PERCEPTIONS OF SCIENTIFIC LITERACY

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

By

Lawrence Lee Gabel, B.S., M.S.

* * * * *

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CHAPTER I

INTRODUCTION

Need for the Study

Science in the Curriculum

Fundamental determinants of educational directions, sometimes called the historical forces behind education, are usually cited to be economic, political, social, and religious by nature. Perkinson (1968) examined a century of education in the United States between the years of 1865 and 1965 and succinctly demonstrated how education has been an imperfect panacea in dealing with these forces. Rapid changes during the Twentieth Century have wrought upon the schools even more forces. Fox (1969, chapter 2) argued that science and technology have come to be additional determining forces of educational directions.

Concern for the inclusion of science in the education of youth has been recognized for many years. In the mid 1700's science was taught in the form of "natural history" and "natural philosophy." It was hoped that children would gain a better understanding of God and would cling to elevated moral horizons. Still a century later "God was explained by science and science by God." (Pella, 1967, p. 347)

During the 1900's science has been taught for varying reasons. It has been a means of training the mind, of bettering society, and of bettering the whole individual. During the Fifties and Sixties, science was taught in a discipline-centered fashion; the intention was to emphasize the organization and methods of science. The curricula which were developed toward this end have come to be labeled the ABC curricula. At the senior high level physics was the thrust of the Physical Science Study Committee (PSSC) and Harvard Project Physics (HPP); chemistry was the thrust of the Chemical Bond Approach (CBA) and the Chemical Education Materials Study (CHEMS); and biology was the thrust of the Biological Sciences Curriculum Study (BSCS). At the junior high level Introductory Physical Science (IPS) emphasized chemistry and physics, and the Earth Science Curriculum Project (ESCP) emphasized the earth sciences.

The above mentioned discipline curricula and others recently developed have been for the most part accepted as strong, positive developments by science educators. However, not all students experience all or any of these in their classes. Schlessinger, et al., (1973, p. 147) indicated that the ABC curricula were on the average being used in approximately fifty percent of the nation's schools. Furthermore:

> ...for about three fourths of all school children, their secondary school instruction in science includes no more than two years at the junior high school level and probably a 10th grade course in biology; probably fewer than 25 percent of all 18-year olds have studied chemistry, and no more than one in a dozen has taken a course called physics. (Belasco, 1970, p. 19)

As science has been taught in the schools for various reasons so too has the curriculum changed. New content has been added; some has been deleted. On the whole, "The gradual process of curriculum change...(has) tended to reflect the relatively gradual evolution of society itself." (Goodlad, 1966, p. 9) Presently, it seems science is taught in the schools for three basic reasons:

(1) to prepare future scholars for the different disciplines of science;

(2) to help individuals attain the necessary backgrounds for entry into technological occupations and professions; and

(3) to provide an aspect of the individual's general education which will promote effective citizenship.

(Clem, 1950; Baily, 1957; Hurd, 1958; Behnke, 1960; Kusch, 1960; Waterman, 1960; Ubel, 1961; Weaver, 1962; Johnson, 1962; Evans, 1962; Wittlin, 1963; Shamos, 1963; Pella, 1966; Korth, 1969; Broudy, 1972; Agin, 1974)

For more than a decade scientists and other intellectuals have generally cited the need for scientifically literate citizens. Science educators have been specific in clarifying this need. In a society that is scientifically and technologically oriented all people should be broadly educated in science, including its products, its processes, its philosophy, and its impact on society. (NSTA, 1964; Pella, 1967; Klopfer, 1969; Richardson and Showalter, 1969; Andrews, 1970; Belasco, 1970; Evans, 1970; NSTA, 1971; Agin, 1974) "The single most important goal of school science must be to prepare scientifically literate citizens for the future." (Gatewood, 1968, p. 20) Hurd (1970, p. 14) claimed "The broad goal of science teaching ought to foster the emergence of an enlightened citizenry, capable of using the intellectual resources of science to create a favorable environment that will promote the development of man as a human being."

However, to forestall any belief that the argument for education to include science for all individuals has occurred only recently, one should heed a statement attributed to Benjamin Franklin by Agin (1974, p. 404). Writing in 1749, Franklin stated:

> With the History of Men, Times, and Nations, should be read at proper Hours and Days, some of the best "Histories of Nature," which would not only be delightful to Youth; ...but afterwards of a great use to them, whether they are Merchants, Handicrafts, or Divines; enabling the first the better to understand Commodities, Drugs, etc., the second to improve his Trade of Handicraft by new Mixtures, Materials, etc., and the last to adorn his Discourses by new Proofs of Divine Providence.

Schilling (1959, chapter 5) analyzed the essence of science. He saw science as: (1) a Body of Organized Knowledge, (2) a Way of Knowing, (3) an Area of Experience, (4) a Foundation of Technology, (5) an Intellectual and Moral Influence, and (6) a Social Enterprise. Fox (1969) and Hurd (1970) suggested that emphasis in science education during the last two decades has been on science as a "Body of Organized Knowledge" (product) and science as a "Way of Knowing" (process). Separately, both Fox and Hurd emphasized the need to concentrate on the other aspects of science because the science courses are leaving youth unable to cope with the demands and problems of a science-oriented society. Hurd believed "The majority of adults are unaware of or are misinformed about the meaning of science and its influences on the material, social, and intellectual life of our time....they have little insight into the meaning of problems which plague mankind today..." (Hurd, 1970, p. 13)

O'Hearn (1975) illuminated the point that Fox and Hurd made.

> Non-rigorous examination shows that most texts are deficient in social and cultural implications with varying degrees of coverage of the processes of science and the nature of science. It is clear that in some courses, reference to technological applications and social implications, and applications of scientific knowledge have been systematically avoided or reduced. There is evidence that much work needs to be done if high school graduates are to be literate in science.

Scientific Literacy--What Does It Mean?

In the early Sixties Robert Carleton, (at that time the executive secretary of the National Science Teachers Association, NSTA) asked some of the nation's scientists and science educators, "What does it mean to be scientifically literate?" (Carleton, 1963, p. 33) The responses suggested that a person is scientifically literate if he understands the processes of science and if he is aware of the accomplishments of several of the science disciplines. The statement by Hugh Odeshaw (at that time the executive director of the Space Science Board of the National Academy of Science) was representative of the various replies to Carleton's query. "Scientific literacy can be defined as comfortable familiarity with the development, methodology, achievements, and problems of the principal scientific disciplines."

By the mid Sixties scientific literacy had come to be defined more broadly. Haney (1966, p. 24) in a prepared statement for the Association for Supervision and Curriculum Development of the National Education Association stated that scientific literacy had six dimensions.

1. The pupil should acquire knowledge which he can use to explain, predict, and control natural phenomena.

2. The pupil should grow in his ability to engage in the processes of science and to apply these processes in appropriate situations as he confronts them in his daily life.

3. The pupil should acquire the attitudes of scientists and learn to apply these attitudes appropriately in his daily experiences.

4. The pupil should come to understand the various interrelationships between science and society.

5. The pupil should learn numerous useful manipulative skills through the study of science.

6. The pupil should acquire a variety of interests that may lead to hobbies and possibly to a vocation.

This statement introduced scientific attitudes and interrelationships between science and society as important aspects of scientific literacy. It also suggested that the person who is gaining scientific literacy will find personal pleasure and enjoyment through involvement in science related activities.

In the early Seventies a Committee on Curriculum Studies for the NSTA stated that the development of scientific literacy should be viewed as a continuum. The end result of this continuum would be a scientifically literate person who:

1. uses science concepts, process skills, and values in making everyday decisions as he interacts with his environment

2. understands that the generation of scientific knowledge depends upon the inquiry process and upon conceptual theories

3. distinguishes between scientific evidence and personal opinion

4. identifies the relationship between facts and theory

5. recognizes the limitations as well as the usefulness of science and technology in advancing human welfare

6. understands the interrelationships between science, technology, and other facets of society including social and economic developments

7. recognizes the human origin of science and understands that scientific knowledge is tentative, subject to change as evidence accumulates

8. has sufficient knowledge and experience so that he can appreciate the scientific work carried out by others

9. has a richer and more exciting view of the world as a result of his science education

10. has adopted values similar to those which underlie science so that he can use and enjoy science for its intellectual stimulation, its elegance of explanation, and its excitement of inquiry

11. continues to inquire and increase his scientific knowledge throughout his life (NSTA, 1971, pp. 47-48)

This statement was much more comprehensive than previous statements. It, like the others, emphasized products and processes of science. However, the need to perceive the interrelationships between science and society is explicated to include technological, social, and economic developments. This statement exceeded the others and implied a need for the scientifically literate person to understand and be familiar with the "nature of science."

Several definitions of scientific literacy have been offered during the last quarter of a century. Within this time frame the definitions have differed considerably in content and comprehensiveness. (Carleton, 1963; Pella, 1967; Klopfer, 1969; Daugs, 1970; Evans, 1970; Hurd, 1970; Agin, 1974; Showalter, 1974) One would be hard pressed to find that any one of the definitions was developed as a result of intellectual input from many people with varying backgrounds and interests. It appears that at no time has any segment of the general public been asked to respond to the various definitions of scientific literacy. Stated in another way, individuals have not been asked to specify what they believe is important, or not important, with regard to elements of the dimensions of scientific literacy. "Many individuals use the term 'scientific literacy' but fail to give it an adequate meaning; they assume that everyone knows what the concept means." (Agin, 1974, p. 405) By asking people from all walks of life to indicate what they value the most, or the least, with regard to specific elements of scientific literacy, a starting point could be established for giving meaning to the term scientific literacy.

<u>Scientific Literacy--Is It Instrumented?</u>

As concerned writers have expressed a need for a scientifically literate citizenry, attempts have been made to assess levels of scientific literacy. These fall into two broad types of assessment. First, researchers have been interested in only one particular aspect of scientific literacy. Second, researchers have tried to assess levels of scientific literacy by using a battery of instruments or one instrument that covers several aspects.

Figure 1 indicates some of the particular aspects of scientific literacy that have been a concern to various researchers. It is not comprehensive but is indicative of this type of assessment.

Other investigators have attempted to measure several aspects of scientific literacy in their research. Leake and Hinerman (1973) used the Science Forms 4A, 3A, 2A and 1A of the Sequential Tests of Educational Progress and the Wisconsin Inventory of Science Processes to measure comprehension, reasoning abilities, and process skills in science of high school seniors. Gallagher (1969) described the use of eight tests to measure eight different aspects of scientific literacy of graduating seniors in the Test Every Senior Project.

Richardson and Showalter (1969) sought to measure the effects of a unified science curriculum on high school graduates by developing the Abridged Scientific Literacy Instrument around three of the six general objectives of Haney's list (see pages 6-7). The three they chose were numbers 3, 4, and 6. They recognized that scientific literacy is a

School Level	Interrelationships of Science and Society	Process of Science	Nature of Science	Scientific Values	Attitudes Toward Science	Scientific Attitudes
Junior High		Tannebaum (1971)	Wachs (1966) Thomas (1968) Mackay (1971)		Champlin (1970)	Moore (1971)
Senior High	Keith (1968) Steiner (1971)	Welch & Pella (1967)	Jungwirth (1972) Aikenhead (1972) Glass & Yager (1970) Troxel (1968) Woodman (1972)			
Undergraduate		Miller (1969) Wood (1972)	Craven (1966)			
Post graduate			Kimball (1968) Jerkins (1969)	Brown & Brown (1972)		

Figure 1

Assessment of Particular Aspects of Scientific Literacy term frequently used by science educators and that science educators agree in a general way on the various dimensions of the term. However, to develop an instrument to account for all the aspects of scientific literacy was beyond the scope of their research. As a result, important items such as numbers 1, 2, and 5 of Haney's list were excluded in their instrument.

Cossman, desiring to evaluate the success achieved in an experimental secondary school course, "Science and Culture," designed to foster scientific literacy, used six different tests in his research. He stated: "Except for the case of substantive knowledge, available measuring instruments are few in number and typically still in experimental stages." (Cossman, 1969, p. 276)

A major effort was undertaken in the summer of 1965 to define the achievements of American education in the area of science. This was part of the National Assessment of Educational Progress (NAEP). Test items were developed and administered to 28,000 nine year olds, 28,000 thirteen year olds, 28,000 seventeen year olds, and 10,000 young adults, twenty-six through thirty-five years of age. The major areas of assessment were:

I. Know fundamental facts and principles of science.

II. Possess the abilities and the skills needed to engage in the processes of science.

III. Understand the investigative nature of science.

IV. Have attitudes about and appreciations of scientists, science, and the consequences of science that stem from adequate understandings.
(Committee on Assessing the Progress of Education, 1969, Chapter 2)

This national effort was impressive, and its continuation should bring increased knowledge and understanding about the effects of science education in the United States. However, Merrill (1970, p. 18) expressed criticism in that "The most striking feature (of the assessment project) is that almost twice as many exercises were administered to measure Objective I as were used for all other objectives combined!" In his opinion "The released information for Objectives II and III is rather scant, and for Objective IV is so meager as to be almost worthless."

Three years later, in 1972-1973, NAEP undertook a follow-up study using 230 questions that were used in the study described above. This represented apprcximately one-half of the original number of questions used with an average of seventy-six questions for each age group. (Ahmann, et al., 1975, p. 23) The results reported by NAEP (1975) indicated that nine year-olds, thirteen year-olds, and seventeen year-olds performed on the average less well in 1972-73 than they had in 1969-1970. It has been suggested that some of the questions do not represent the present-day, school science curricula nor the emphases made in the teaching of science (Howe, 1975). This suggestion and Merrill's comments about Objectives II, III, and IV should temper reactions to these gloomy findings.

One senses that the state of the art of instrument development to assess scientific literacy is not well advanced. If scientific literacy is not well defined at present, how could it be anticipated that a valid, integrated measure of scientific literacy should exist? "To date, no system has been developed for assessing student achievement in the identified areas of scientific literacy, other than knowledge, with occasional attempts to assess learning in the processes of science and in attitudes toward science." (O'Hearn, 1975) Building upon O'Hearn's ideas, Doran (1975) pointed out that "...some of the existing standardized and research instruments...are totally or in part useful for measuring student progress toward scientific literacy, but they should not be the 'tail that wags the dog' and specify the objectives for scientific literacy."

Scientific Literacy--What Does It Mean to the General Public?

Learned writers often point to the impact of science upon the lives of the world's people. "One of the most remarkable characteristics of modern life is the completeness with which it is dominated by science and its sister subject technology." (Russell, 1955, p. 5) Many do not recognize this impact, but without it, life for them would soon be non-existent. "Although only a sixth of the world's population is in this country and although only a seventh of the world's area lays within its borders, yet the United States produces one-half of the world's manufactured goods." (Riggs, 1969, p. 115) Oppenheimer (1954, p. 89) suggested that neither wars nor disasters change lives as rapidly as does science. No longer does one generation follow another seeing little deviation from established social patterns. Our ends and beginnings have not much in common.

It has been suggested that the general mood of the people has now become less supportive of science and technology. After World War II the nation's military strength was seen as a safeguard. Now many view it as a potential invitation to war as a result of situations such as the recent Vietnam Conflict. There is growing concern that the world is becoming overpopulated. The conquest of many diseases and improved agricultural methods are both major factors in this problem. Finally, continual industrial growth is considered by many as a rape of the environment. (Price, 1974, p. 97; Steiner, 1971, p. 2)

Weinberg (1970, p. 141) claimed that science and the resulting technology are on the defensive from four fronts. Some journalists, labeled as "scientific muckrakers," picture the scientific enterprise as a corrupt political organization quibbling within itself for "scientific dollars." Secondly, some legislators and administrators sense a decline in the relevance of science as certain social problems demand national attention. Thirdly, there are the "technological critics" who cry for a slowdown and redirection of technology "because of its detrimental side effects." Finally, there are the "scientific abolitionists" who claim that the scientific-technological mode has been a catastrophe for the past 100 years.

Shills (1974, pp. 2-3) stated that support for science is based generally on a belief in its efficacy and a belief in its ability to sustain future life. He warned that "these beliefs are affected by the tides of mood and opinion which rise and fall in the ocean of the larger society."

Etzioni and Nunn (1974) sought to gain an understanding of the public appreciation of science in contemporary America. In their study the data base consisted of various public opinion polls and attitude surveys taken during the fifteen years preceeding their study. Using these sources for their only data base, the researchers recognized that their conclusions could at best be only tentative. They learned little "about the factors, vectors, and dynamics underlying the status of science in the public mind today." (p. 202) Their major finding was that "the overwhelming majority of the public seems to confuse science and technology and sees science in a very technological instrumental light." (p. 203) The researchers expressed a need for an "encompassing, updated, analytic study." (p. 203)

It can be inferred from Etzioni and Nunn's statements that a meaningful study would be to determine what it is that people today value with regard to the scientific enterprise. The public's appreciation of science and its interrelationships with technology and society does not seem well understood. On one hand, science is valued; it is seen as a very positive influence upon our lives. On the other hand, science is not valued; it is seen as a negative influence upon our lives. Often science is confused with technology and technology with science. Over a span of a few years the mood of the nation (influenced by the economy by war, by catastrophes, or whatever) tends to oscillate from positive feelings toward science, to no feelings, to negative feelings toward science.

An editorial in the Journal of Chemical Education (1972, p. 785) asked "...how can a society grow with science and technology without being devoured by them?" Many citizens see science as being able to find the correct answers. Many see science as a golden goose--a good science with happy solutions messianicly replacing hard difficult man-made decisions.

Science and technology have made life more convenient without making it easier to live. This paradox often leaves people physically more comfortable but emotionally less comfortable. Instead of using science and technology to tell us how to do things we have thought we wanted to do, we must now use science and technology to decide what we really want to do. (Morrison, 1970, p. 22)

Research in science education can be helpful in this effort. Kahn and Weiner (1067, pp. 398-399) developed soundly the need for future-oriented research. It can clarify, define, name, and expound major issues. It can increase the ability to identify new patterns and crises and can help to understand their character and significance. It can improve the administrative ability for decision-makers to react appropriately to the new and unfamiliar. A potential direct consequence of future-oriented research would be to decrease "scientific illiteracy." Scientific illiteracy is a barrier to the resolution of present day dilemmas that often exist when science is deployed towards social objectives. (Menchar, 1971, p. 35)

The present state of affairs appears to commend itself to education of the public through the mass media. Increased use of educational television, newspapers and popular periodicals could begin to remedy present public misunderstandings of science and its interrelationships to technology and society. (Seaberg, 1971, p. 15; Daddario, 1974, pp. 141-142)

> ...education for citizenship...everybody's education - will have to provide not only adequate knowledge of science in general ...,but above all, understanding of the impact of science on fundamental aspects of human

> existence. That,...,is the central problem of education in the coming decades. Unfortunately, not much is being done about it. (Rabinowitch, 1971, p. 1149)

If in fact science does play a big role in the lives of people, there is a need to determine what people believe will best prepare high school graduates to face this. One way to accomplish this is to ask persons what importance they attach to particular behaviors on the part of high school graduates with regard to science and its relationships to technology and to society. From their responses one should be able to make, at the very least, limited inferences about what constitutes scientific literacy in their minds. A more complete understanding of these inferences could then be gained if the inferences are compared on the basis of variables which might be an influence on the status of science in the public mind today. Finally, the results of such a study could be used as a basis for developing viable science education programs not only for the schools but also for out-of-school education.

Scientific Literacy--Can It Be a Theoretical Foundation for Science Education?

It has been said that science education is not a discipline, that science education has no philosophy, no rationale, nor no theoretical basis. Hurd (1971, p. 243) stated that a much neglected factor in science education research is a theory base. Watson (1962, p. 277) nearly a decade before leveled the same serious criticism of research in science education. Watson suggested the lack of a propositional framework, or the lack of explicating one, had the effect of leaving the results of research without meaning. Hurd (1971, p. 244) suggested that without a theory base we are left without a "...notion of the actual state of knowledge, the stature of the field, and the location of the frontier." Instead, he called for "decision oriented research" which could contribute to alternatives, options, and directional probabilities in science education.

In 1975 the cry continued for research which could be the initial foundation for a theory base in science education. Agin (1975), recognizing the lack of coherence in science education and science education research, explicitly described science educators as "grasping at ideas and techniques like people at a bargain basement sale, and what we get most of the time isn't a bargain."

To respond to the conditions described above, the National Association for Research in Science Teaching (NARST) and the National Institute of Education (NIE) have outlined eight (8) areas to receive priority in future research (NARST-NIE, 1975). One of these priority areas is scientific literacy. The Commission believes that "Continued restatement of specific goals and emphases appropriate to the changing role of science education should be encouraged."

Pella (1975) pointed out that the vocabulary in science education selected from many sources such as science, engineering, and philosophy "has been prostituted to the point where any one word, regardless of context, represents as many concepts as people who use it." Decrying the sad state of research in science education, Pella stated, "Because of inadequacies in conceptual vocabulary and frames of reference for assessment the results of our research are contradictory."

Referring to ideas developed through the Center for Unified Science Education at The Ohio State University Showalter (1975) stated:

> There is general agreement in the science education community that the concept of scientific literacy is of very great importance in today's education in science. There is further agreement that the function of the concept of scientific literacy is to serve as a primary source of overall objectives for school science programs...A necessary precondition for developing instructional programs intended to enable learners to achieve desirable levels of scientific literacy is a comprehensive and functional statement of the dimensions of scientific literacy <u>and</u> of the factors associated with each dimension. (Showalter, 1975)

Doran (1975) suggested that although scientific literacy as a concept was actively discussed in the middle and late 1960's as an overarching schema to conceptualize the goals of science education, it has recently been replaced by other concerns. Doran felt "the time is ripe for a 're-look' at what we are about..."

Summary

From the foregoing discussion the following needs have been inferred:

1. There is a need to develop a theoretical definition of scientific literacy in order to:
   a. have a valid, comprehensive, and functional definition at the present time.
   b. facilitate communication in reference to the educational goal of developing scientifically literate citizens.
   c. provide a basis for developing science education programs which will enable students to attain appropriate levels of scientific literacy.
   d. provide a basis for developing an instrument to assess student achievement in the identified dimensions of scientific literacy.
2. There is a need to ask persons with varied educational, experiential, and environmental backgrounds to specify the importance of each of several elements of a theoretical definition of scientific literacy.
3. There is a need to infer what constitutes dimensions of scientific literacy in the minds of the persons who are asked to attach importance to elements of a theoretical definition of scientific

literacy.

4. There is a need to find correlates to the inferred dimensions of scientific literacy of the particular groups of persons.

Statement of the Purpose

The purpose of this study is to develop dimensions of scientific literacy for two groups of persons, science oriented and nonscience oriented, using their perceptions of importance of several elements of a theoretical definition of scientific literacy and to find correlates to these inferred dimensions.

Statement of the Problem

The problems for this study are as follows:

1. To infer dimensions of scientific literacy with regard to a theoretical definition of scientific literacy for each of two groups of persons, science oriented and nonscience oriented, and for the two groups combined.
2. (a) To compare the strength of agreement of the science oriented group of persons and the nonscience oriented group of persons with the overall inferred dimensions of scientific literacy of the two orientation groups combined.

(b) To compare the strength of agreement of the subgroups of the two orientation groups (university pure science, university applied science, university nonscience, public science, and public nonscience) with the overall inferred dimensions of scientific literacy of the two orientation groups combined.

3. To determine what relationships exist between the inferred dimensions of scientific literacy with regard to a theoretical definition of scientific literacy for the groups of science oriented and nonscience oriented persons and the variables: (a) amount of previous education; (b) amount of previous science education; (c) amount of previous education of parents or guardians; (d) age; and (e) sex.

Hypotheses

The hypotheses of this study are as follows:

Hypothesis 1. (a) There are significant differences in the factor scores of the science oriented group of persons and the nonscience oriented group of persons on each of the inferred dimensions of scientific literacy.

(b) There are significant differences in the factor scores of the subgroups of the two orientation groups of persons on each of the inferred dimensions of scientific literacy.

Hypothesis 2. There are significant predictors or combinations of predictors among the variables: (a) amount of previous education; (b) amount of previous science education; (c) amount of previous education of parents or guardians; (d) age; and (e) sex of the persons in the science oriented and nonscience oriented groups of persons and the inferred dimensions of scientific literacy.

Definitions

Science oriented person: a person whose occupation requires formal training, or its equivalence, in a science or science-related field.

Nonscience oriented person: a person whose occupation does not require formal training, or its equivalence, in a science or science-related field.

Theoretical Model of Scientific Literacy (TMSL): the theoretical definition of scientific literacy developed for this study.

Dimension of scientific literacy: a recognizable group of behaviors within the TMSL which together define a particular aspect of scientific literacy.

Component of dimension of scientific literacy: a recognizable group of behaviors which are a subset of a dimension of scientific literacy.

Element of scientific literacy: a discreet behavior in the TMSL which specifies expectations of the scientific literate person.

Scientifically literate person: a person who demonstrates the behaviors described by the TMSL at a specified criterion level.

Scientific Literacy Q-set (SLQ): a set of forty-five (45) statements developed for this study which represents the elements within the TMSL.

INFORMATION SHEET: a questionnaire developed for this study designed to elicit information about (a) amount of previous education; (b) amount of previous science education; (c) amount of previous education of parents or guardians; (d) age; and (e) sex.

Respondent: a person who responded to the SLQ, the Information Sheet, or both.

Inferred dimension of scientific literacy: the commonality believed to be shared by a group of SLQ statements.

Assumptions

This study assumes:

1. The persons selected to respond to the INFORMATION SHEET and the SLQ represent the groups of persons from which they were drawn.
2. No systematic variance developed in the process of using a standard procedure for distributing and collecting data.
3. The respondents completed the Information Sheet with integrity, that is, they supplied the correct information to the best of their knowledge.
4. The respondents sorted the SLQ statements according to the instructions.
5. Each SLQ statement is equivalent in meaning to the TMSL statement from which it was developed.
6. Inferred dimensions of scientific literacy for a grouping of persons can be developed from their perceptions of importance of elements of the TMSL.

Delimitations

This study has the following delimitations:

1. The study was conducted with public persons who lived within Franklin County in the state of Ohio.
2. The study was conducted with university faculty members at The Ohio State University.

Limitations

This study has the following limitation:

1. Any finding related to this study cannot be generalized beyond persons living within Franklin County, Ohio and faculty members of The Ohio State University.

Overview

Scientific literacy has become a term commonly used to delineate the basic goals of science education. However, the term remains somewhat in the realm of jargon. For this research literature related to science education was searched for descriptions of what it means to be scientifically literate. The TMSL was developed as a theoretical definition of scientific literacy and is the theory base for this study.

Forty-five (45) elements of the TMSL were randomly selected. These were rewritten at an eighth grade reading level. Two pilot studies were conducted to refine these statements. The set of forty-five (45) statements became the SLQ which along with the INFORMATION SHEET was administered to two types of persons, science oriented and nonscience oriented.

There were four major results of the study. First, a set of inferred dimensions of scientific literacy was developed for the total group of persons. Second, a set of inferred dimensions of scientific literacy was developed for the group of science oriented persons. Third, a set of inferred dimensions of scientific literacy was developed for the group of nonscience oriented persons. Four, a set of personal background variables which correlated with the inferred dimensions of scientific literacy was identified for each group of persons.

Chapter II is the result of a review of the literature necessary to develop this study. Chapter III describes the TMSL, the SLQ, the groups of science oriented and nonscience oriented persons, the variables considered in the study, the procedures used in the study, and the analyses used on the data collected. Chapter IV is a description of the results of the analysis of the data. Chapter V contains conclusions, implications and recommendations related to the research.

CHAPTER II

REVIEW OF THE RELATED LITERATURE

Literacy

One objective of this study was to examine the essence of scientific literacy. It would be well to illuminate literacy. In 1962, UNESCO through its International Committee of Experts on Literacy defined literacy as:

> A person is literate when he has acquired the essential knowledge and skills which enable him to engage in all those activities in which literacy is required for effective functioning in his group and community and whose attainments in reading, writing, and arithmetic make it possible for him to continue to use it towards his own and the community's development and for the active participation in the life of his country. In quantitative terms the standard of attainment in functional literacy may be equated to the skills of reading, writing, and arithmetic achieved after a set number of years of primary or elementary schooling. (Curle, 1964, p. 12)

Stanley (1972) spoke out declaring that in the United States, and in Western culture, literacy is essentially technicist in nature and that a modern society often subordinates human freedom to the dictates of its primary tools, its technology. A technicist society is one characterized by sophisticated technology, by an inordinate faith in technological capacities, and, most importantly, by bending human reason to the service of instrumental rationality. "In such a society the 'ends' or purposes of instruments are not subjected to intensive rational analysis at the public level." (p. 375) He suggested that technicism is a "radical disjunction between the application of reason to means as against ends." (p. 375) Four (4) identifying elements of a technicist culture are: (1) a domination of the notion of objectivity; (2) a metaphorical domination of non-human domains such as from mechanics, biology, or engineering (this means a loss of metaphors from the "spontaneous dimensions of human existance"); (3) specialization or social division of labor; and (4) the general population yielding its responsibility for action, at a personal level, to society's technicians, people trained technically. These factors contribute to the grave danger whereby the public resigns "to the dictates of expertise" and subsequently withdraws "into private hedonisms of consumer existance...accompanied by proliferating forms of refusal to endow the society at large with moral stature." (pp. 376-380)

It is important to belabor the concept of a technicist culture in the context of this study of scientific literacy. Stanley illuminates the concept well using examples easily observable in the United States.

1. stylish cynicism - refusal of esteem to anything;

2. internal flight - refusal of participation in the solution of social problems, migration from cities to suburbs;
3. voluntary ignorance - refusal of hope that to know anything is to be able to change anything;
4. sabotage - "ripping off the establishment," refusal of respect for public authority;
5. spiritual neglect of one's children - refusal of the parental authority to represent society and its values to children; and
6. doctrines of cultural revolution - refusal of legitimacy to the mythological foundation's of one's civilization. (p. 381)

Other observations of world development complement and add meaning to Stanley's exposé.

> In some developed countries there seems to be a disturbing trend towards diminishing interest in science and technology. In some articles appearing in periodicals, it is claimed that progress in science has made young people more selfish; that they now behave more as consumers than as responsible members of society. Some authors say that science has become an occult doctrine, which can be understood by a small and select group and that a gulf between general culture and scientific knowledge is very hard to bridge. (Teterin, 1971, pp. 3-4)

Bruner (1971), the learning theorist and spokesman for the intellectual, science curriculum reform of the Sixties, has also noted a need for reflection on what it means to be literate. He has moved away from previous stances and now believes a means must be found to bring society back to its values and priorities. He suggested that it is now time to de-emphasize the structure of the disciplines and to emphasize structure in the context of the societal problems now faced by the world.

The implications for scientific literacy from these brief statements are clear. Scientific literacy must mean that a person is not willing to yield the dominion of knowledge to the societal elites but will remain personally committed to acquiring the essence of new learnings. The scientifically literate person will actively scrutinize both the means and the predicted ends of instrumented action by public officials or their designates. The scientifically literate person will participate in the solution process of socio-technic problems of the world society. The scientifically literate person will seek to bridge the gulf between general culture (with its myths, values, morays, and heritages) and the growing scientific knowledge with its resulting technology.

Definitions of Scientific Literacy

The call to educate for living in a scientific and technological world is not new. Much has been previously written. Many of these writings have had an influence on science education during this century. (Whitehead, 1921; Becker, 1936; Bush, 1946; Bryson, 1947; Conant, 1947;

Russel, 1951; Brown, et al., 1957; Basalla, 1968)

Since 1963 (when Carleton first sought answers to, "What does it mean to be scientifically literate?") many definition ave been given to explicate scientific literacy. The respons given to Carleton (1963) essentially said, a person is scientifically literate if he understands the processes of science and if he is aware of the accomplishments of several of the science disciplines. Carleton's collection of responses was drawn together at a time when the ABC curricula were being interwoven into American education. Examining Haney's list (1966) and NSTA's list (1971), one senses the change in thinking, by a great majority of educators, during the years following the introduction of the first ABC curriculum, PSSC.

The listing by Haney (1966, p. 24) is at a mid-point:

1. The pupil should acquire knowledge which he can use to explain, predict, and control natural phenomena.

2. The pupil should grow in his ability to engage in the processes of science and to apply these processes in appropriate situations as he confronts them in his daily life.

3. The pupil should acquire the attitudes of scientists and learn to apply these attitudes appropriately in his daily experiences.

4. The pupil should come to understand the various interrelationships between science and society.

5. The pupil should learn numerous useful manipulative skills through the study of science.

6. The pupil should acquire a variety of interests that may lead to hobbies and possibly to a vocation.

The 1971 statement of NSTA's Committee on Curriculum Studies was made during the maturing stage of the ABC curricula in American science education. Because of changes in society insightful people were beginning to state that science education should be more than discipline-centered teaching. This change in thinking is reflected in NSTA's statement; the scientifically literate person.

1. uses science concepts, process skills and values in making everyday decisions...;

2. understands that the generation of scientific knowledge depends upon the inquiry process and upon conceptual theories;

3. distinguishes between scientific evidence and personal opinion;

4. identifies the relationship between facts and theory;

5. recognizes the limitations as well as the usefulness of science and technology in advancing human welfare;

6. understands the interrelationships between science technology, and other facets of society...;

7. recognizes the human origin of science and understands that scientific knowledge is tentative...;

8. has sufficient knowledge and experience... (to) appreciate the scientific work carried out by others;

9. has a richer and more exciting view of the world as a result of his science education;

10. has adopted values similar to those which underlie science so that he can use and enjoy science for its intellectual stimulation, its elegance of explanation, and its excitement of inquiry; and

11. continues to inquire and increase his scientific knowledge throughout his life. (NSTA, 1971, pp. 47-48)

Scientists, science educators, and philosophers of science have all had definitions of what it means to be scientifically literate. Robinson (1968, chapter 12) presented a lengthy treatise on the nature and organization of scientific knowledge as it related to scientific literacy. He dealt with the nature of scientific thought; Man's view of the universe; the nature of science; the processes of scientific reasoning; the constraints of scientific reasoning (that is, assumptions, observations and operations, language, logic and mathematics, prediction, confirmation, validity, and models); intuition; and discovery. His writing was a comprehensive treatment of the relationships between the structure and processes of science.

Kimball (1967-1968) wanted to compare scientists' and science teachers' understanding of the nature of science. After an extensive study of the literature on the nature and philosophy of science, he developed a model of the nature of science. The eight assertions in the model are important characteristics of science and possibly represent a dimension of scientific literacy.

1. The fundamental driving force in science is curiosity concerning the physical universe...

2. In the search for knowledge, science is ...a dynamic, ongoing activity rather than a static accumulation of information.

3. In dealing with knowledge as it is developed and manipulated, science aims at ever-increasing comprehension and simplification, emphasizing mathematical language as the most precise and simplest means of stating relationships.

4. There is no one "scientific method" as often described in school science textbooks...

5. The methods of science are characterized by a few attributes which are more in the realm of values than techniques...

6. A basic characteristic of science is a faith in the susceptibility of the physical universe to human ordering and understanding.

7. Science has a unique attribute of openness, both openness of mind...and openness of the realm of investigation, unlimited by such factors as religion, politics, or geography.

8. Tentativeness and uncertainty mark all of science. Nothing is ever completely proven in science...
(pp. 111-112)

Charging that past science curriculum designers have "shied away from any direct consideration of the connection between science technology, society, and the individual," Hurd (1970) has substituted scientific enlightment for scientific literacy as the end result of today's science curricula. Hurd stated that the scientifically enlightened person:

> sees the need to view the scientific enterprise within the broad perspectives of culture, society, and history;
>
> appreciates the cultural conditions within which science thrives;
>
> expects that social and economic innovations may be necessary to keep pace with and to enhance scientific and technological developments with regard to both solving contemporary social problems and making it possible to use research knowledge for improving the condition of man;
>
> views science and technology as interrelated and dependent upon each other; however, he is also aware that they are not synonomous and that their goals are different;
>
> appreciates the universality of scientific endeavors, their lack of national cultural and ethnic boundaries, and their potential for developing bonds of understanding between countries that can lead to worldwide cooperation in research;
>
> has some awareness of the need to generate a system of concepts within which science, society and the humanities can fit. (Hurd, 1970, pp. 14-15)

Daugs (1970) reasoned that scientific literacy is essentially growth along a continuum and is not an either-or situation. A person is always "becoming" scientifically literate. He felt that no one could be considered scientifically literate if the definition included: (1) understanding science as a source of social change; (2) understanding he relationship of science to the humanities; (3) understanding the ethics that control the scientist in his work; and (4) rejecting myths and superstitions. Working with these aspects of scientific literacy, Daugs contended that it is probably impossible to be completely literate in any field of science.

It was suggested previously that definitions of scientific literacy have evolved from definitions containing only a few aspects (such as knowing and understanding the products and processes of science) to larger, more elaborate definitions. This has been in part caused by changing needs within society itself. It is understandable then that writers would link scientific literacy to environmental concerns. O'Hearn (1972) and Longbrake (1974) alluded to the necessity of environmental education if scientific literacy is a part of the common education for citizenship. Through environmental education the public can begin to understand the difference between the short and long term social benefits or problems brought about by wise or unwise use of technology.

The unified science education movement holds scientific literacy as "the basic premise of the whole approach." (Showalter, 1974, p. 1) Showalter posited his definition with seven basic dimensions of scientific literacy. The scientifically literate person:

I. understands the nature of scientific knowledge;

II. accurately applies appropriate science concepts, principles, laws, and theories in interacting with his universe;

III. uses processes of science in solving problems, making decisions, and furthering his own understanding of the universe;

IV. interacts with the various aspects of his universe in a way that is consistent with the values that underlie science;

V. understands and appreciates the joint enterprise of science and technology and the interrelationships of these with each other and with other aspects of society;

VI. has developed a richer, more satisfying, and more exciting view of the universe as a result of his science education and continues to extend this education throughout his life; and

VII. has developed numerous manipulative skills associated with science and technology. (p. 2)

Klopfer (1969) projected science education into the future. To visualize what science education would be like in 1991, he used scientific literacy as the bas. . Only through literacy in science will a person be able to function effectively in twentieth century culture. Being scientifically literate a person will be able to make intelligent choices about his personal well-being; will be able to judge and take action on issues related to science affecting every citizen; and will be better able to understand and appreciate the functions of science and technology in a transformed world. Klopfer offered these dimensions of scientific literacy:

1. understand the key concepts and principles of science;

2. understand how scientific ideas are developed;

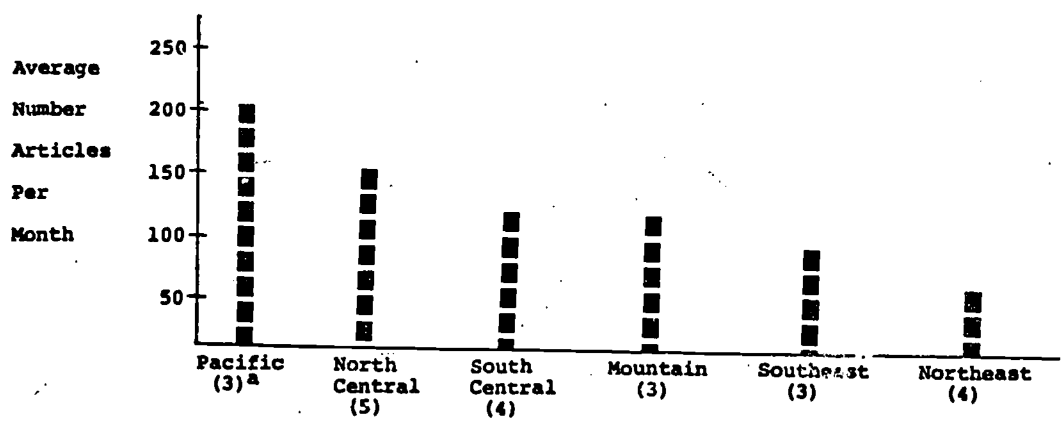
3. understand the process of scientific inquiry; and

4. understand the interactions between science and the general culture.

Four (4) major research efforts have attempted to define elements of scientific literacy by examining newspapers and periodicals. Koelsche and Morgan's work (1964) was representative of the thinking of the late Fifties and early Sixties. They sought "to determine the scientific information needed by people in order to interpret and understand science articles they read in newspapers and magazines and to provide science curriculum study groups with information that could serve as a guide to design course content in science for general education." (p. 5) Science content as it was developed in the study referred basically to the first two elements of Schilling's analysis presented in Chapter I.

Twenty-two daily newspapers from various sections of the nation and nine of the most widely circulated magazines were subscribed to from November 1, 1962 until May 1, 1963. Articles, found within these publications, dealing in any way with science, were scrutinized for words or phrases which required a knowledge of science to understand. The words and phrases were categorized according to the science area with which they were associated, and the related science principle or concept for each word or phase was identified.

Of the magazines, one had no science related articles at all during the six month period. The eight other magazines yielded 116 articles with biology being the predominant field of related discussion, followed by physics. In the newspapers 2,883 science related articles appeared during the six months. A breakdown is presented in the figure below.



[a] subscriptions per region

Figure 2

Frequency of Science Articles Appearing in Selected Publications

Interestingly, the months of November and December yielded 62.0 per cent of the articles. Private releases contributed 45.5 per cent of the sources of articles. The median level of reading comprehension of the articles in both newspapers and magazines was at the eleventh grade level with extremes at four and sixteen. It was estimated that erroneous statements with regard to science were made in less than one per cent of the articles.

Another study (Goldberg, 1966) had as its purpose "to determine the size and quality of the scientific vocabulary required to read the material related to science in The New York Times and in the political campaign literature produced by the Republican and Democratic Parties in 1960." It was found that "Forty-six science words constituted a science vocabulary without whose understanding Americans could not be scientifically literate in 1960."

Wood, Pella, and O'Hearn (1967-1968) in a study similar to that by Koelsche and Morgan analyzed the scientific and technical articles which appeared in twenty-two (22) capital city newspapers representing nine (9) geographical areas in the United States. Their study included 157 daily and 57 Sunday editions over a six month period. Some of the findings were that Sunday editions contained more articles per edition than did the daily editions. These Sunday articles were also longer. Article themes fell into five (5) major classes: space, automation-cybernetics, disciplines of science, nuclear energy, and medicine. "The greatest proportion of the newspaper articles were classified as medicine (38%), followed by articles dealing with disciplines of science (33%), and space (22.5%)." (pp. 152-153) Technology and resulting applications were predominantly emphasized more than science. Few articles dealt with the processes of science. Over three-fourths (3/4) of the articles required some science knowledge by the reader; most of these articles dealt with biology as opposed to physics. Less than one-fourth (1/4) of the articles dealt with social implications of science or technology.

A related study, by Pella, O'Hearn, and Gale (1966), was more comprehensive than the preceeding three (3) studies. As a result it is often cited by others as a definitive statement about what it means to be scientifically literate. They sought to determine the referents pertaining to scientific literacy. The Reader's Guide to Periodic Literature and The Educational Index were searched for articles during the period from 1946 to 1964. Topics for searching purposes were: scientific literacy; science and/or technology and the citizen; relationships or interrelationships of science and/or technology and society and social problems; relationships of science and technology; science and/or technology and culture; relationship between scientists and nonscientists; science and the public domain; science and general education; and the scientific and/or technological revolution. In addition six science journals from 1950 to 1964 were searched for articles. The card catalog of the University of Wisconsin library was searched for relevant titles; two newspaper science editors were consulted; consultations with selected scholars at the University of

Wisconsin were held; and all bibliographic references cited in the analyzed documents were searched for relevant titles.

After analyzing documents it was determined that referents were becoming repetitive; an additional 34 documents failed to produce any new referents. Therefore, for 100 documents a frequency for each referent was determined:

1.	science and society	67
2.	ethics of science	59
3.	nature of science	51
4.	conceptual knowledge	26
5.	science and technology	21
6.	science and humanities	21

It was discovered that "attitude toward science" was used repeatedly, but that all documents used this phrase as "a means of pointing up one or more of the other referents..." (p. 200)

Pella, O'Hearn, and Gale concluded:

> The scientifically literate individual presently is characterized as one with an understanding of the (a) basic concepts in science, (b) nature of science, (c) ethics that control the scientist in his work, (d) interrelationships of science and society, (e) interrelationships of science and the humanities and (f) differences between science and technology.
>
> Evidence from analysis of the literature concerned with scientific literacy reveals that knowledge of the (a) interrelationships of science and society, (b) ethics of science, and (c) nature of science are more important than (d) conceptual knowledge, (e) difference

> between science and technology, and (f) the interrelationships of science and the humanities. (p. 206)

Pella (1967), authoring an article by himself, capsulized what he thought were the elements of scientific literacy. The scientifically literate person should:

> 1. understand the interrelationships between science and society;
>
> 2. understand the methods and processes of science;
>
> 3. have knowledge of fundamental science concepts and conceptual schemes;
>
> 4. understand the difference between science and technology; and
>
> 5. understand the relationship between science and the humanities or better still look upon science as one of the humanities. (pp. 348-352)

It is interesting that two aspects of scientific literacy, illuminated in Pella's, et al., research study as being quite important, were conspicuously left out in his description of a scientifically literate person a year later. Pella (1967, p. 348) suggested that the referents identified in the research project may not be of much consequence because the "data were the opinions of those who talk about scientific literacy." The dimensions of scientific literacy need further refinement in terms of definitions so they may be assessed quantitatively and qualitatively. (p. 353)

The early statements defining scientific literacy exemplified by those reported by Carleton (1963), emphasized the understanding of scientific facts, concepts, and conceptual schemes. All of the later statements have followed suit, but by including these only as dimensions of scientific literacy. Pella, et al., (1966) suggested that these dimensions were of lesser importance as referents of scientific literacy than were others. Evans (1970) called these components of scientific literacy "literacy in science." Evans pointed out that just as the literacy in science of an individual scientist differs from one area of science to another, the level of literacy in science is different for individuals, that is, the scientist, politician, business executive, housewife, and science teacher. Yet he claimed it is possible for all of these persons to be scientifically literate. Although there is little agreement about what the minimal list of facts, concepts, and conceptual schemes should be that the scientifically literate person should command, it is generally agreed that citizens must be able to read, to interpret and to discuss scientific information found in newsstand-type literature.

Evans agreed that the referents identified by the research of Pella, et al., (1966) form the nucleus of a description of a scientifically literate person. However, he added that "The scientifically literate person (1) possesses objectivity, (2) has faith in and values logical reasoning, (3) rejects myths and superstitions, (4) accepts conclusions when supported by data, (5) is critical and skeptical, (6) displays the habit of weighing evidence, and (7) uses the methods of science to solve problems when the methods are appropriate." (p. 82) He reported, however, that even though scientific literacy is generally an accepted major goal of science teaching, little effort has been expended to properly define the term. He suggested (p. 83) that "...an all-out effort to come to grips with the characteristics of scientifically literate persons and with the means of achieving these characteristics once they are identified,..." is a most pressing need at the present.

In an invited paper presented at NARST's annual meeting in 1975, Pella (1975) again specified the requirements for scientific literacy. Referring to the citizenry of the United States, he suggested that the literate citizenry should be able to communicate about knowledge or ideas of nature of natural objects and phenomena and to communicate about the utilization and control of natural objects and forces. The citizenry should be able to rationally use empirical concepts and laws in adjusting to, explaining, and predicting events within the environment. The citizenry should be able to read about scientific developments. It is aware of differences between theoretical concepts and laws <u>and</u> empirical concepts and laws in terms of (1) how they come into being, (2) how they are expressed, and (3) how they are used. With regard to scientific knowledge the citizenry should be aware that it is probable in nature as opposed to absolute and that it is developed for the empirical universe. The citizenry should be able to use science processes and be aware of regulatory principles which guide scientists in their work.

> In summary it may be stated that a scientifically literate citizenry understands some of the knowledge library of science, knows some of the limitations and potentials of the contents of the library, knows how and when to apply the knowledge library, knows where the contents of the library come from, and knows some of the regulatory principles involved in knowledge production and use.

Assessment of the ABC Curricula

Schlessinger, et al., (1973) made a 1970-71 survey of science teaching in the United States' public schools to establish "bench mark" data. The analysis of the data yielded an indication of the acceptance of the ABC curricula into the schools of the United States as of 1971. "The population consisted of all public secondary schools in the United States that were listed in the state education directories for the 1969-70 school year." (p. 1) Of this population 6,398 schools were drawn as the sample to which questionnaires were sent. Representative sampling was striven for with an elaborate, multi-stage random sampling technique.

Analysis of the data allowed the researchers to establish approximate percentages of the types of courses offered in the public secondary schools. It was determined that 42% of the schools offered a course in general science; 26%

offered a course in life science; 48% offered a course in physical science (31% offered Introductory Physical Science); 16% offered a course in health science; 73% offered a course called biology (27% offered BSCS Green, 20% offered BSCS Blue, and 27% offered BSCS Yellow); 40% offered a course in earth science and 4% offered a course in geology (19% offered the Earth Science Curriculum Project); 69% offered a course in chemistry (34% offered the Chemical Education Materials Study and 4% offered the Chemical Bond Approach); and 66% offered a course in physics (33% offered the Physical Science Study Committee course and 12% offered the Harvard Project Physics course).

It appears that the science curriculum projects of the Fifties and Sixties have been instituted in approximately 50% of the sample public schools in the United States. However, the data analysis indicated that not all regions have adopted the new programs equally. The New England and Far West regions were mentioned most frequently as having greater percentages of schools using these programs.

The sentiments of the nation were very positive in the mid-Fifties for curriculum reform in the sciences as a result of poor performances turned in on military tests in science areas in previous war years. These positive sentiments turned to demands after the launching of the Russian Sputnik in the fall of 1957. The science curriculum reform projects had common threads. Science was presented as a mode of inquiry, and the teaching-learning procedures often emphasized inquiry in the form of processes of science. Life-like experimentation was sought for in the laboratory exercises in the hope that scientific knowledge would be conceptualized. Generalizations, patterns, and mental models were developed in the teaching-learning situations in the hope that order and meaning could be achieved with what may appear to students as discrete and unrelated facts. (Rutledge, 1973; Schwab and Brandwein, 1962; Goodlad, 1964; National Science Foundation, 1970) Fox (1969) summed adequately the beliefs that many held about the success the curricular projects had in the product and process objectives for teaching science.

> With more than a decade of investment of federal resources in the development of new programs suited to these ends and with the prodigious effort made to help teachers with these curricular innovations, it may be reasonable to assume that science education is making fair progress toward these two objectives. (p. 13)

Tyler (1973) suggested that citizens are adequately prepared in science when they can deal with the issues that confront them today and can understand the role and contributions of science in developing the modern world and its potential role in maintaining and improving society as a whole. This is the point at which criticism of the new science curricula begins. Fox (1969) saw the dominant and urgent problems of society rooted deeply in technology, and hence, criticism must be made of the modern science curricula because they do not illuminate the interrelatedness of science and technology. Neither do they address the components of the critical personal and social problems (such as youth alienation and loss of self-identity).

Crane (1970, p. 22) questioned if the new curriculum projects "...are doing anything at all to the potential of students to be creative..." Belasco (1970) and Klohr (1974) have also been critical of the new science curricula. Both persons claimed that the curricula have not taken their place with the other disciplines such as English, social studies, history, or the arts. Instead they have been overly emphasized as a part of the student's general education for becoming a literate citizen. This is most likely a backlash effect of the curriculum projects' discipline-approach.

Andrews (1970) criticized the new high school science courses as being "conspicuously aimed at the potential science major." He suggested that "If high school graduates who study contemporary science emerge as scientifically literate citizens, serendipity has played a significant role." (p. 30)

Ulhorn (1970) and Schmidt (1970) reported studies of the image of the scientist among elementary students. They found that elementary students see scientists in long white lab coats; as chemical mixers; as skeleton examiners; as having no time for family life or play; and as predominantly male. It was suggested that both the mass media of today and the students' experiences in the elementary classroom of today contribute strongly to these perceptions. (Schmidt, 1971, p. 28)

Pella (1967) after examining many of the new science programs (he labeled them "Government science courses") was critical of their ability to project the six referents of scientific literacy which he and others had previously developed through research. He found that even though they stressed understanding rather than memorization of facts still they presented large amounts of factual information. Some attention was given to the ethics of science, but much less than was given to the concepts and processes of science. No mention was made of technology, per se, nor of the relationship between science and technology. Likewise, nothing was done in the new science curricula to develop either the social implications of science or the humanity aspects of science. He concluded that no curriculum project or combination of projects, "has yet arrived at perfection concerning the objective of scientific literacy." (p. 356)

Assessment of Dimensions of Scientific Literacy

This investigator perceives that science educators have assessed both explicitly and implicitly for scientific literacy. That is, some investigators referenced their assessment of certain dimensions of scientific literacy to a specific model of scientific literacy. However, other investigators assessed particular dimensions, usually only one per investigation, without reference to any model of scientific literacy.

Explicit Assessment of Scientific Literacy

Leake and Hinerman (1973) proposed to determine the level of achievement on two dimensions of scientific literacy, the ability to use the knowledge of processes of science and scientific knowledge. The instruments used in the study were the Wisconsin Inventory of Science and the Sequential Tests of Educational Progress; Science. Their student sample was randomly drawn from the population of graduating high school seniors from small, medium, and large high schools in each of five college districts in the state of Missouri.

They chose as sub-problems to investigate the degree of relationship between each of the two dimensions of scientific literacy and (1) total school enrollment; (2) percent of seniors going on to higher education; (3) average salary of science teachers; (4) annual school science budget per student enrolled; (5) number of science credits required for graduation; (6) and the average size of science classes. An additional sub-problem was to determine if significant differences existed among mean scores on the instruments from the five geographic areas.

Significant positive correlations were identified between the two dimensions of scientific literacy and (1) the percent of seniors going on to college and (2) the total school enrollments. Variance, too great to be attributed to chance, was established with respect to geographic areas and mean understanding of the two dimensions of scientific literacy as measured by the two instruments.

Richardson and Showalter (1967) developed the Abridged Scientific Literacy Instrument using three of the six dimensions of scientific literacy identified by Haney (1966) (see pages 34-35 of this chapter). Items in the instrument were written as "situation - establishing statements followed by a seven-point-scale of which only the extreme points and the mid-point were explicated as possible responses." (p. 46) Thus, the scale represented a continuum along which a respondent could mark his personal "position." The instrument was validated using seniors in a high school class and a panel of science educators selected from the membership of the National Association for Research in Science Teaching. The panelists were asked to respond to each item "...as he would expect an 'ideal' scientifically literate person to do..." The responses of the panel "...created a kind of operational definition of scientific literacy." (p. 48)

The instrument was used in the study to evaluate the longitudinal effects of a four-year unified science curriculum on graduates from the Ohio State University High School. Attempting to control several variables (intelligence, schcol achievement, school setting, age, and sex), the study indicated a general and consistent favorability for the graduates from the unified science curriculum as opposed to those graduates from the same high school not experiencing the unified science curriculum. Additional findings that resulted from the study were: (1) boys take more science in grades 9-12 than do girls; (2) boys and students with higher levels of intelligence have a greater general interest in science; and (3) interest in science increased after the students graduated from high school.

Cossman (1969) sought to determine if an experimental course, "Science and Culture," could produce significant increases in students':

1. understanding of the scientific process;
2. understanding of scientists as an occupational group;
3. understanding of science as an institution and its relationship to other institutions in our society;
4. ability to think critically;
5. substantive scientific knowledge;
6. assessment of the importance of theoretical values; and

7. understanding of the character of scientific and non-scientific segments within the culture and their knowledge of the evidence for the interaction between them. (p. 276)

Students were tested using the Stanford Achievement Test--Advanced Science, the Test On Understanding Science, the Facts About Science Test, the Watson Glaser Critical Thinking Appraisal, and Study of Values, the "Iowa Science and Culture Achievement Test," and the "Science Opinion Survey." The latter two tests are unpublished instruments designed for use with adults (Kindall, 1965).

The results of the analysis indicated that pretreatment--posttreatment growth score differences between the comparison groups were significant at the .01 level on all tests except the Stanford Achievement Test--Advanced Science. Cossman cited "...(1) the lack of emphasis that the experimental course places upon teaching scientific facts and (2) the much larger number of science courses taken by control group subjects during the experimental period..." as potential reasons for the one nonsignificant finding.

Jaffarian (1968) had as one purpose of his study "to determine the level of scientific literacy as indicated by measures of subject matter knowledge, knowledge of the nature of science, and the academic science background of twelfth grade students" in Wisconsin. The instruments used were STEP--Science Form 2B, the Wisconsin Inventory of Science Processes (WISP), and a student questionnaire which was used to collect information concerning the academic science background of the students. Two findings of particular interest were: (1) chemistry, physics, and advanced science were being studied almost exclusively by only those students planning to attend a college or university, and (2) physics and advanced science were courses elected only by students planning a college major in a scientific or technical field. Many persons in the United States never go on to college. If they have not studied physics or chemistry, it could leave them ill prepared to face the big role science plays in their lives each day. Also, they could be less effective in making decisions on issues related to science and technology.

Hamilton (1965) assessed the scientific literacy of Kentucky students. Among her findings were: (1) scientific literacy depends upon mental ability; (2) a positive relationship exists between the number of science courses completed in high school and scientific literacy; and (3) the students' environment contributes to scientific literacy.

Jones (1969) sought to determine if a physical science course could be so structured such that certain aspects of scientific literacy could be developed in college freshmen. He used the Sequential Test of Educational Progress (STEP): Science, Forms 1A and 1B, to measure the students' abilities to apply methods of science and to measure the students' knowledge and understanding of scientific facts, concepts, and principles. The Watson-Glaser Critical Thinking Appraisal was used to assess student progress in critical thinking. A modified version of the Attitude Scale developed by Allen (1959) was used to determine if the students developed favorable attitudes toward science and the scientific enterprise.

The results of the study were not supportive of the physical science course. The results of the study indicated that those students who have knowledge and skill in science also have high scholastic ability. Critical thinking ability of the students was found to be directly related to their general scholastic ability and their knowledge and skill in science. The students' attitudes toward science, scientists, and scientific careers was directly related to their general scholastic ability.

The Test Every Senior Project (Gallagher, 1969) was largely an endeavor to acquire baseline data concerning knowledge of and attitudes toward science of high school seniors in schools affiliated with the Educational Research Council of America in Cleveland, Ohio. Eight aspects of scientific literacy were studied:

a. knowledge of content;

b. understanding and ability to apply processes of science;

c. understanding the nature of science;

d. understanding the relationships between science and society;

e. ability to read and interpret literature on science;

f. critical thinking ability;

g. attitudes toward science; and

h. creativity.

Eight separate tests were used to test 12,800 seniors. To accomplish this overwhelming task the survey design was such that each student took only one test. The tests were randomly distributed among the population in such a way that all eight tests would be given simultaneously in any classroom in which students were participating in the survey. Randomization amongst the students was accomplished by ordering the tests randomly prior to packaging them for each student.

The majority of the results of this project were reported only to the schools involved. However, Gallagher (1969) reporting on aspects of attitudes toward science cited these findings. A comparison was made of students who took chemistry and/or physics to students who took neither of these courses. The former group demonstrated more favorable attitudes toward science than did the latter. No differences were found between the two groups in attitudes toward scientists although girls demonstrated more favorable attitudes than did boys. The former group demonstrated more favorable attitudes toward science teachers and themselves as scientists than did the latter group. In these two comparisons girls demonstrated more favorable attitudes than did boys, but the reverse was true with regard to themselves as scientists. Gallagher stated that cultural conditions influence attitudes as much as does education; drawing conclusions from these findings must be done with care.

In another description of the project Korth (1969) reported on the aspect of social aspects of science. It was found that the group of students who had taken either chemistry and/or physics as compared to the group of students who had taken neither had a more positive attitude toward science, a better understanding of the nature of the scientific enterprise, and a more realistic conception of the characteristics of scientists. The results indicated that the latter group of students had serious misconceptions concerning the nature of science, the scientific enterprise and the interaction between science and society. There was evidence that even among the group of students who had taken chemistry and/or physics there was a confusion of science with technology, a tendency to agree with the idea of a scientific method, a failure to understand the nature of scientific knowledge, and a tendency to associate science with material products rather than acquisition of knowledge.

Implicit Assessment of Scientific Literacy

Much study has been done in the area of attitudes concerning science. Summaries of many of these studies have been completed by Matala and McCollum (1957), Boeck and Washton (1961), Miles and VanDeventer (1961), and Aiken (1969). Aiken (1969, pp. 295-296) reported that the majority of studies concern "attitudes toward science" and deal with affect or feeling toward science in general or a particular science. Other like or dislike type studies are the "attitude toward scientists" studies dealing with the activities engaged in by scientists or the kinds of people that scientists are thought to be. Some studies, however, deal with attitudes in a more cognitive way such as "scientific attitude," another term for adherence to or knowledge of "scientific method."

Attitudes concerning science have been measured with checklists (Lewis and Potter, 1961); attitude scales such as the Likert-type (Allen, 1959); semantic differential techniques (Klopfer, 1966); projective techniques (Lowry, 1966); and even multiple measures (Blankenship, 1966). A few theory based instruments have been developed through which the investigator represents a pre-conceived idea of the aspects of scientific attitude. (Baumel and Berger, 1965; Schwirian, 1968; Vitrogan, 1967; Allen, 1959)

Korth (1968) attempted to assess student change in conceptions of the social aspect of science. He developed for his research the Test On Social Aspects of Science. Steiner (1971) made a study of attitudes among high school seniors toward socially significant science-related issues. He developed an Inventory of Societal Issues instrument for his study.

Brown and Brown (1972) developed an instrument to study scientific values. This was administered to professors of science and the humanities in their study.

Understanding the "nature of science" is often specified as being necessary if one is to be scientifically literate. The Test On Understanding Science (TOUS) (Klopfer and Cooley, 1963) is used quite often as an instrument to assess this understanding even though it attempts to measure general attitudes and an understanding of the whole of science. It has been used at the junior high level to determine the effectiveness of different instructional techniques (Wachs, 1966; Thomas, 1968; Mackay, 1971); at the senior high level with the new curricula: BSCS, CHEMS, and PSSC (Glass and Yager, 1970; Troxel, 1968; Jungwirth, 1972; Woodman, 1972); and at the undergraduate level with pre-service teachers (Craven, 1966).

An instrument dealing specifically with the "nature of science" is the Nature of Science Scale (NOSS). It was developed as a research instrument by Kimball (1968). The researcher constructed a model of the nature of science before developing the instrument, making the NOSS a theory-based instrument. Kimball used the instrument in one part of his study to explore the understanding of the nature of science exhibited by science teachers compared with the understanding exhibited by scientists. He found that when science teachers had undergraduate majors in science no differences were found between science teachers and scientists in their understanding of the nature of science.

Measuring an understanding of the processes of science has been attempted with various instruments. Welch and Pella (1967) developed the Inventory of Knowledge on the Processes of Science and Tannebaum (1971) developed the Test on Science Processes. Another instrument used in assessing students' understanding of scientific processes is the Wisconsin Inventory of Science Processes (Wood, 1972).

A brief review of the literature soon reveals that many research studies have been undertaken in the hope of gaining a better understanding of concept development. Several of these have been conducted at the Wisconsin Research and Development Center for Cognitive Learning located at The University of Wisconsin. Directed primarily by Dr. Milton O. Pella, these have been developed from a common goal--to gain a better understanding of cognitive learning of children and improving related educational practices.

Stauss (1968), Helgeson (1968), and Carey (1968) focused on selected concepts of the conceptual schemes of the biological cell, of force, and of the particle nature of matter, respectively. In each of the studies mastery of a particular concept was judged in terms of knowledge, comprehension, and application. These represented increasing levels of mastery. In each of the studies it was found that pupils in grades 1-3 could master several of the separate concepts at the knowledge and comprehension levels. Mastery of the concepts at the application level was accomplished primarily in grades 4-6.

In Stauss' study age was not found to be significantly related to pupils' abilities to achieve mastery of a particular concept at any one of the levels of mastery. This was within a particular grade level. He did find that the degree of relationship between concept test scores, regardless of the level of mastery, and IQ was greater in grades 4-6 than in grades 2-3. To the contrary, Helgeson did not find IQ to be related to concept test scores within a grade level for any of the levels of mastery. He did find that maturity, as indicated by grade level, was a factor in determining mastery of the concepts. Carey found both IQ and grade level to be positively correlated with levels of mastery.

Voelker (1968) and Pella and Ziegler (1967) studied concept development using different instructional techniques. In both studies IQ and past achievement in science and mathematics were not found to be significantly related to the ability of children in grades 2-6 to formulate the concepts. Pella and Ziegler also found the same nonsignificant relationships with regard to grade level and age.

Boles (1968) sought to determine the feasibility of teaching biological concepts to high school students through instruction on the relationships of science and society and the social implications of science. Statistically, this experimental instructional approach produced significantly larger gain scores than did the traditional instructional approaches to teaching biology and social science. Gain scores were shown to be independent of IQ. Students felt that the experimental instructional materials were more interesting and less difficult than other science materials with which they were familiar.

Q-sort Technique

Q-methodology Versus R-methodology

Q-methodology has its origin in the Thirties. It was independently developed by William Stephenson (1935) and Sir G. H. Thompson (1935). It is Stephenson, however, who is most frequently associated with Q. Brooks (1970, p. 165) reported that Stephenson developed Q from the traditional means of correlating and factor analyzing test responses--sometimes referred to as R-methodology. Stephenson believed that a meaningful analysis would be to correlate and factor analyze the responses to the test items in terms of the persons who made the responses. The former, and more traditional, analysis yields various groups of items which seem to measure different factors. The latter analysis, that suggested by Stephenson, yields various groups of people who have responded similarly to a set of items.

During the ensuing years, much argument developed as to the similarities and differences of R and Q. Stephenson (1952, p. 483) labeled many of these arguments as superficial. Two of the primary comparisons to which he made reference were: (1) "...all that is involved is a single matrix of data which when correlated down the rows is R, and along the columns is Q." (p. 484) and (2) "If there are more persons than tests, then tests are correlated (R), but if there are more tests than persons, then persons are correlated instead (Q)." (p. 483)

Kerlinger (1973, p. 598) pointed out that Q-methodology is not well-suited for testing hypotheses with large numbers of individuals. As a result, one does not often attempt to generalize to the populations from which the Q-persons are sampled. What is attempted is to test a theory on a small set of subjects who have been carefully chosen for particular characteristics which one has theorized they possess. On the other hand, R-methodology is well-suited for testing hypotheses with large numbers of individuals and generalizing the findings to the population universe.

Q-sort Technique

In the literature the term "Q-methodology" has been used in reference to several ideas. Often authors use "Q-methodology" when discussing: Q-correlation; responses by card sorting; a specialized use of questionnaire items; forced responses so that data fall into preestablished distributions; and factor analysis of Q-correlations. Q-sort technique has been closely associated with Q-methodology, but it is simply a means to collect data from people. It is the technique of Q-sorting that will be furthered illuminated.

Brooks (1970, pp. 165-166) described the Q-sort technique as a procedure involving the selection of "something" that is directly related to a concept or a theory under examination. The "something" which is given to persons to select from may be single words, phrases, or even pictures. If verbal expressions are used, they are typed one to a card, shuffled, and given to a person with instructions to sort them into piles according to the extent of his agreement with the statements. "The purpose of the sorting is to get a conceptual representation of the sorter's attitude toward the subject being considered - 'what is in his head'." (p. 166) Thus the Q-sort technique has the advantage of allowing the individual subject to use his own frame of reference.

A general review of the literature shows that the Q-sort technique is used as a research tool much more predominately than is the Q-methodology used as a basis to formulate the research study. A review of science education literature revealed three studies in which the Q sort technique had been used. Halterman (1969) used a Q-sort technique to study the characteristics of effective science teachers. Deamer (1973) used a Q-sort technique to determine the perceptions held by individuals involved with a science teacher education program. Her purpose was to determine what was most important to them about a field experience, preparatory program. Mandelare (1973) used the Q-sort technique as a means by which secondary chemistry students could express their cognitive preferences of memory, application, principles, and critical questioning in their study of chemistry. These studies typify many others in which the Q-sort technique is used to collect data, even though the research study is formulated with R postulates. The analysis of the data in these studies is traditional in the sense that responses with specific items in the Q-sort are given prime attention, as opposed to the types of persons who made the responses.

Structured Versus Unstructured Q-sorts

As hinted above, one typically puts together a set of cards to form a Q-set in order to use the Q-sort technique in research studies. The Q-sets are either structured or unstructured. At least two reviews of the literature have indicated which type of Q-set has most often been used. Wittenborn (1961, pp. 132-142) reported that the great majority of Q-sort studies used unstructured Q-sets. Kerlinger (1973, p. 587) reported the same finding.

"An unstructured Q-sort is a set of items assembled without specific regard to the variables or factors underlying the items." To develop an unstructured Q-set one gathers or writes several homogeneous items which presumably represent one broad variable. This set of items is like the set of items contained in an attitude measurement scale. It is not difficult to imagine that a theoretically infinite population of items could exist for a particular concept. The concern is to make the Q-set a representative sample of the item population. (Kerlinger, 1973, p. 587)

Brooks (1970, p. 158) noted that the developer of a Q-set might desire to randomly draw items from a larger population of items as a better means of developing a Q-set. Still, the end result would be unstructured if the population of items was homogeneous with regard to one broad concept.

Stephenson (1953, pp. 65-85) explicated the development and use of the structured Q-set. To develop a structured Q-set, one must create items which will correspond to a theory or a set of hypotheses one might desire to test. "Since the instrument is constructed to embody the theory, the sorting of items by known types of individuals can test the hypotheses generated by the theory." (Brooks, 1970, p. 168) When the theoretical variables included within a theory are identified and items are developed which correspond to each of these variables, one is in a better position to test the theory in operational terms.

> To structure a Q sort is virtually to build a "theory" into it....In the use of Q as Stephenson sees it, individuals as such are not tested; theoretical propositions are tested. Naturally, individuals must do the sorting. And, Q sorts can, of course, be used to measure characteristics of individuals. But the basic rationale of Q, as Stephenson sees it, is that we have individuals sort the cards not so much to test the individuals as to test "theories" that have been built into the cards." (Kerlinger, 1973, p. 588)

Olson and Gravitt (1968, pp. 14-15) argued that the structured Q-set is superior to the unstructured Q-set since the former has a theory built into it and, the latter does not. When unstructured Q-sets are used in research studies, theories essentially remain untested. Goldberg (1962, p. 255) and Brown (1975) both suggested that when the concept under study has three or four identifiable sub-areas, the structured Q-set should have an equal number of items for each area so the theory involved can be fully represented. The emphasis, however, is on full representation of the theory.

There are extensive details in the literature to guide an investigator in developing a structured Q-set. Stephenson (1967, pp. 19-20) summarized many earlier statements about structured Q-set design by comparing the structured Q-set design to an analysis of variance design. Kerlinger (1972) extended this idea. He claimed the structured Q-set "...has built into it at least one partitioning of a dimension or variable and follows Fisherian analysis of variance design principles. Partitioning breaks a set down into subtests that are disjoint and mutually exclusive." (p. 5)

Previously it was stated that the structured Q-set represents aspects of a theory such that the Q items are operational descriptors of the various facets of the theory. Kerlinger (1972, pp. 6-7) developed a discrete description of a structured Q-set following a one-way analysis of variance design.

> A theory is about some phenomenon or set of phenomena and the relations between this phenomenon or set of phenomena and other phenomena. There is a universe, U, of aspects of the phenomenon. Within U there are subsets, A, B, and so on. These subsets can be partitioned into further subsets A_1, A_2, ,..., B_1, B_2,....Structured Q sorts consist of these sets and subsets. The task of the researcher in building a structured sort is to be able to define and describe the universe and the subsets and to obtain or write items that fit the final partitions of the structure.

As with analysis of variance designs, structured Q-sets can be much more complicated than the design just described. Stephenson (1952, pp. 487-490; 1953, pp. 65-85 and pp. 114-338) developed the rationale for higher order variance designs and used many exemplars of these designs from research in psychology. Brown (1970) explicated the use of variance designs and provided examples from research in political science. Kerlinger (1966, 1972, 1973) also discussed higher order Q-set designs and provided examples from research in social science.

Validity is a term used in terms of measures, that is, test instruments. It cannot so aptly be applied to a method of collecting data. Cataldo, et al., (1970, pp. 209-210) stated, "A measure is valid if it measures what we intend it to measure....When there is no proven valid external measure of a property,...,face or content validity is often the best initial judgment that can be made." Jackson and Bidwell (1959, p. 226) addressed the issue of validity directly:

> Once the selection of items to be placed within each category has been made, the accuracy of the investigator's judgment may be checked through the use of competent judges. A panel of three or four judges may be asked to classify according to the statement of categories, the tentative array selected by the investigator. The ratings assigned to each of the statements by the judges and by the investigator may be compared through the use of Kindall's coeffecient of concordance, intraclass correlation, or some similar device, which will indicate the extent of agreement among them and in so doing indicate the adequacy of the investigator's classification. The array so classified will then either be accepted or modified or perhaps subjected to further judging.

The number of items in a Q-set has been bounded by recommended minimum and maximum limits. Schlinger (1969, p. 54) suggested that Q-sets should have sufficient items in order to establish stability and statistical reliability,

"...but not so many as to overwhelm the respondents." She believed fifty-five (55) to seventy-five (75) items would be ideal. Kerlinger (1973, p. 584) also posited stability and reliability arguments for his recommended range. He suggested that "...the number should probably be not less than 60 (40 or 50 in rare cases) nor more than 140, in most cases no more than 100. A good range is from 60 to 90 cards." Brooks (1970, p. 167) acknowledged that no stipulated number of statements must be selected, but the numerical range should be between fifty (50) and 100. Again, the argument is for stability and reliability. One must keep in mind that the stability and reliability arguments stem from a Q-methodology perspective. If one operates from the R perspective, these arguments are not as meaningful. In fact, one could use less than forty (40) cards, but because of respondent overload, one should not exceed the upper number limits.

Forced Versus Unforced Sorting

One of the most controversial aspects of the Q-sort technique in the literature has been forced versus unforced sorting procedures for the Q-set items. The forced sort requires the subject to place the cards in a predetermined number of piles; each pile has a predetermined number of cards. By specifying the number of cards per pile and the number of piles the investigator controls the shape and the scatter of the distribution curve.

Brooks (1970, p. 169) offered an example of the forced sorting procedure. Given ninety items describing a person, the person is asked to sort the cards along a rank order continuum from "Most like me" to "Least like me" with varying degrees between the extremes. This is exemplified below; the numbers signify the number of cards per pile.

Most like me — Least like me

3	4	7	10	13	16	13	10	7	4	3

> The center pile with 16 cards is neutral. The statements in this pile may be ambiguous to the sorter or may be left over after he made other choices. The three statements or items in the pile at the extreme left are the statements the sorter believes to be most like himself, while the three statements or items in the pile at the extreme right are the statements the sorter believes to be least like himself. (Brooks, 1970, p. 170)

Brooks (1970, p. 170) offered other potential distributions with differing numbers of cards and categories. These distributions were used in research by Block (1961), Knapp (1963), and Goldberg (1963).

The unforced Q-sort allows the sorter to place any number of statements within a category and to use any number of categories. Olson and Gravitt (1968, p. 15) pointed out that sometimes maxima or minima are specified by the investigator. This type of sorting procedure, sometimes called free-choice, allows the final distribution to have any shape and scatter.

Brown (1971, p. 283) cited the common argument against forced sorting. Such sorting "discards possibly important information in terms of elevation, scatter, and skewness." Cronbach and Gleser (1953, p. 461) have supported this argument strongly. They defined elevation as the "mean of all scores for a given person;" scatter as "the square root of the sum of squares of the individual's deviation scores about his own mean;" and shape as "the residual information in the score set after equating profiles for both elevation and scatter." Additionally, Gaito (1962) and Jones (1956) leveled the same criticisms against forced sorting.

Kerlinger (1972, p. 17) recognized that each time a coefficient of correlation is computed the elevation (means) and scatter (standard deviation) is lost which results in all individuals having the same general mean and the same general standard deviation. However, he argued for the forced distribution:

> Because all subjects do not "naturally" sort the cards into a normal distribution does not mean that a normal distribution or quasi-normal distributions should not be used. There are several reasons why subjects do not sort 'normally': the sample of items, and so on. Furthermore, the distribution of traits may be normal, but subjects may of course not perceive the distribution in themselves.

Several studies have been undertaken to compare forced and unforced procedures. Hess and Hink (1959, p. 89) after a study of the two procedures concluded that "...the free and forced sorts do not give strikingly different results." Brooks (1970, p. 172) described a similar study in which subjects were asked to do a forced and unforced sort with a set of items. "When the subjects' unforced sorts were correlated with their forced sorts, the mean for the 55 correlations was found to be .94 and only two correlation coeffecients were below .90."

Brown (1971, p. 283) reported that other investigators--in particular: Livson and Nichols (1956), Nunnally (1967), and Schill (1966)--have concluded that distribution shape does not matter. In a theoretical study Brown (1971) developed eleven strikingly different, Q-sort distributions (skewed right, skewed left, normal, rectangular, platykurtic, leptokurtic, etc.) and compared the possible correlations of the results. He concluded that the distribution does not noticeably effect correlation coefficients or factor loadings of these correlation coefficients when factor analysis is used as an extended analysis of the data. In the study he used four procedures for intercorrelating the eleven distributions: "(a) Kendall's $\underline{\tau}$ corrected for ties; (b) Pearson's $\underline{r}$; (c) Spearman's $\underline{r}$ uncorrected for ties; and (d) Spearman's $\underline{r}_s$ corrected for ties." (p. 284) He concluded that Pearson's $\underline{r}$ was the best procedure for intercorrelational purposes.

Brooks (1970, p. 172) summarized the criticisms of several researchers with regard to forced sorting. The thrust of the criticism is on statistical grounds to the effect that the forced sort violates the assumption of independence; that is, the chance that an item can be placed in any pile is lessened with each placement of an item in a pile. Brooks then offered four rebuttals to this criticism:

> (1) all forced choice procedures violate the assumption of independence, thus making Q sorting no different from other commonly used instruments in the behavioral sciences;
>
> (2) when a Q sort is properly administered, subjects understand that they are free to take any item from the pile into which it has been sorted and place it in any other pile;
>
> (3) the violation is so minute that 'it is doubtful that too much is risked in Q-statistical situations, if there is a fairly large number of items...'; and
>
> (4) the requirement for statistical significance in Q sorts may be raised from the .05 level to the .01 level.

A calculation by Brown (1974, p. 5) illuminates point (3) of Brooks' rebuttal. He reported that a Q-set having fifty-five (55) items to be sorted offers the sorter 1,485 judgments in the process. This is calculated from the formula $1/2n(n-1)$, where "n" represents the total number of items in the Q-set.

Brooks (1970, p. 172) and Kerlinger (1973, p. 596) reported that Q-sorting is criticized because it is said to constrain the subjects; they do not like to do the sorting. However, both researchers report opposite results from subjects with whom they have worked. Also, Livson and Nichols (1956, p. 162), having used Q-sorting procedures, reported that "the Q sorter is his own worst critic and that researchers should not be unduly alarmed by adverse sorter criticisms of the method."

If the free-choice Q-sorting procedure is used, it often provides data which are too unwieldly, or even impossible, to analyze. Whereas, the forced Q-sorting procedure yields data which are more easily analyzed (Brooks, 1970, p. 173). Block (1956, p. 492) concluded from a comparative study of forced versus free-choice procedures that "...no great loss is suffered and many benefits are achieved...by forcing all sorters into comparable data systems." Olson and Gravitt (1968, p. 19) compared forced versus free sorting and concluded that "...little information was either gained or lost as a result of either method."

As with validity, reliability is a term that refers to measures or test instruments. If an instrument is reliable in a given situation, it is said to be true, stable, and relatively free from random error. Hence, discussion of the reliability of Q-technique must be couched in this perspective. "It is possible, however, to speak about the potentials of a method to produce reliable data. A measure is reliable if it is accurate; that is, if the items of the measure are homogeneous and internally consistent." (Cataldo, et al., 1970, p. 208) From a measurement viewpoint, one might prefer the word "precise" instead of the word "accurate" in Cataldo's statement.

To this end investigators have reported the reliability of the Q-technique. Frank (1956) used the test-retest method to ascertain the reliability of Q-sorts. Using Pearson's r, he calculated the reliability coefficients and found them to be between .93 and .97. Hess and Hink (1959) also used test-retest methods and Pearson's r as a means of calculating reliability coefficients. Their values ranged as high as .95 and .99. Olson and Gravitt (1968) also used the test-retest method, over a two week period, and calculated the Pearson's r to determine reliability values. Their study produced average reliability coefficients of .80. Livson and Nichols (1956, p. 165) discovered from their study that "...as more discriminations were made in the (forced) Q-sort situation, the test-retest reliability of the sort tended to increase." They recommended that if one were to use a forced distribution, it should be a rectangular distribution.

<u>Sampling</u>

Q-sorting is possibly a more time consuming method of data collection than are some other commonly used methods. For this reason the consideration of the number of subjects to be used becomes important. Kerlinger (1973, p. 595) concluded that cross-sectional or large sample type studies are not well suited for the use of Q-sort technique. He argued for carefully selected small samples unto which one would apply the Q-sort technique. Guilford (1954, pp. 532-533) suggested that stable correlations of data can be obtained if the number of responders is approximately three times the number of items in an instrument.

The major criterion is representativeness--making sure that all parties or groups of people are represented. This can be accomplished via random sampling of a population universe. Schlinger (1969, p. 55) suggested the structured sample design as the most judicious means to achieve representativeness.

> Such a design allows the researcher to predetermine the classes of respondents for the study, and it allows the researcher to specify how many respondents within each class should be interviewed. Structured samples are not intended to represent proportionately, the characteristics of the...population. Instead the structured samples are used in order to make certain that relevant sub-classes of respondents are sufficiently represented even though the incidence of those in the population may be relatively small.

Analysis

After the data are collected one must consider how the data will be analyzed. Actually, the data are in a sense "created." Given the continuum of piles for card placement purposes, one assigns numerical values to each pile. All statistical analyses are performed on these assigned values. In the figure below the numbers above the line are the number of cards per pile, while the numbers below the line are those assigned for computational purposes.

3	4	7	10	13	16	13	10	7	4	3
+5	+4	+3	+2	+1	0	-1	-2	-3	-4	-5

Brown (1970, p. 183) pointed out the several potential methods for analysis of Q-sort data. Correlation, factor analysis, analysis of variance, chi-square, and percentage and frequency counts have all been used in Q-studies. An examination of Q-literature revealed that most analysis have been correlational in nature (Wittenborn, 1961, pp. 132-142). Kerlinger (1972, p. 15) has expressed his belief that the amenability of Q-data to correlational analysis is one of its salient, technical strengths. "This is an important and powerful mode of analysis that enables the behavioral scientist to test theories...in a preliminary way and, just as important, to discover aspects of theory, that he may not be aware of, or that he may only have been vaguely groping for."

Factor analysis is rapidly becoming a tool of the researcher as he endeavors to discover relationships in data. Factor analysis allows one to group either items or subjects on the basis of the various Q-sorts by the subjects in such a way that one can "...reduce the number of variables to those few which appear to be most responsible or most active in the process he is studying." (Brooks, 1970, p. 174) Brooks further pointed out that parametric statistical tests, such as t and F may be used to evaluate the significance of the differences of the various factors. "If the distribution of the Q values of the two groups being compared are reasonably symmetrical and have variances that are not too divergent, then the t test may be used to test the significance of the difference between means of two groups or the F test for three or more groups." (Brooks, 1970, p. 175)

Although analysis of variance has been used in the analysis of Q-sort data, it is not used as often as other methods are. Kerlinger (1972, p. 14) advised "...to use analysis of variance and other statistical tests and indices as though it were all right to do so, but to be especially careful in conclusions and generalizations drawn from such analyses." The warning is offered in light of (1) forced "normalacy" of the distribution due to forced sorting procedures and (2) the "loss" of independence of a Q-set's items, due to separate item placement in a pile. Examples of studies using analysis of variance are Neff and Cohen (1967) and Nahinsky (1965; 1967). Brown (1970) after a review of the literature stated:

> ...a review of Stephenson's papers, including The Study of Behavior (Stephenson, 1953), will show surprisingly little reliance on analysis of a variance as the preferred analytic method. In fact a search of the literature on Q (Brown, 1968) will not yield a single paper by Stephenson in which analysis of variance is the primary analytic method, and only a handful of papers will be found in which he mentions analysis of variance, and then in the form of a warning that it ought not to be given analytic prominence.

Chi-square was used as an analytic method by Olson and Gravitt (1968). It was used by them to compare sorters' responses to, first, a free-choice sort and then to a forced sort.

Once a factor analysis of the Q-sort data has been accomplished, factor arrays can be developed. Using the R-perspective, the result is particular items which substantially load on a factor or factors. To develop a factor array, "One uses weighted averages of the responses of the individuals substantially loaded on a factor to determine the items most associated with the factor." (Kerlinger, 1972, pp. 24-25) Kerlinger, on a later date, described the process more extensively:

> A factor array is a Q sort constructed from factor analytic results. Conceive factors as similar clusters of objects--in this case persons, or rather, the responses of persons. Those individuals who respond to a Q sort similarly will form clusters of persons. Oversimplified, conceive of summing responses of the individuals of a cluster to any Q-sort item. If we do this for every item in a Q-sort, we will have sums for all items. These sums will, of course, vary a great deal. They can be rank-ordered and then fitted into the original Q distribution. This "new" synthetic Q sort is literally a description of the factor, which can be directly interpreted. Usually the top and bottom two or three piles of the Q distribution are used for interpretive purposes. Factor arrays are calculated similarly for each factor. (Kerlinger, 1973, p. 592)

Although Kerlinger described the factor array in terms of persons, as if one is operating from the Q-perspective, his description is quite apropos to factor arrays developed in terms of items, as if one is operating from the R-perspective.

CHAPTER III

METHODS AND PROCEDURES

Introduction

This chapter describes the methods and procedures which were used in this study to develop the instrumentation, to collect the data, and to analyze the data. The organization of this chapter follows the same order in which the study was conducted. First it was necessary to develop a theoretical definition of scientific literacy before anything else could be done. By the time this was accomplished it had been decided that a structured Q-set and a biographical questionnaire would be the best means of instrumentation given the hypotheses that were to be tested. The sample of persons was drawn, and the data were collected. Another, separate sample of persons, representative of the study sample, was developed. This sample of persons was used in a test-retest setting in order to obtain data which could be used to determine reliability coefficients for the stability of the SLQ. Finally, the data for the main study were coded, punched on cards, and computer analyzed.

Development of a Theoretical Model of Scientific Literacy

The process of developing a Theoretical Model of Scientific Literacy (TMSL) was begun in June, 1974 and continued through February, 1976. Utilizing (1) the data base of the Educational Resources Information Center (ERIC) at the ERIC Clearinghouse on Science, Mathematics, and Environmental Education at The Ohio State University; (2) science education journals such as: Journal of Research in Science Teaching, Science Education, and School Science and Mathematics; and (3) appropriate dissertations found through Dissertation Abstracts, 1885 to the present, a collection of statements describing scientific literacy was made. The individual statements were for the most part gleaned from larger sets of statements developed by science educators or persons interested in the teaching of science.

The goal, pursued by this investigator, was to develop a theoretical definition of scientific literacy. The task was perceived to be that of developing a scheme by which the various statements could be uniquely classified. After many attempts, a scheme containing eleven (11) dimensions was developed. Each dimension contained a number of categories, and within each category were the statements which had been gleaned from the literature review. Figure 3 contains a representative portion of this classification scheme.

Dimension Name	Science and Culture	
	The scientifically literate person:	
Category Label	IX.1	Understands the broad cultural perspective of science.
Literature Statements	IX.1.1	...sees the need to view the scientific enterprise within the broad perspectives of culture, society, and history. (Hurd, 1970, p. 15)
	IX.1.2	...understands the interactions between science and the general culture. (Klopfer, 1969, p. 6)
	IX.1.3	...is aware of certain important historical and philosophical developments in science. (Kaiser, 1973)

Figure 3

A Representative Portion of the Initial Classification Scheme

This scheme was given to the eight (8) science educators of the Faculty of Science and Mathematics Education at The Ohio State University plus the director of the Center for Unified Science Education located at The Ohio State University. These persons were asked to critique the scheme in terms of:

1. proper grouping of literature statements for common meaning;
2. appropriate category labeling; and
3. appropriate dimension naming.

As a result of the criticisms offered by these persons, it was decided that much confusion developed when this particular classification scheme was used as a theoretical definition of scientific literacy. Specifically, the literature statements did not have the same meaning to each individual; some literature statements seemed to belong to more than one category; and some categories seemed to belong to more than one dimension.

Noting that the literature statements were couched in terms of behaviors that could be expected of the scientifically literate person, it was conceived that perhaps a more meaningful classification scheme could be developed utilizing the cognitive and affective taxonomies. Drawing upon the ideas presented in Handbook I: Cognitive Domain (Bloom, 1956) and Handbook II: Affective Domain (Krathwohl, 1964), the previous classification scheme was modified. Upon refinement this resulted in the Theoretical Model of Scientific Literacy (TMSL) which was the theoretical definition of scientific literacy for this study (Appendix A). Figure 4 highlights the structure of the TMSL.

A THEORETICAL MODEL OF SCIENTIFIC LITERACY

Dimensions of Scientific Literacy	Taxonomies of Educational Objectives								
	A. Major Classes of the Cognitive Domain						B. Major Classes of the Affective Domain		
	1.	2.	3.	4.	5.	6.	1.	2.	3.
1.									
I.2.									
3.									
II.									
III.									
IV.									
V.									
VI.									
VII.									
VIII.									

Figure 4

Structure of the TMSL

The TMSL is a two-way, classification scheme with dimensions of scientific literacy versus taxonomies of educational objectives. The two taxonomical domains are the cognitive domain and the affective domain. The cognitive domain is sub-divided into six (6) major classes:

A.1 knowledge, A.2 comprehension, A.3 application, A.4 analysis, A.5 synthesis, and A.6 evaluation. These classes and their descriptions were adapted from Handbook I: Cognitive Domain (Bloom, 1956). The affective domain is subdivided into three (3) major classes: B.1 valuing, B.2 behaving, and B.3 advocating. These classes and their descriptions were adapted from Handbook II: Affective Domain (Krathwohl, 1964). The classes define the columns of the matrix.

The dimensions of scientific literacy define the rows of the matrix. The particular dimensions chosen seemed to subsume the greatest number of literature statements in the most succinct manner. For this study the dimensions of scientific literacy were:

I. Organization of Knowledge;

II. Intellectual Processes;

III. Values and Ethics;

IV. Process of Inquiry;

V. Human Endeavor;

VI. Interaction of Science and Technology;

VII. Interaction of Science and Society; and

VIII. Interaction of Science, Technology, and Society.

There are two noticeable differences between the delineation of dimensions used in this study and those discussed in Chapter II. "Nature of science" and "attitudes toward science" are not treated as distinct dimensions. To identify these in the TMSL it would be necessary to use a three-way perspective as opposed to the two-way perspective which is used. Pella, O'Hearn, and Gale (1966, p. 200) addressed this issue with regard to "attitude toward science" (see page 45 of Chapter II).

Each cell in the TMSL contains at least one element. Each cell has two characteristics: (1) a dimension characteristic and (2) a major class characteristic. Each cell contains at least one element. An element describes a behavior that can be expected of a scientifically literate person. The statements about scientific literacy which were found in the literature were used to develop the elements. The elements were written to capture the essence of what other writers had previously stated. Some cells were initially empty because appropriate literature statements were not found. Elements were written to fill these cells. Figure 5 indicates which cells were filled in this manner.

Because the descriptions of scientific literacy found in the literature were used to develop the elements, coherence does not always exist in going across a dimension. Therefore, each element should be thought of as a single sample drawn from a population of elements each of which would be appropriate for a particular cell.

The TMSL has a quasi-hierarchical nature. The dimensions of the matrix increase in complexity from the Organization of Knowledge dimension to the Interaction of Science,

A THEORETICAL MODEL OF SCIENTIFIC LITERACY

Dimensions of Scientific Literacy	Taxonomies of Educational Objectives: A. Major Classes of the Cognitive Domain						B. Major Classes of the Affective Domain		
	1.	2.	3.	4.	5.	6.	1.	2.	3.
I. 1.						x		x	
I.2.									
I. 3.				x	x	x	x		
II.									
III.					x				
IV.			x				x	x	x
V.							x		
VI.							x	x	x
VII.								x	
VIII.									

Figure 5

Cells of TMSL for which Appropriate Statements Were Not Found in the Literature

Technology, and Society dimension. Within the Organization of Knowledge dimension there are three components: I.1 a Factual Component, I.2 a Generalizations Component, and I.3 a Discipline Component. A component is a recognizable group of behaviors which is a subset of a dimension. In this case the dimension increases in complexity from the Factual Component to the Discipline Component.

The affective domain is seen as being more complex than is the cognitive domain. The cognitive domain is more easily dealt with programmatically than is the affective domain (Shock, 1973). Each of the two domains increases in complexity from left to right. That is, major classes tend to be subsumed by the ones to their right (Stedman, 1973; Kropp and Stoker, 1966).

Each element is of an "entry level" nature. "Entry level" implies the least of which would be expected of a scientifically literate person.

Development of the Scientific Literacy Q-set

It was decided that the Q-sort technique would be an appropriate instrumentation technique to use to collect data for the purpose of pursuing Problem 1 (see page 23 of Chapter I). A structured Q-set embodies a theory, and when sorted by persons it allows for the study of the embodied theory (see pages 70-72 of Chapter II: Kerlinger, 1968, p. 588; Brooks, 1970, p. 168; Olson and Gravitt, 1968, pp. 14-15; and Stephenson, 1953, pp. 65-85).

The Scientific Literacy Q-set (SLQ) was developed over a five (5) month period from October, 1975 through February, 1976. By developing the SLQ on the basis of the TMSL a structured Q-set was produced.

A prototype SLQ was developed which had one Q-statement for each element in the SLQ. The results of a small pilot study indicated that this was too many Q-statements.

It was decided to randomly select forty-five (45) elements from the TMSL to be represented in the SLQ. Three stipulations were imposed. Only one element from a cell could be selected (this was done using a table of random numbers). Five (5) cells would be selected from each major class (see page 71 of Chapter II: Goldberg, 1962, p. 255 and Brown, 1975). The three (3) components of Dimension I would be treated as though they were each a dimension. The reason for this latter stipulation was that there were so many more literature statements appropriate to Dimension I than there were for the other dimensions. Figure 6 shows which cells of the TMSL were selected to be represented in the SLQ. The underlined identification numbers in the TMSL (Appendix A) are the elements which were selected to be represented in the SLQ.

The eventual use of the SLQ with persons in the general public meant that possibly some persons would have low reading levels. A decision was made to rewrite each element selected at an eighth grade reading level. This was accomplished by:

A THEORETICAL MODEL OF SCIENTIFIC LITERACY

Dimensions of Scientific Literacy	Taxonomies of Educational Objectives: A. Major Classes of the Cognitive Domain						B. Major Classes of the Affective Domain		
	1.	2.	3.	4.	5.	6.	1.	2.	3.
I. 1.	x		x	x	x	x			
I. 2.		x	x		x		x		
I. 3.	x				x	x		x	x
II.				x			x	x	x
III.	x	x			x	x	x		
IV.	x	x	x	x	x				
V.				x			x	x	x
VI.	x	x	x	x		x			
VII.		x				x		x	x
VIII.			x				x	x	x

Figure 6

TMSL Cells Randomly Selected to be Represented in the SLQ

1. using elementary science textbooks for appropriate words;

2. using the Dolch word list (Buckingham and Dolch, 1936);

3. using the Fry Readability Formula (Fry, 1968); and

4. developing definitions for key words which of necessity had to be used.

The definitions of these words were presented on the instruction sheet for sorting the SLQ (Appendix B).

Questions were raised about the efficacy of the SLQ and the sorting instructions. Because the Q-statements reflect the two-way, classification scheme of the TMSL, the question was posed as to whether persons would consistently key on one characteristic to the exclusion of the other while sorting the Q-statements. Secondly, were the sorting instructions easy to use? Thirdly, were the definitions on the sorting instructions sheet useful?

To answer these questions a pilot study was undertaken with a ninth grade science class in Franklin County, Ohio. It was selected because:

1. it was composed of students from a middle class neighborhood; and

2. the mean reading level of the class was below ninth grade level.

Fifteen (15) representative statements were selected from the SLQ. This set of fifteen (15) Q-statements constituted a Modified SLQ for this phase of piloting. Four (4) variations of the Modified SLQ were produced.

1. Variation one was comprised of Q-statements just as they came from the SLQ.

2. Variation two had the verbs of the Q-statements underlined to emphasize the major class characteristic of the TMSL.

3. Variation three had key words within the Q-statements underlined such that the dimension characteristic of the TMSL was emphasized.

4. Variation four had both verbs and key words underlined in order to emphasize the two primary characteristics of the TMSL.

It was hypothesized that underlining would focus attention on particular parts of the Q-statements during the sorting process, if true then the sorting of the variations of the Modified SLQ would produce significantly different sorts. The sets were randomly distributed to the students. The students were asked to sort the fifteen (15) Q-statements in accordance with the sorting instructions. The instructions called for:

2 cards in each of the +4, +3 and +2 piles;

1 card in each of the +1, 0, -1 piles; and

2 cards in each of the -2, -3, and -4 piles.

Questions raised by individual students about particular Q-statements and the sorting process were noted. In addition, after the students had completed the task, they were asked about the Q-statements as a whole, particular words, the sorting process, and the format of the sorting instructions. These responses were recorded to be used to refine the sorting instructions and the Q-statements in the total SLQ.

The pilot study data were prepared for computer analysis. The subprogram CROSSTABS from the Statistical Package for the Social Sciences (SPSS) (Nie, et al., 1975) was used to confirm that the four (4) variations of the Modified SLQ were distributed randomly to the students with respect to their reading abilities.

To determine if any one (1) of the variations of the Modified SLQ was sorted in a significantly different way, a univariate analysis of variance was made (Clyde, 1969). Each of the Q-statements was treated as a dependent variable, and the underline condition was treated as the independent variable. The four (4) variations of underlining were coded as values of the independent variable. Table 1 is a summary of the results of the analyses of variance. Since none of the univariate F tests were significant, $p \leq 0.05$, it was concluded that none of the variations produced significantly different results.

The students' verbal reactions during the pilot study were used to refine the total SLQ and the sorting instructions. It was decided not to underline any part of any of the Q-statements in the SLQ. In late February, 1976 the total SLQ was piloted. This time twelve (12) adults, three (3) for each type of person to be used in the major study, were asked to use the sorting instructions to sort the SLQ. After each person completed the sort they were interviewed in terms of:

Table 1

ANOVA Results for the Effect of Underlining on Rank of Q-statements

Q-statement	F[a]	Mean SQ	p
VIIB31	0.482	4.042	0.699
IIIA21	0.961	5.486	0.430
VB31	0.485	4.153	0.696
IB33	2.878	17.486	0.062
VB21	0.964	7.889	0.429
VIIIB31	0.085	0.819	0.967
IVA11	0.403	4.153	0.753
IVA31	0.373	2.833	0.774
IA51	0.013	0.111	0.998
IVA51	0.503	5.042	0.685
IA13	1.653	10.333	0.209
IA41	0.722	4.944	0.551
VIIA61	1.193	12.944	0.338
IA223	0.088	0.708	0.966
IA31	1.916	11.111	0.160

[a]df = 3,20

1. what meaning they read into the words and the Q-statements; and
2. the viability of the sorting instructions.

The Q-statements and sorting instructions were again refined to incorporate their reactions.

At this point it was concluded that the Q-statements of the SLQ:

1. were easily readable;
2. were written at an eighth grade level; and
3. had the same meaning as did the TMSL elements which they represented.

Appendix C contains the SLQ used in the major study. The Q-statements are ordered as they appeared in the SLQ. The lower left-hand identification numbers were not on the Q-statements which persons in the study received. They have been added to identify the appropriate element in the TMSL which each Q-statement represents. The lower right-hand numbers were on the Q-statements which the persons in the study received. These numbers were used to order the Q-statements randomly in the SLQ.

Development of the Sorting Instructions

The sorting instructions for the SLQ (Appendix B) were referred to in the discussion of the piloting of the SLQ. The reading level of these instructions is below eighth grade level (Fry, 1968). The instructions ask persons to sort the Q-statements of the SLQ into a rectangular distribution of nine (9) piles with five (5) cards per pile. This means that persons were asked to distribute the Q-statements using a forced sort technique. The forced sort technique requires the person to place the Q-statements in a predetermined number of piles; each pile must contain a predetermined number of cards. By specifying the number of piles and the number of cards per pile the shape of the distribution curve is controlled.

Cronback and Gleser (1953), James (1956), and Gaito (1962) have criticized the forced sort. Stephenson (1953), Brooks (1970), and Kerlinger (1973) have argued for the forced sort. Hess and Hink (1959) and Brooks (1970) cited research findings which indicated that the forced sort does not give strikingly different results from non-forced sorts on the same Q-sets. See pages 75-77 of Chapter II.

Hess and Hink (1959), Schill (1966), Nunnaly (1967), Brooks (1970), and Brown (1971) have concluded on the basis of research findings that the forced distribution which results from a forced sort does not greatly influence the results of the analysis of the data. Livson and Nichols (1956) argued for the use of a rectangular forced sort on the grounds that test-retest reliability of the sort is enhanced. See pages 77-80 of Chapter II.

The note after STEP 6 and the comment in STEP 12 explain to the persons that Q-statements may be changed from one pile to another at any time. This is in line with Brooks' (1970) comments. See page 78 of Chapter II.

The persons sorting the Q-statements were asked to do so in terms of how important they thought each was. This reflects Showalter's approach in his use of members of the National Association for Research in Science Teaching to create an "operational definition of scientific literacy" (1969, p. 48). See page 55 of Chapter II.

Development of the INFORMATION SHEET

The INFORMATION SHEET (Appendix D) was developed to collect data for the purpose of testing Hypotheses 1 and 2. The information requested of each person fell into the broad areas of:

1. amount of previous education;
2. amount of previous science education;
3. amount of previous education of parents or guardians;
4. occupation;
5. age; and
6. sex.

The INFORMATION SHEET was piloted during the final piloting of the SLQ. This was described on page 73. Based upon the persons reactions it was revised to:

1. ensure that it could be easily completed; and
2. ensure that the necessary information would be secured from each person.

Development of the Population Sample

The Sampling Frame

To focus on two types of persons, science oriented and nonscience oriented, it was arbitrarily decided that persons' occupations would be most indicative of their particular orientation. Science oriented persons would most likely have science related occupations. Nonscience oriented persons would most likely not have science related occupations.

It was decided that the sample of persons for the study would be drawn from two different sources. One portion would be drawn from faculty members at The Ohio State University. The other portion would be drawn from persons residing within Franklin County, Ohio. Since there was a high probability that the university persons resided in or very close to Franklin County, it was assumed that variables such as form of government, politics, economic conditions, and religious persuasions would be partially controlled.

Figure 7 indicates the numbers of persons by type that were drawn. Seventy-five (75) University Science Oriented persons (UNVSC), seventy-five (75) University Nonscience

	Science Oriented	Nonscience Oriented
University	75 persons	75 persons
Public	100 persons	100 persons

Figure 7

The Sampling Frame Used for the Study

Oriented persons (UNVNONSC), one hundred (100) Public Science Oriented persons (PUBSC), and one hundred Public Nonscience Oriented persons (PUBNONSC) composed the sample for the study. Three considerations were made in deciding on this sampling frame.

1. Stable correlations of data can be obtained if the number of responders is approximately three (3) times the number of items in the instrument (Guilford, 1954, pp. 532-533).

2. Large cross-sectional studies are not well suited for the use of the Q-sort technique (Kerlinger, 1973, p. 595).

3. The major criterion in a Q-sort study is representativeness - making sure that all groups of people are represented, not necessarily proportionately (Schlinger, 1969, p. 55).

See page 81 of Chapter II.

The University Sample

The Ohio State University is located in the City of Columbus in Franklin County, Ohio. It is one of the largest universities in the United States with a graduate school enrollment of approximately 8,000 students. Besides the Graduate School and the Undergraduate University College the university has fifteen (15) colleges, four (4) of which are Colleges of Arts and Sciences and eleven (11) of which are undergraduate professional colleges.

The university sample was drawn using the 1975-1976 Faculty and Staff Directory. The listings of departments were divided and alphabetized into two groups, science oriented and nonscience oriented. The science oriented departments were further divided into the pure science departments and the applied science departments. (Note: some of what are called departments in this study are actually faculties. However, for convenience "department" will be used.) Table 2 indicates these divisions.

The assistant professors, associate professors, and professors, who were not visiting professors and who did not have emeritus status, were identified. These persons (in total approximately 3,300) comprised the university population of faculty members from which seventy-five (75) nonscience oriented persons (UNVNONSC) and seventy-five (75) science oriented persons (UNVSC) were drawn. The decision was made to draw thirty-seven (37) pure science persons (UNVPURSC) and thirty-eight (38) applied science persons (UNVAPPSC) to comprise the UNVSC group.

A random sample was drawn from each group in the same fashion. The desired number of persons for each sub-sample was divided into the total population of each group to develop a skip number (Backstrom and Hursh, 1963, pp. 39-40). A table of random numbers was consulted to find a random number less than the skip number. This became the first person in the group to be drawn. The next person drawn was identified by the skip number. For example, if the skip number were 20 and the first person drawn was person 12 then the next person drawn would be person 32. The process

Table 2

Number of Persons in the University Sample by College

Source	Nonscience Oriented	Science Oriented	
		Pure Science	Applied Science
Colleges of Arts and Science			
Arts	14		
Biological Sciences		15	
Humanities	15		
Mathematics and Physical Sciences	5	21	
Social and Behavioral Sciences	17		
Professional Colleges			
Administrative Science	11		
Agriculture and Home Economics	5		3
Education	7	1	
Engineering			12
Pharmacy			
Dentistry			3
Law	1		
Medicine			14
Optometry			3
Veterinary Medicine			3
Total	75	37	38

was continued until the required number of persons was drawn. Table 2 shows the number of persons drawn in each of the groups by the college with which they were associated.

Table 3 shows the number of persons in each group by rank.

Table 3

Number of Persons in the University Sample by Rank

Rank	Nonscience Oriented	Science Oriented	
	UNVNONSC	UNVPURSC	UNVAPPSC
Assistant Professor	22	11	9
Associate Professor	24	5	11
Professor	29	22	17
Total	75	38	37

The Public Sample

The persons from which the public sample of persons was drawn lived within Franklin County, Ohio. The Columbus Area Chamber of Commerce reported that Franklin County had an estimated 1975 population of 905,600; thirteen percent of which was non-white. According to the 1970 federal census Franklin County had 271,253 housing units with an average of 3.1 persons per occupied unit. In 1973 the county birth rate was 16.3 per 1000 persons, and the death rate was 8.3 per 1000 persons. The 1974 assessed valuation of properties was $3,471,512,390.

The R. L. Polk Directory for the City of Columbus, Ohio (Polk, 1975) was used as a source of persons from which to select the public sample. The directory lists persons alphabetically with a description of their full time occupation, by whom they are employed, and with their home address. The two criteria used to select the public sample from the directory were:

(1) the persons worked within the city of Columbus; and

(2) they lived within Franklin County.

The description of each person's occupation was used to determine in which orientation group a person belonged. For both orientation groups the approximate number of persons in the directory was determined; a skip number and a random starting point were developed. As with the university sample the public sample was selected in two parts. First, one hundred (100) public nonscience oriented persons (PUBNONSC) were drawn randomly; second, one hundred (100) public science oriented persons (PUBSC) were drawn randomly.

After the two groups of persons were drawn the Ohio Bell and Vicinity, 1975-1976 Telephone Directory and the Ohio Bell Directory Assistance were used to determine if the selected persons still resided within Franklin County. Twenty-six (26) of the PUBNONSC group and ten (10) of the PUBSC group were found to no longer live in the area. Replacements for these persons were selected randomly from the

R. L. Polk Directory. The confirmation and replacement process was continued until each orientation group contained one hundred (100) persons.

The PUBNONSC persons were classified occupationally using the 1970 Census of Population and Housing - Census Tracts publication of the U. S. Department of Commerce and a listing by Backstrom and Hursh (1963, pp. 99-101). Table 4 compares the occupations of the PUBNONSC group with 1970

Table 4

Compraison of PUBNONSC Group with 1970 Franklin County Census Data by Occupation

Occupational Classification	Male				Female				Total			
	Franklin County		Sample		Franklin County		Sample		Franklin County		Sample	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Professional	60,962	18[a]	8	11	23,769	17	5	19	84,731	18	13	13
Administrators/ Managers	29,762	9	15	21	4,738	3	1	4	34,500	7	16	16
Sales Workers	26,511	8	8	11	9,891	7	1	4	36,402	8	9	9
Clerical Workers	74,166	22	4	5	56,156	41	6	22	130,322	28	10	10
Craftsmen	40,173	12	12	16	-	-	1	4	40,123	9	13	13
Operatives, except Transport	638,991	12	5	7	14,736	11	-	-	53,729	11	5	5
Transport Operatives	12,009	4	4	5	-	-	-	-	12,009	3	4	4
Laborers, Not Farm	12,700	4	11	15	3,438	3	5	19	16,138	3	16	16
Farmers/Farm Managers	-	-	-	-	-	-	-	-	-	-	-	-
Farm Laborers	1,449	0	-	-	200	0	-	-	1,649	0	-	-
Service Workers	35,947	11	2	3	19,626	14	4	15	55,573	12	6	6
Private Household	3,462	1	-	-	3,301	2	-	-	6,763	1	-	-
Retired/No Occupation	-	-	4	5	-	-	4	15	-	-	8	8
Total	336,162	100	73	100	135,857	100	27	100	471,989	100	100	100

[a]Rounded to the nearest percent.

census data for Franklin County.

To determine if the PUBNONSC group of persons represented their respective occupational types in the county, a statistical test of proportions was made on each occupational type total for Franklin County versus the totals for the sample (Ferguson, 1966, pp. 176-178). The Transport Operatives, Laborers, and Farm Laborers were found not to approximate a normal distribution because of the small numbers of sample persons drawn from these types. Of those which approximated a normal distribution the Managers/Administrators and the Clerical Workers were found not to represent their respective types, $p \leq 0.002$. There was too large a percentage of Managers/Administrators in the sample; there was too small a percentage of Clerical Workers in the sample.

Table 5 shows the breakdown of the PUBSC persons into four (4) major types.

Table 5

Proportionment of the Public Science Oriented Sample of Persons by Occupation

	Number	Percent
Technicians (Subtotal)	15	15
Laboratory	4	4
Research	1	1
Engineering	6	6
Dental	4	4
Pure Scientists (Subtotal)	8	8
Engineers (Subtotal)	38	38
Medical Personnel (Subtotal)	39	39
Physicians	9	9
Dentists	3	3
Optometrists	3	3
Podiatrists	1	1
Chiropractors	1	1
Pharmacists	4	4
Nurses	15	15
Radiologists	1	1
Dietitians	1	1
Therapists	1	1
Total	100	100

Data Collection

Before the collection of data was initiated permission was requested from The Ohio State University Human Subject Review Committee to be waived from the requirement of using a consent form with each person selected for the study. Permission was granted. (Appendix E)

Packets of materials were prepared for the 350 persons in the sample. Each packet consisted of:

(1) a form letter with a personalized heading and salutation (Appendix F);

(2) the INFORMATION SHEET;

(3) the INSTRUCTIONS FOR USING THE SMALL CARDS AND SMALL ENVELOPES;

(4) the SLQ;

(5) nine small envelopes marked +4 Most Important, +3,...,-3, -4 Least Important;

(6) a postcard - stamped and addressed to the investigator for the respondent to return stating that the materials had been completed and forwarded; and

(7) a stamped and addressed 5"x7" envelope for returning the responses.

For the nonscience oriented persons blue ink was used to prepare the address labels for their 5"x7" return envelopes. For the science oriented persons black ink was used to prepare the address labels for their 5"x7" return envelopes. Lines were used to differentiate between the returns of the UNVPURSC and UNVAPPSC persons. One line was used to underline "campus mail" on the return envelopes of the UNVAPPSC persons. Two lines were used to underline "campus mail" on the return envelopes of the UNVPURSC persons.

The material packets were mailed to all persons on April 5, 1976 using both the United States Postal Service and the campus mailing system. As the returns were received a record was kept of who had returned the postcard and on what date it was received by the investigator. Also, the number of returns per day for each group was graphed. The graph facilitated an understanding of the rate of return of the materials.

Figure 8 is indicative of the graphing technique; it shows the total daily returns.

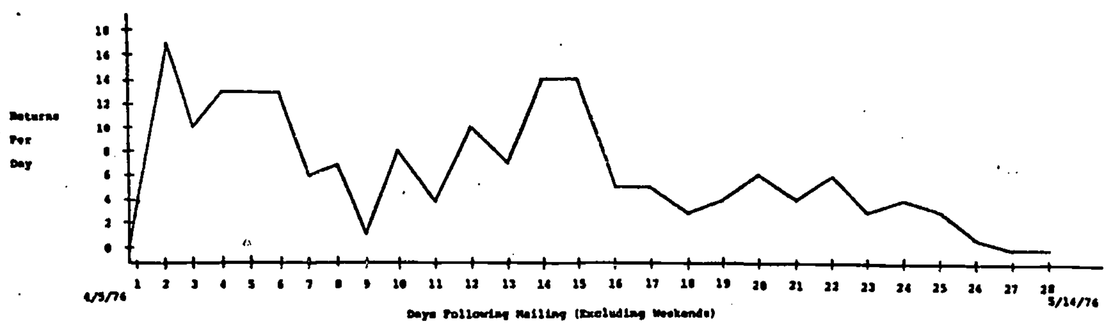


Figure 8

Graph of Total Number of Returns Each Day

It had been decided previously that when an extended and marked drop occurred in the daily returns telephoning would be initiated. Those persons whose postcards had not been received were called. Telephoning was initiated on Day 9 to those persons who had published telephone numbers. Eight (8) percent of the public portion of the sample did not have published numbers. Each call amounted to:

1. determining if the person had received the materials;
2. determining if any portion of the materials should be clarified; and
3. determining if the person planned to complete the materials in the near future.

Some telephone calls resulted in the person stating that the materials had already been discarded or that they would not be completed. This information was recorded.

Telephoning was initiated again after Day 16. Calls were made to those persons who during the first call had indicated they would respond but whose postcards had not yet been received. During the second call, the persons were told that the data collection period would soon end; they were encouraged to respond.

Telephone calls were also made to approximately 15% of the persons who returned the completed materials. These calls were made the same day on which the postcard was received. Each person was asked if he could explain what was in his mind as he sorted the cards. That is, what was the general basis for placing cards on the positive side as opposed to the negative side. These comments were recorded for future use in the interpretation of the results of the data analysis. In addition these persons were asked about their reactions to the sorting process. The responses reflected the same skepticism on their parts as has previously been reported in Q-sort literature (see page 79 of Chapter II).

The data were prepared for computer analysis as they were received. Using the SPSS CROSSTABS subprogram it was determined that telephoning did not bias the way persons responded. After Day 17 the accumulated data were analyzed with the SPSS FREQUENCIES subprogram. This was repeated after Day 28. A comparison of the results of the analyses indicated that the percentage of response on the values of each variable did not change by more than three (3) percent. It was decided to terminate the data collection period after Day 28 and to begin the analysis of the data. Two completed sets of materials were received several days later but were not included in the analyses.

Table 6 summarizes the records which were kept on the returns for each group of the sample. By taking into account those persons who stated they did not receive the materials and those persons whose materials were returned because they had moved, it can be observed that the

Table 6

Summary of Data Collection

Group	Original Sample		Did Not Receive	Adjusted Sample		Responded		
	No.	%	No.	No.	%	No.	% of Adjusted Sample	% of Total
University Science (UNVSC)[a]	75	21.4	7	68	21.9	45	24.3	66.2
University Pure Science (UNVPURSC)	37	10.6	3	34	11.0	23	12.4	67.6
University Applied Science (UNVAPPSC)	38	10.9	4	34	11.0	22	11.9	64.7
University Nonscience (UNVNONSC)	75	21.4	6	69	22.2	46	24.9	66.7
Public Science (PUBSC)	100	28.6	15	85	27.4	52	28.1	61.2
Public Nonscience (PUBNONSC)	100	28.6	12	88	28.4	42	22.7	47.7
Total	350	100	40	310	100	185	100	100

[a]UNVPURSC and UNVAPPSC combined

percentages of responses were similar for the UNVSC, UNVNONSC, and PUBSC groups. The PUBNONSC group had the lowest percentage of response.

An additional question was asked about the returns. Within each of the groups did more of some type or types of persons respond than did other types? A chi-square test was made on each group in terms of the percent sampled to the percent returned by each type of person; for example in the PUBNONSC group Sales Workers would be considered a type of person. It was found that in each group there was no skewing of the number of returns in terms of the types of persons. It was concluded that the responses from each group could be considered representative of each group as it had originally been sampled.

Reliability of the SLQ

Reliability of the Q-sort technique with a given Q-set has most often been determined by a test-retest method. The statistical analysis has been to calculate the correlation coefficient of each Q-statement with itself using Pearson's r. See pages 79-80 of Chapter II.

To determine the reliability of the SLQ in this study the test-retest method was used. A range of one (1) to eight (8) weeks passed between the first and second sorting of the SLQ. Pearson's r was used to calculate the correlation of each Q-statement with itself from the test-retest situation. The sample of persons was selected to represent the five groups used in the study (UNVPURSC, UNVAPPSC, UNVNONSC, PUBSC, and PUBNONSC). There were thirty-eight (38) persons in this sample.

The analysis produced correlation coefficients ranging from 0.1264 to 0.7969. The average of the coefficients was

0.497. Of the forty-five (45) correlation coefficients five (5) were not significant at $p \leq 0.05$ (Guilford and Fruchter, 1973, p. 516). The five (5) Q-statements which did not correlate significantly were Q37, Q8, Q10, Q20, and Q42. Excluding these, the average correlation coefficient of the remaining forty (40) Q-statements was 0.5332.

The Variables

The variables which were used to test Hypotheses 1 and 2 are presented in this section. The following presents:

1. the section of the INFORMATION SHEET from which the variable was developed;
2. the variable symbol;
3. a description of the variable;
4. the coded values of the variable for computer analysis; and
5. the value labels.

INFORMATION SHEET SECTION	VARIABLE SYMBOL	VARIABLE DESCRIPTION	CODED VALUE	VALUE LABEL
A	SEX	sex of respondent	1[a]	female
			2	male

INFORMATION SHEET SECTION	VARIABLE SYMBOL	VARIABLE DESCRIPTION	CODED VALUE	VALUE LABEL
B	AGE	age of respondent	1 2 3 4 5 6	18-25 years 26-35 years 36-44 years 45-54 years 55-65 years 66 years or older
F	OWNSCHYR	last year completed by respondent	1-8 9-12 13-16 17-24	elementary school secondary school college graduate or professional school
G	MOTSCHYR	last year of school completed by mother/ guardian of respondent	1-8 9-12 13-16 17-24	elementary school secondary school college graduate or professional school
H	FATSCHYR	last year of school completed by father/ guardian of respondent	1-8 9-12 13-16 17-24	elementary school secondary school college graduate or professional school
J	SHGENSCI	senior high science	0 1	did not have did have
J	SHERTSCI	senior high earth science	0 1	did not have did have
J	SHBIOL	senior high biology	0 1	did not have did have
J	SHCHEM	senior high chemistry	0 1	did not have did have

INFORMATION SHEET SECTION	VARIABLE SYMBOL	VARIABLE DESCRIPTION	CODED VALUE	VALUE LABEL
J	SHPHYS	senior high physics	0 1	did not have did have
J	CLBIOSCI	college level biological sciences	0 1 2 3	no space checked 0-12 quarter hrs 13-36 quarter hrs 37 or more quarter hrs
J	CLPHYSCI	college level physical sciences	0 1 2 3	no space checked 0-12 quarter hrs 13-36 quarter hrs 37 or more quarter hrs
J	CLERTSCI	college level earth sciences	0 1 2 3	no space checked 0-12 quarter hrs 13-36 quarter hrs 37 or more quarter hrs
J	CLENGSCI	college level engineering courses	0 1 2 3	no space checked 0-12 quarter hrs 13-36 quarter hrs 37 or more quarter hrs
	IA11 to VIIIB31	the 45 Q-statements of the SLQ	+4 +3 +2 +1 0 -1 -2 -3 -4	most important least important

INFORMATION SHEET SECTION	VARIABLE SYMBOL	VARIABLE DESCRIPTION	CODED VALUE	VALUE LABEL
	STATUS[b]	the respondents categorized into five (5) groups	1	university pure science persons (UNVPURSC)
			2	university applied science persons (UNVAPPSC)
			3	university nonscience persons (UNVNONSC)
			4	public science persons (PUBSC)
			5	public nonscience persons (PUBNONSC)
	ORIENT[b]	the respondents categorized into two (2) groups	1	science oriented persons
			2	nonscience oriented persons

[a] In addition to the variable values listed blanks were coded for all variables to which the respondent did not respond.

[b] These variables were created in preparing the data for the SPSS system from the identification of the respondent's return envelope.

Analysis of the Data

As has been discussed the data were coded for computer analysis. Punched cards were visually checked for mistakes, and the raw data were compared to outputs of the various SPSS (Nie, et al., 1975) subprograms for errors. When the punched cards were believed to be completely accurate the analysis of the data was begun.

The SPSS subprogram FREQUENCIES was used to ascertain the absolute frequency and the percentages of response on each value of each variable. This subprogram also computed the values of the mean and standard deviation for the variables.

The SPSS subprogram PEARSON CORR was used to derive the correlations among the variables. Charts were constructed to show graphically the significant correlations.

The SPSS subprogram FACTOR was used for factor analysis of the responses to the Q-statements. In the factor analysis principle-component solutions were developed with the main diagonal elements of the correlation matrix replaced by R^2 communality estimates. Orthogonal rotations were developed as opposed to oblique rotations. This subprogram was also used to develop standardized factor scores for the factor solutions which were developed.

The SPSS subprogram ONEWAY was used to test Hypothesis 1. The factor scores, from each of the seven factors developed for the total sample (OVERALL), were treated individually as dependent variables. The test for significant differences was made with:

1. ORIENT: persons were classified as science oriented or nonscience oriented; and
2. STATUS: persons were classified as university pure science, university applied science,

university nonscience, public science, and public nonscience.

ORIENT and STATUS were treated as independent variables. Posteriori testing was done by the Scheffe' method for post hoc multiple comparisons.

The <u>SPSS</u> subprogram REGRESSION was used to test <u>Hypothesis 2</u>. The dependent variables were the seven (7) factor scores from the factor solution for all respondents combined. The independent variables came from the sections in the INFORMATION SHEET which dealt with:

1. amount of previous education;
2. amount of previous science education;
3. amount of previous education of parents or guardians;
4. age; and
5. sex.

CHAPTER IV

ANALYSIS OF THE DATA

Introduction

In this chapter the results of the analysis of the data are presented in five (5) sections. The first section is a presentation of the descriptive statistics - absolute frequencies, percentages, means, and standard deviations - of responses to particular variables, and the second section is a presentation of the results of correlating these variables. Section three is a description of the results of the factor analysis performed on the responses to the Q-statements. In this section the inferred dimensions of scientific literacy are developed and named. Section four compares the science oriented groups of persons to the nonscience oriented groups of persons in terms of the inferred dimensions of scientific literacy. The results of the analyses of variance performed to test Hypotheses 1 (a) and (b) form the basis for this comparison. Finally, section five is a presentation of the regression analyses which were performed to test Hypothesis 2. An overall summary concludes the chapter. In this summary the results from the previous analysis sections were brought together.

Descriptive Statistics for INFORMATION SHEET Data

The variables discussed in this section were generated from the INFORMATION SHEET. Each table in this section specifies the number of persons and the respective group proportion of those persons who did not respond to each variable. These "non-responders" were excluded from all calculations which ultimately were summarized in terms of means and standard deviations. The SPSS subprogram FREQUENCIES (Nie, et al., 1975) was used to analyze the data for this section.

Overall 85% of the respondents were males and 15% were females (Table 7). The PUBNONSC and UNVNONSC groups had

Table 7

Frequency and Percentage for Sex of Respondents (SEX)

Group	No Response		Female		Male	
	No.	% of Group	No.	%[a]	No.	%
UNVPURSC	1	4.3	1	4.5	21	95.5
UNVAPPSC	1	4.5	-	-	21	100.0
UNVSC[b]	2	4.4	1	2.3	42	97.7
UNVNONSC	6	13.3	8	20.0	32	80.0
PUBSC	1	1.9	6	11.8	45	88.2
PUBNONSC	1	2.4	12	29.3	29	70.7
OVERALL	10	5.4	27	15.4	148	84.6

[a] Adjusted to exclude the No Response column

[b] UNVPURSC and UNVAPPSC combined

greater percentages of females than did the PUBSC and UNVSC groups. Recalling that in Table 4 on page 110 of Chapter III the PUBNONSC group was 27% female, the 29.3% female response might seem strange. It should be remembered that not all persons received the materials so that the original sample was in effect reduced in size (see Table 6 on page 117 of Chapter III). Also one PUBNONSC respondent did not indicate his/her sex. Both factors would contribute to the difference in female percentages.

Table 8 shows that of all groups the PUBNONSC group had the smallest mean age and the largest standard deviation. The PUBSC group was somewhat similar to the PUBNONSC group. As would be anticipated the university respondents tended to be older and have less deviation in their ages.

Only 4% of the respondents were retired (Table 9). The retirees were public persons since the university persons were chosen from a population in which there were no retired persons.

Table 10 does not duplicate Table 4 on page 110 of Chapter III. Table 10 was developed from the more complete description of the respondent's occupation as given in section D of the INFORMATION SHEET. Table 4 was developed from the short description of the person's occupation in the R. L. Polk Directory. Also, a person who was listed as retired in the directory supplied a description of his occupation when he completed the INFORMATION SHEET; this

Table 8

Descriptive Statistics for Age of Respondents (AGE)

Group	No Response[a]		18-25 Yrs.		26-35 Yrs.		36-44 Yrs.		45-54 Yrs.		55-65 Yrs.		66 Yrs. or Older		Mean	SD
	No.	% of Group	No.	%[b]	No.	%	No.	%	No.	%	No.	%	No.	%		
UNVPURSC	2	8.7	-	-	6	28.6	8	38.1	3	14.3	3	14.3	1	4.8	3.286	1.189
UNVAPPSC	-	-	-	-	2	9.1	6	27.3	8	36.4	4	18.2	2	9.1	3.909	1.109
UNVSC[c]	2	4.4	-	-	8	18.6	14	32.6	11	25.6	7	16.3	3	7.0	3.605	1.178
UNVNONSC	5	10.9	-	-	13	31.7	10	24.4	10	24.4	8	19.5	-	.-	3.317	1.128
PUBSC	1	1.9	5	9.8	16	31.4	8	15.7	13	25.5	7	13.7	2	3.9	3.137	1.371
PUBNONSC	1	2.4	7	17.1	12	29.3	6	14.6	8	19.5	4	9.8	4	9.8	3.049	1.580
OVERALL	9	4.9	12	6.8	49	27.8	38	21.6	42	23.9	26	14.8	9	5.1	3.273	1.333

[a] Coded: No Response = blank; 18-25 Yrs. = 1; 26-35 Yrs. = 2; 36-44 Yrs. = 3; 45-54 Yrs. = 4; 55-65 Yrs. = 5; 66 Yrs. or Older = 6

[b] Adjusted to exclude the No Response column

[c] UNVPURSC and UNVAPPSC combined

Table 9

Descriptive Statistics for Retirement Status of Respondents (RETIRED)

Group	No Response[a]		Yes		No		Mean	SD
	No.	% of Group	No.	%[b]	No.	%		
UNVPURSC	1	4.3	-	-	22	100.0	2.000	0.000
UNVAPPSC	-	-	-	-	22	100.0	2.000	0.000
UNVSC[c]	1	2.2	-	-	44	100.0	2.000	0.000
UNVNONSC	5	10.9	-	-	41	100.0	2.000	0.000
PUBSC	1	1.9	2	3.9	49	96.1	1.961	0.196
PUBNONSC	1	2.4	5	12.2	36	87.8	1.878	0.331
OVERALL	8	4.3	7	4.0	170	96.0	1.960	0.195

[a]Coded: No Response = blank; Yes = 1; No = 2

[b]Adjusted to exclude the No Response column

[c]UNVPURSC and UNVAPPSC combined

occupation was coded as such.

Almost all university respondents were classified as professionals whereas 88% of the PUBSC group and 35% of the PUBNONSC groups were. The other more highly represented occupations in the PUBNONSC group were Administrators/ Managers, Craftsmen, and Clerical Workers. The coding of this variable was not of an interval nature but was of a classification nature.

As would be expected the last school attended by the university respondents was a college or university. The same was true of the 90% of the PUBSC group and 54% of the PUBNONSC group. However, 37% of the PUBNONSC group had not gone beyond the high school level (Table 11).

Table 10

Descriptive Statistics for Occupation of Respondents (OCCUPAT)

Group	No Response[a]		Professionals		Managers/ Administrators		Sales Workers		Clerical Workers		Craftsmen		Operatives, except Transport		Transport Operatives		Service Workers		No Occupation		Mean	SD
	No.	% of Group	No.	%[b]	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%		
UNVPURSC	1	4.3	22	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.000	0.000
UNVAPPSC	-	-	21	95.5	1	4.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.045	0.213
UNVSC[c]	1	2.2	43	97.7	1	2.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.023	0.151
UNVNONSC	5	10.9	40	97.6	-	-	-	-	1	2.4	-	-	-	-	-	-	-	-	-	-	1.073	0.469
PUBSC	1	1.9	45	88.2	4	7.8	-	-	-	-	1	2.0	-	-	-	-	-	-	-	-	1.073	0.469
PUBNONSC	2	4.8	14	35.0	6	15.0	1	2.5	5	12.5	6	15.0	3	7.5	1	2.5	3	7.5	1	2.5	3.725	3.146
OVERALL	9	4.9	142	80.7	11	6.3	1	0.6	6	3.4	7	4.0	3	1.7	1	0.6	4	2.3	1	0.6	1.744	2.022

[a]Coded: No Response = blank; Professionals = 1; Managers/Administrators = 2; Sales Workers = 3; Clerical Workers = 4; Craftsmen = 5; Operatives, except Transport = 6; Transport Operatives = 7; Laborers, except Farm = 8; Farmers and Farm Managers = 9; Farm Laborers = 10; Service Workers = 11; No Occupation = 12

[b]Adjusted to exclude the No Response column

[c]UNVPURSC and UNVAPPSC combined

Table 11

Descriptive Statistics for Last School Attended by Respondents (SCHLEVEL)

Group	No Response[a]		Senior High		Technical School		Junior College		College or University		Mean	SD
	No.	% of Group	No.	%[b]	No.	%	No.	%	No.	%		
UNVPURSC	1	4.3	-	-	-	-	-	-	22	100.0	6.000	0.000
UNVAPPSC	-	-	-	-	-	-	-	-	22	100.0	6.000	0.000
UNVSC[c]	1	2.2	-	-	-	-	-	-	44	100.0	6.000	0.000
UNVNONSC	6	13.0	-	-	-	-	-	-	40	100.0	6.000	0.000
PUBSC	1	1.9	-	-	4	7.8	1	2.0	46	90.2	5.824	0.555
PUBNONSC	1	2.4	15	36.6	3	7.3	1	2.4	22	53.7	4.732	1.432
OVERALL	9	4.9	15	8.5	7	4.0	2	1.1	152	86.4	5.653	0.907

[a]Coded: No Response = blank. Elementary = 1; Junior High = 2; Senior High = 3; Technical School = 4; Junior College = 5; College = 6

[b]Adjusted to exclude the No Response column

[c]UNVPURSC and UNVAPPSC combined

Table 12 shows that the university respondents had attended school for a similar number of years. The UNVSC group had on the average one (1) more year of school than did the UNVNONSC group. Somewhat surprising is the evidence that two (2) UNVNONSC respondents had completed only sixteen (16) years of school. The PUBSC group averaged one (1) year beyond the Bachelor's level while the PUBNONSC group averaged two (2) years beyond high school.

On the average parents of the PUBNONSC respondents completed approximately eleven (11) years of school. On the average parents of the respondents in the PUBSC, UNVNONSC, and UNVSC groups completed approximately twelve (12) to thirteen (13) years of school. The delineation of the number of years of school completed by mothers and fathers of

Descriptive Statistics for Last Year of

Group	No Response[a]		10		11		12		13		14		15		16	
	No.	% of Group	No.	%[b]	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
UNVPURSC	2	8.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UNVAPPSC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UNVSC[c]	2	4.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UNVNONSC	5	10.9	-	-	-	-	-	-	-	-	-	-	-	-	2	4.9
PUBSC	1	1.9	-	-	-	-	1	2.0	2	2.9	5	9.8	2	3.9	17	33.3
PUBNONSC	1	2.4	1	2.4	2	4.9	16	39.0	1	2.4	5	12.2	3	7.3	7	17.1
OVERALL	9	4.9	1	0.6	2	1.1	17	9.7	3	1.7	10	5.7	5	2.8	26	14.8

[a]Coded: No Response = blank; 1 = 1; 2 = 2; ...; 24 = 24

[b]Adjusted to exclude the No Response column

[c]UNVPURSC and UNVAPPSC combined

Tabl

Descriptive Statistics for Last Year of School C

Group	No Response[a]		4		5		6		7		8		9		10	
	No.	% of Group	No.	%[b]	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
UNVPURSC	2	8.7	-	-	-	-	2	9.5	-	-	3	14.3	2	9.5	1	4.8
UNVAPPSC	3	13.6	1	5.3	-	-	-	-	1	5.3	3	15.8	-	-	1	5.3
UNVSC[c]	5	11.1	1	2.5	-	-	2	5.0	1	2.5	6	15.0	2	5.0	2	5.0
UNVNONSC	5	10.9	-	-	1	2.4	-	-	-	-	9	22.0	-	-	3	7.3
PUBSC	7	13.5	-	-	-	-	1	2.2	-	-	12	26.7	1	2.2	1	2.2
PUBNONSC	8	19.0	1	2.9	1	2.9	1	2.9	-	-	4	11.8	1	2.9	3	8.8
OVERALL	25	13.5	2	1.2	2	1.2	4	2.5	1	0.6	31	19.4	4	2.5	9	5.6

[a]Coded: No Response = blank; 1 = 1; 2 = 2; ...; 24 = 24

[b]Adjusted to exclude the No Response column

[c]UNVPURSC and UNVAPPSC combined

Descriptive Statistics for Last Year of Sch

Group	No Response[a]		3		4		5		6		7		8		9		10		11
	No.	% of Group	No.	%[b]	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.
UNVPURSC	2	8.7	-	-	1	4.8	-	-	3	14.3	-	-	3	14.3	-	-	-	-	-
UNVAPPSC	2	9.1	1	5.0	1	5.0	-	-	1	5.0	2	10.0	-	-	-	-	1	5.0	1
UNVSC[c]	4	8.9	1	2.4	2	4.9	-	-	4	9.8	2	4.9	3	7.3	-	-	1	2.4	1
UNVNONSC	5	10.9	1	2.4	-	-	1	2.4	1	2.4	1	2.4	3	7.3	1	2.4	2	4.9	-
PUBSC	8	15.4	1	2.3	-	-	-	-	-	-	-	-	10	22.7	1	2.3	3	6.8	1
PUBNONSC	8	19.0	-	-	-	-	1	2.9	3	8.8	-	-	7	20.6	2	5.9	3	8.8	3
OVERALL	25	13.5	2	1.9	2	1.3	2	1.2	8	5.0	3	1.9	23	14.4	4	2.5	9	5.6	5

[a]Coded: No Response = blank; 1 = 1; 2 = 2; ...; 24 = 24

[b]Adjusted to exclude the No Response column

[c]UNVPURSC and UNVAPPSC combined

Table 12

...stics for Last Year of School Completed by Respondents (OWNSCHYR)

	16		17		18		19		20		21		22		23		24		Mean	SD
%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%		
-	-	-	-	-	-	-	2	9.5	6	28.6	8	38.1	3	14.3	2	9.5	-	-	20.857	1.108
-	-	-	-	-	3	13.6	3	13.6	3	13.6	3	13.6	3	13.6	2	9.1	5	22.7	21.182	2.152
-	-	-	-	-	3	7.0	5	11.6	9	20.9	11	25.6	6	14.0	4	9.3	5	11.6	21.023	1.711
-	2	4.9	-	-	4	9.8	2	4.9	16	39.0	9	22.0	2	4.9	2	4.9	4	9.8	20.415	1.684
.9	17	33.3	6	11.8	5	9.8	5	9.8	4	7.8	3	5.9	1	2.0	-	-	-	-	16.902	2.283
.3	7	17.1	3	7.3	2	4.9	-	-	-	-	1	2.4	-	-	-	-	-	-	13.951	2.439
.8	26	14.8	9	5.1	14	8.0	12	6.8	29	16.5	24	13.6	9	5.1	6	3.4	9	5.1	18.040	3.488

Table 13

...Last Year of School Completed by Mothers/Guardians of Respondents (MOTSCHYR)

	10		11		12		13		14		16		17		18		20		Mean	SD
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%		
5	1	4.8	-	-	5	23.8	1	4.8	4	19.0	2	9.5	-	-	-	-	1	4.8	11.667	3.554
	1	5.3	2	10.5	6	31.6	-	-	2	10.5	3	15.8	-	-	-	-	-	-	11.316	3.250
0	2	5.0	2	5.0	11	27.5	1	2.5	6	15.0	5	12.5	-	-	-	-	1	2.5	11.500	3.374
	3	7.3	1	2.4	13	31.7	5	12.2	3	7.3	5	12.2	-	-	1	2.4	-	-	11.683	2.893
2	1	2.2	-	-	17	37.8	1	2.2	5	11.1	6	13.3	1	2.2	-	-	-	-	11.578	2.959
9	3	8.8	1	2.9	17	50.0	3	8.8	-	-	2	5.9	-	-	-	-	-	-	10.941	2.651
5	9	5.6	4	2.5	58	36.2	10	6.3	14	8.7	18	11.2	1	0.6	1	0.6	1	0.6	11.453	2.565

Table 14

...Last Year of School Completed by Fathers/Guardians of Respondents (FATSCHYR)

10		11		12		13		14		15		16		17		18		19		20		21		22		Mean	SD
No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%		
-	-	-	-	6	28.6	2	9.5	3	14.3	-	-	-	-	1	4.8	-	-	-	-	1	4.8	1	4.8	-	-	11.619	4.477
1	5.0	1	5.9	5	25.0	-	-	2	10.0	-	-	5	25.0	-	-	1	5.0	-	-	-	-	-	-	-	-	11.700	4.342
1	2.4	1	2.4	11	26.8	2	4.9	5	12.2	-	-	5	12.2	1	2.4	1	2.4	-	-	1	2.4	1	2.4	-	-	11.459	4.357
2	4.9	-	-	12	29.3	2	4.9	5	10.9	2	4.9	3	7.3	1	2.4	2	4.9	1	2.4	1	2.4	-	-	2	4.9	12.878	4.250
3	6.8	1	2.3	17	38.6	-	-	3	6.8	-	-	5	11.4	1	2.3	1	2.3	-	-	1	2.3	-	-	-	-	11.682	3.326
3	8.8	3	8.8	10	29.4	-	-	1	2.9	-	-	3	8.8	-	-	-	-	-	-	-	-	1	2.9	-	-	10.676	3.373
9	5.6	5	3.1	50	31.2	4	2.5	14	8.7	2	1.2	16	10.0	3	1.9	4	2.5	1	0.6	3	1.9	2	1.2	2	1.2	11.769	3.965

the respondents is given in Tables 13 and 14.

The great majority of university respondents held a doctorate or its equivalent (Table 15). More PUBSC respondents (43%) held a Bachelor's degree than any other degree. The majority of the PUBNONSC respondents (54%) held a high school diploma as their highest degree.

Comparing Tables 16 and 17, it is observed that the respondents had a better memory for the science courses they had at the senior high level than for those they had at the junior high level.

Table 18 indicates that 33% of the respondents did not believe they had science in the seventh grade. Table 19 indicates that 23% of the respondents did not believe they had science in the eighth grade. These percentages were surprisingly large. Woodburn and Obourn (1965) reported that general science was an accepted offering in the seventh and eighth grades in the 1920's. They cited Bulletin 26 on the Reorganization of Science in Secondary Schools (Caldwell, 1920) as a major influence in establishing science in these grades. Table 8 showed that 95% of the respondents were not older than 65 years. Therefore, since even the 65 year old persons would not have been in the seventh grade until approximately 1923, it was believed that more persons had science . . the seventh and eighth grades than was reported.

Table 15

Descriptive Statistics for Highest Diploma or Degree Earned by Respondents (DIPDEG)

Group	No Response[a]		Junior High		High School		Two Year College		Bachelor's		Master's		Doctorate		Other		Mean	SD
	No.	% of Group	No.	%[b]	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%		
UNVPURSC	1	4.3	-	-	-	-	-	-	-	-	-	-	22	100.0	-	-	6.000	0.000
UNVAPPSC	0	-	-	-	-	-	-	-	-	-	4	18.2	18	81.2	-	-	5.818	0.395
UNVSC[c]	1	2.2	-	-	-	-	-	-	-	-	4	9.1	40	90.9	-	-	5.909	0.291
UNVNONSC	5	10.9	-	-	-	-	-	-	2	4.9	6	14.6	33	80.5	-	-	5.756	0.538
PUBSC	1	1.9	-	-	3	5.9	6	11.8	22	43.1	9	17.6	9	17.6	2	3.9	4.412	1.203
PUBNONSC	1	2.4	2	4.9	22	53.7	4	9.8	12	29.3	-	-	1	2.4	-	-	2.732	1.096
OVERALL	8	4.3	2	1.1	25	14.1	10	5.6	36	20.3	19	10.7	83	46.9	2	1.1	4.706	1.524

[a] Coded: No Response = blank; Junior High = 1; High School = 2; Two Year College = 3; Bachelor's = 4; Master's = 5; Doctorate = 6; Other = 7

[b] Adjusted to exclude the No Response column

[c] UNVPURSC and UNVAPPSC combined

Table 16

Descriptive Statistics for Respondents' Knowledge of Having Science at the Junior High School Level (JHSDNK)

Group	No Response[a]		Person Knew		Person Did Not Know		Mean	SD
	No.	% of Group	No.	%[b]	No.	%		
UNVPURSC	2	8.7	18	85.7	3	14.3	0.143	0.359
UNVAPPSC	–	–	14	63.6	8	36.4	0.364	0.492
UNVSC[c]	2	4.4	32	74.4	11	25.6	0.256	0.441
UNVNONSC	6	13.0	33	82.5	7	17.5	0.175	0.385
PUBSC	1	1.9	41	80.4	10	19.6	0.196	0.401
PUBNONSC	1	2.4	29	70.7	12	29.3	0.293	0.461
OVERALL	10	5.4	135	77.1	40	22.9	0.229	0.421

[a]Coded: No Response = blank; Person Knew = 0; Persons Did Not Know = 1

[b]Adjusted to exclude the No Response column

[c]UNVPURSC and UNVAPPSC combined

Table 17

Descriptive Statistics for Respondents' Knowledge of Having [illegible]nce at the Senior High School Level (SHDNK)

Group	No Response[a]		Person Knew		Person Did Not Know		Mean	SD
	No.	% of Group	No.	%[b]	No.	%		
UNVPURSC	2	8.7	20	95.2	1	4.8	0.048	0.218
UNVAPPSC	–	–	20	90.9	2	9.1	0.091	0.294
UNVSC[c]	2	4.4	40	93.0	3	7.0	0.070	0.258
UNVNONSC	6	13.0	38	95.0	2	5.0	0.050	0.221
PUBSC	1	1.9	49	96.1	2	3.9	0.039	0.196
PUBNONSC	1	2.4	35	85.4	6	14.6	0.146	0.358
OVERALL	10	5.4	162	92.6	13	7.4	0.074	0.263

[a]Coded: No Response = blank; Person Knew = 0; Person Did Not Know = 1

[b]Adjusted to exclude the No Response column

[c]UNVPURSC and UNVAPPSC combined

Table 18

Descriptive Statistics for Seventh Grade Science of Respondent (JHS7)

Group	No Response[a] No.[d]	% of Group	Did Not Have No.	%[b]	Did Have No.	%	Mean	SD
UNVPURSC	5	21.7	4	22.2	14	77.8	0.778	0.428
UNVAPPSC	8	36.4	4	28.6	10	71.4	0.714	0.469
UNVSC[c]	13	28.9	8	25.0	24	75.0	0.750	0.440
UNVNONSC	13	28.3	8	24.2	25	75.8	0.758	0.435
PUBSC	11	21.2	19	46.3	22	53.7	0.537	0.505
PUBNONSC	13	31.0	10	34.5	19	65.5	0.655	0.484
OVERALL	50	27.0	45	33.3	90	66.7	0.667	0.473

[a]Coded: No Response = blank; Did Not Have = 0; Did Have = 1

[b]Adjusted to exclude the No Response column

[c]UNVPURSC and UNVAPPSC combined

[d]Includes those persons who did not respond and who had no knowledge of having science at the Junior High level

Table 19

Descriptive Statistics for Eighth Grade Science of Respondent (JHS8)

Group	No Response[a] No.[d]	% of Group	Did Not Have No.	%[b]	Did Have No.	%	Mean	SD
UNVPURSC	5	21.7	4	22.2	14	77.8	0.778	0.428
UNVAPPSC	8	36.4	5	35.7	9	64.3	0.643	0.497
UNVSC[c]	13	28.9	9	28.1	23	71.9	0.719	0.457
UNVNONSC	13	28.3	7	21.2	26	78.8	0.788	0.415
PUBSC	11	21.2	9	22.0	32	78.0	0.780	0.419
PUBNONSC	13	31.0	6	20.7	23	79.3	0.793	0.412
OVERALL	50	27.0	31	23.0	104	77.0	0.770	0.422

[a]Coded: No Response = blank; Did Not Have = 0; Did Have = 1

[b]Adjusted to exclude the No Response column

[c]UNVPURSC and UNVAPPSC combined

[d]Includes those persons who did not respond and who had no knowledge of having science at the Junior High level

Figure 9 summarizes Tables 20, 21, 22, 23, and 24. The percentages of respondents in the UNVPURSC, UNVAPPSC, UNVNONSC, PUBSC, and PUBNONSC groups who had general science, earth science, or biology did not vary by much. Few of the respondents had an earth science course. This was not surprising. Woodburn and Obourn (1965) reported that in 1920 only 4.5% of all ninth through twelfth grade students were enrolled in an earth science course. By 1949 this enrollment had decreased to 0.4%! With the introduction of the Earth Science Curriculum Project in the mid 1960's more schools have built earth science into the curriculum.

Table 20

Descriptive Statistics for Senior High General Science of Respondent (SHGENSCI)

Group	No Response[a]		Did Not Have		Did Have		Mean	SD
	No.[d]	% of Group	No.	%[b]	No.	%		
UNVPURSC	3	13.0	8	40.0	12	60.0	0.600	0.503
UNVAPPSC	2	9.1	8	40.0	12	60.0	0.600	0.503
UNVSC[c]	5	11.1	16	40.0	24	60.0	0.600	0.496
UNVNONSC	8	17.4	12	31.6	26	68.4	0.684	0.471
PUBSC	3	5.8	21	42.9	28	57.1	0.571	0.500
PUBNONSC	7	16.7	11	31.4	24	68.6	0.686	0.471
OVERALL	23	12.4	60	37.0	102	63.0	0.630	0.484

[a]Coded: No Response = blank; Did Not Have = 0; Did Have = 1

[b]Adjusted to exclude the No Response column

[c]UNVPURSC and UNVAPPSC combined

[d]Includes those persons who did not respond and who had no knowledge of having science at the Senior High level

Table 21

Descriptive Statistics for Senior High Earth Science of Respondent (SHERTSCI)

Group	No Response[a]		Did Not Have		Did Have		Mean	SD
	No.[d]	% of Group	No.	%[b]	No.	%		
UNVPURSC	3	13.0	17	85.0	3	13.0	0.150	0.366
UNVAPPSC	2	9.1	16	80.0	4	20.0	0.200	0.410
UNVSC[c]	5	11.1	33	82.5	7	17.5	0.175	0.385
UNVNONSC	8	17.4	37	97.4	1	2.6	0.026	0.162
PUBSC	3	5.8	43	87.8	6	12.2	0.122	0.331
PUBNONSC	7	16.7	31	88.6	4	11.4	0.114	0.323
OVERALL	23	12.4	144	88.9	18	11.1	0.111	0.315

[a]Coded: No Response = blank; Did Not Have = 0; Did Have = 1

[b]Adjusted to exclude the No Response column

[c]UNVPURSC and UNVAPPSC combined

[d]Includes those persons who did not respond and who had no knowledge of having science at the Senior High level

Table 22

Descriptive Statistics for Senior High Biology of Respondent (SHBIOL)

Group	No Response[a]		Did Not Have		Did Have		Mean	SD
	No.[d]	% of Group	No.	%[b]	No.	%		
UNVPURSC	3	13.0	4	20.0	16	80.0	0.800	0.410
UNVAPPSC	2	9.1	5	25.0	15	75.0	0.750	0.444
UNVSC[c]	5	11.1	9	22.5	31	77.5	0.775	0.423
UNVNONSC	8	17.4	11	28.9	27	71.1	0.711	0.460
PUBSC	3	5.8	16	32.7	33	67.3	0.673	0.474
PUBNONSC	7	16.7	8	22.9	27	77.1	0.771	0.426
OVERALL	23	12.4	44	27.2	118	72.8	0.728	0.446

[a]Coded: No Response = blank; Did Not Have = 0; Did Have = 1

[b]Adjusted to exclude the No Response column

[c]UNVPURSC and UNVAPPSC combined

[d]Includes those persons who did not respond and who had no knowledge of having science at the Senior High level

Table 23

Descriptive Statistics for Senior High Chemistry of Respondent (SHCHEM)

Group	No Response[a]		Did Not Have		Did Have		Mean	SD
	No.[d]	% of Group	No.	%[b]	No.	%		
UNVPURSC	3	13.0	4	20.0	16	80.0	0.800	0.410
UNVAPPSC	2	9.1	-	-	20	100.0	1.000	0.000
UNVSC[c]	5	11.1	4	10.0	36	90.0	0.900	0.304
UNVNONSC	8	17.4	7	18.4	31	81.6	0.816	0.393
PUBSC	3	5.8	6	12.2	43	87.8	0.878	0.331
PUBNONSC	7	16.7	18	51.4	17	48.6	0.486	0.507
OVERALL	23	12.4	35	21.6	127	78.4	0.784	0.413

[a]Coded: No Response = blank; Did Not Have = 0; Did Have = 1

[b]Adjusted to exclude the No Response column

[c]UNVPURSC and UNVAPPSC combined

[d]Includes those persons who did not respond and who had no knowledge of having science at the Senior High level

Table 24

Descriptive Statistics for Senior High Physics of Respondent (SHPHYS)

Group	No Response[a]		Did Not Have		Did Have		Mean	SD
	No.[d]	% of Group	No.	%[b]	No.	%		
UNVPURSC	3	13.0	4	20.0	16	80.0	0.800	0.410
UNVAPPSC	2	9.1	2	10.0	18	90.0	0.900	0.308
UNVSC[c]	5	11.1	6	15.0	34	85.0	0.850	0.362
UNVNONSC	8	17.4	12	31.6	26	68.4	0.684	0.471
PUBSC	3	5.8	10	20.4	39	79.6	0.796	0.407
PUBNONSC	7	16.7	26	74.3	9	25.7	0.257	0.443
OVERALL	23	12.4	54	33.3	108	66.7	0.667	0.473

[a]Coded: No Response = blank; Did Not Have = 0; Did Have = 1

[b]Adjusted to exclude the No Response column

[c]UNVPURSC and UNVAPPSC combined

[d]Includes those persons who did not respond and who had no knowledge of having science at the Senior High level

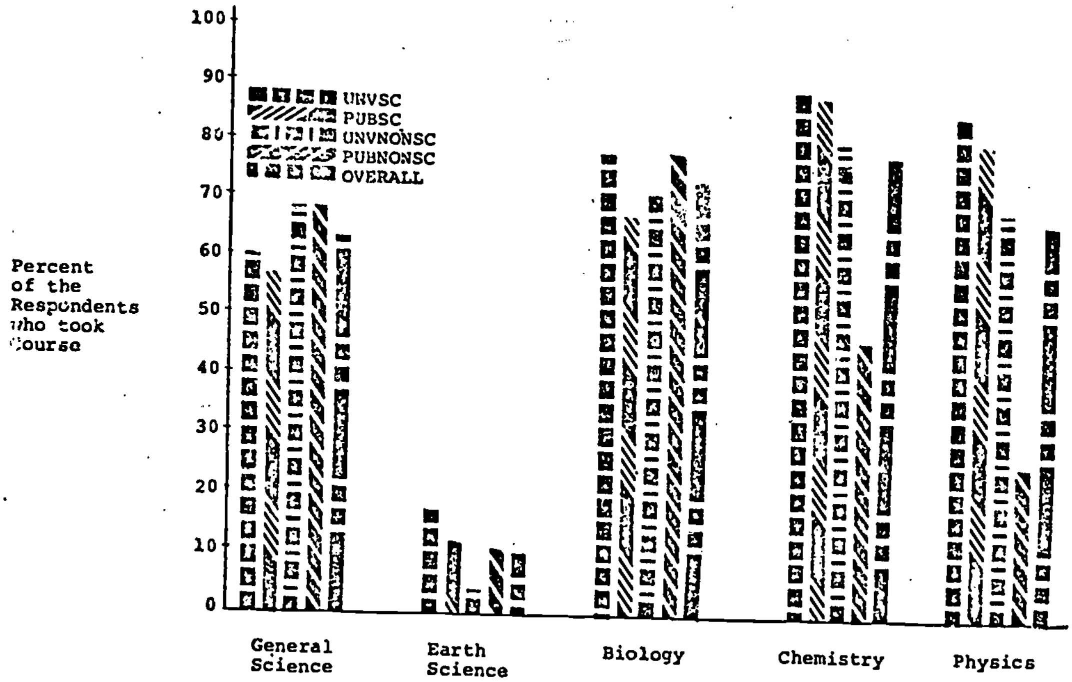


Figure 9

Percent of Respondents Who Had the Science Courses Described in Tables 20, 21, 22, 23, and 24

However, even as late as the 1970-71 school year only 40% of the schools participating in a study by Schlessinger, et al. (1973) reported offering an earth science course (see page 49 of Chapter II). With regard to chemistry and physics, the UNVSC, UNVNONSC, and PUBSC groups followed the same trend; however, the PUBNONSC group deviated markedly.

Figure 10 clarifies how the variables CLBIOSCI, CLPHYSCI, CLERTSCI, and CLENGSCI were coded for computer analysis. This figure is hypothetical example for two

Respondent A

College: major Geology ; minor Math
Graduate or Professional School:
major Geology ; minor Physics

	Number of Quarter Hours		
	0-12	13-36	37 or more
Biological sciences			
Physical sciences			
Earth sciences			
Engineering courses			

Respondent B

College: major Geology ; minor Math
Graduate or Professional School:
major Geology ; minor Physics

	Number of Quarter Hours		
	0-12	13-36	37 or more
Biological sciences			
Physical sciences		x	
Earth sciences			x
Engineering courses			

Figure 10

Examples of Types of Responses for the Variables, CLBIOSCI, CLPHYSCI, CLERTSCI, and CLENGSCI

different respondents. In both cases the respondents had the same majors and minors. Respondent A did not indicate what sciences he had studied nor what amounts, even though he could be expected to have had several hours of science at the college level. His responses would be coded as "blanks" on each of the variables. Respondent B indicated the types of sciences he studied and the numbers of hours of each. His responses would have been coded for computer analysis as 0, 2, 3, and 0 for these four (4) variables.

The format of the 0-12 quarter hours column should be avoided in any future research with the INFORMATION SHEET. A person who checks this column could be indicating that he had zero (0) hours or that he had from 1-12 hours. For this study it meant that error was introduced into the data on these four (4) variables. However, only four (4) of the 185 respondents checked the 0-12 column for all of these variables; hence, it was believed that the introduced error was small.

Tables 25, 26, 27, and 28 present data concerning the number of quarter hours the respondents completed at the college or university level in the areas of biological science, physical science, earth science, and engineering. In the pure sciences (Tables 25, 26, and 27) it is observed that the UNVSC respondents had considerably more course work than did the other respondents even in the PUBSC group. Since the UNVSC group completed approximately four (4) more years of school than did the PUBSC group, this is to be expected (see Table 12). However, the PUBSC group did exceed the UNVSC group in terms of number of hours completed in engineering courses. Comparing Tables 2 and 5 in Chapter III, it is found that 38% of the persons sampled for the PUBSC group were engineers, whereas only 16% of the persons sampled for the UNVSC group were engineers. Therefore, this difference in hours completed in engineering was not surprising.

Table 25

Descriptive Statistics for Number of Quarter Hours of College Level Biological Science Completed by Respondents (CLBIOSCI)

Group	No Response[a]		Left Blank		0-12		13-36		37 or More		Mean	SD
	No.	% of Group	No.	%[b]	No.	%	No.	%	No.	%		
UNVPURSC	2	8.7	1	4.8	8	38.1	1	4.8	11	52.4	2.048	1.071
UNVAPPSC	6	27.3	4	25.0	3	18.8	3	18.8	6	37.5	1.688	1.250
UNVSC[c]	8	17.8	5	13.5	11	29.7	4	10.8	17	45.9	1.892	1.149
UNVNONSC	9	19.6	12	32.4	18	48.6	7	18.9	-	-	0.865	0.713
PUBSC	5	9.6	19	40.4	12	25.5	6	12.8	10	21.3	1.149	1.179
PUBNONSC	2	4.8	29	72.5	11	27.5	-	-	-	-	0.275	0.452
OVERALL	24	13.0	65	40.4	52	32.3	17	10.6	27	16.8	1.037	1.089

[a]Coded: No Response = blank; Left Blank = 0; 0-12 = 1; 13-36 = 2; 37 or More = 3

[b]Adjusted to exclude the No Response column

[c]UNVPURSC and UNVAPPSC combined

Table 26

Descriptive Statistics for Number of Quarter Hours of College Level Physical Science Completed by Respondents (CLPHYSCI)

Group	No Response[a]		Left Blank		0-12		13-36		37 or More		Mean	SD
	No.	% of Group	No.	%[b]	No.	%	No.	%	No.	%		
UNVPURSC	2	8.7	2	9.5	3	14.3	3	14.3	13	61.9	2.286	1.056
UNVAPPSC	6	27.3	1	6.3	1	6.3	6	37.5	8	50.0	2.313	0.873
UNVSC[c]	8	17.8	3	8.1	4	10.8	9	24.3	21	56.8	2.297	0.968
UNVNONSC	9	19.6	7	18.9	19	51.4	9	24.3	2	5.4	1.162	0.800
PUBSC	5	9.6	10	21.3	9	19.1	15	31.9	13	27.7	1.660	1.109
PUBNONSC	2	4.8	26	65.0	10	25.0	3	7.5	1	2.5	0.475	0.751
OVERALL	24	13.0	46	28.6	42	26.1	36	22.4	37	23.0	1.398	1.131

[a]Coded: No Response = blank; Left Blank = 0; 0-12 = 1; 13-36 = 2; 37 or More = 3

[b]Adjusted to exclude the No Response column

[c]UNVPURSC and UNVAPPSC combined

Table 27

Descriptive Statistics for Number of Quarter Hours of College Level Earth Science Completed by Respondents (CLERTSCI)

Group	No Response[a]		Left Blank		0-12		13-36		37 or More		Mean	SD
	No.	% of Group	No.	%[b]	No.	%	No.	%	No.	%		
UNVPURSC	2	8.7	8	38.1	8	38.1	3	14.3	2	9.5	0.952	0.973
UNVAPPSC	6	27.3	5	31.3	10	62.5	1	6.3	-	-	0.750	0.577
UNVSC[c]	8	17.8	13	35.1	18	48.6	4	10.8	2	5.4	0.865	0.822
UNVNONSC	9	19.6	25	67.6	10	27.0	2	5.4	-	-	0.378	0.594
PUBSC	5	9.6	32	68.1	13	27.7	-	-	2	4.3	0.404	0.712
PUBNONSC	2	4.8	29	72.5	11	27.5	-	-	-	-	0.275	0.452
OVERALL	24	13.0	99	61.5	52	32.3	6	3.7	4	2.5	0.472	0.690

[a]Coded: No Response = blank; Left Blank = 0; 0-12 = 1; 13-36 = 2; 37 or More = 3

[b]Adjusted to exclude the No Response column

[c]UNVPURSC and UNVAPPSC combined

Table 28

Descriptive Statistics for Number of Quarter Hours of College Level Engineering Courses Completed by Respondents (CLENGSCI)

Group	No Response[a]		Left Blank		0-12		13-36		37 or More		Mean	SD
	No.	% of Group	No.	%[b]	No.	%	No.	%	No.	%		
UNVPURSC	2	8.7	12	57.1	6	28.6	2	9.5	1	4.8	0.619	0.865
UNVAPPSC	6	27.3	3	18.8	5	31.3	-	-	8	50.0	1.813	1.276
UNVSC[c]	8	17.8	15	40.5	11	29.7	2	5.4	9	24.3	1.135	1.206
UNVNONSC	9	19.6	27	73.0	6	16.2	1	2.7	3	8.1	0.459	0.900
PUBSC	5	9.6	16	34.0	12	25.5	1	2.1	18	38.3	1.447	1.316
PUBNONSC	2	4.8	32	80.0	5	12.5	3	7.5	-	-	0.275	0.599
OVERALL	24	13.0	90	55.9	34	21.1	7	4.3	30	18.6	0.857	1.156

[a]Coded: No Response = blank; Left Blank = 0; 0-12 = 1; 13-36 = 2; 37 or More = 3

[b]Adjusted to exclude the No Response column

[c]UNVPURSC and UNVAPPSC combined

The average amounts and types of science courses indicated by UNVNONSC respondents in Tables 25 through 28 is not atypical of minimum requirements for undergraduates. Only 32% of the PUBNONSC respondents earned at least a Bachelor's degree (see Table 15). This would contribute to the fact that the PUBNONSC respondents completed so few hours in the science and engineering courses.

Descriptive Statistics for the SLQ Data

In this section the responses to the Q-statements are discussed. The discussion centers around the similarities and differences in the UNVPURSC, UNVAPPSC, UNVNONSC, PUBSC, and PUBNONSC group means on each of the Q-statements. A summary of each table generally will be made in terms of all of the respondents taken as a total group (OVERALL).

Looking at the tables in this section, it is observed that most mean values lie between +1 and -1. Therefore, $\pm$ 1 were used as quasi-references. Q-statements are referred to in terms of their number, for example, Q28 is Q-statement number 28. The type of TMSL cognitive or affective behavior explicated by each Q-statement is enclosed in parentheses with each initial reference to the Q-statement. For example, Q28 refers to a knowledge behavior; it will be noted as Q28(knowledge).

The sorting process forced persons to sort five (5) Q-statements into each of nine (9) piles. The two extremes for the piles were MOST IMPORTANT and LEAST IMPORTANT. Therefore, each Q-statement was sorted in terms of how important it was relative to all of the other Q-statements rather than in terms of absolute importance. During telephone interviews with respondents after they had returned the materials, often the remark was made to the effect, "I had trouble putting Q-statements on the LEAST IMPORTANT side; I thought they all were important."

In Table 29 Q28(knowledge) and Q45(application) were deemed to be more important than the other Q-statements in the table by the respondents (OVERALL). The PUBSC, UNVNONSC, and PUBNONSC groups tended to value both Q-statements similarly. Of the UNVAPPSC group 79% of the respondents felt Q28 was more important, but the UNVPURSC group was split in its opinion. Neither the UNVPURSC group nor the UNVAPPSC group felt as strongly about Q45 as did the other groups. The science oriented groups differed with the non-science oriented groups on Q42(anlaysis). The PUBSC group tended to rate Q39(synthesis) and Q21(evaluation) more highly than did the other groups. The respondents (OVERALL) tended to value the Factual component Q-statements of the Organization of Knowledge dimension. The knowledge and application behaviors were valued to a greater extent than

Table 29

Descriptive Statistics for Responses to Q-statements of the Factual Component of the Organization of Knowledge Dimension

Q-statement	Behavior	Responses -4	-3	-2	-1	0	+1	+2	+3	+4	Mean	SD
UNVPURSC	Valid Cases: 21 (91.3%) Missing Cases: 2 (8.7%)											
IA11[a]	Knowledge	4[c]	2	-	-	1	2	3	3	6		
28[b]		19.0[d]	9.5	-	-	4.8	9.5	14.3	14.3	28.6	0.905	3.177
IA31	Application	3	1	3	1	1	5	1	2	4		
45		14.3	4.8	14.3	4.8	4.8	23.8	4.8	9.5	19.0	0.333	2.817
IA41	Analysis	4	3	2	1	4	1	1	5	-		
42		19.0	14.3	9.5	4.8	19.0	4.8	4.8	23.8	-	-0.571	2.675
IA51	Synthesis	2	4	2	2	2	4	2	1	2		
39		9.5	19.0	9.5	9.5	9.5	19.0	9.5	4.8	9.5	-0.333	2.536
IA61	Evaluation	1	1	2	1	3	4	2	6	1		
21		4.8	4.8	9.5	4.8	14.3	19.0	9.5	28.6	4.8	0.857	2.242
UNVAPPSC	Valid Cases: 19 (86.4%) Missing Cases: 3 (13.6%)											
IA11	Knowledge	-	-	-	1	-	1	2	6	9		
28		-	-	-	5.3	-	5.3	10.5	31.6	47.4	3.053	1.311
IA31	Application	1	2	1	2	1	3	3	1	5		
45		5.3	10.5	5.3	10.5	5.3	15.8	15.8	5.3	26.3	0.947	2.656
IA41	Analysis	2	2	1	4	4	1	2	1	2		
42		10.5	10.5	5.3	21.1	21.1	5.3	10.5	5.3	10.5	-0.211	2.440
IA51	Synthesis	-	3	1	3	-	3	1	5	3		
39		-	15.8	5.3	15.8	-	15.8	5.3	26.3	15.8	0.947	2.549
IA61	Evaluation	1	1	1	5	3	2	2	2	2		
21		5.3	5.3	5.3	26.3	15.8	10.5	10.5	10.5	10.5	0.316	2.262
UNVSC[e]	Valid Cases: 40 (88.9%) Missing Cases: 5 (11.1%)											
IA11	Knowledge	4	2	-	1	1	3	5	9	15		
28		10.0	5.0	-	2.5	2.5	7.5	12.5	72.5	37.5	1.925	2.674
IA31	Application	4	3	4	3	2	8	4	3	9		
45		10.0	7.5	10.0	7.5	5.0	20.0	10.0	7.5	22.5	0.625	2.724
IA41	Analysis	6	5	3	5	8	2	3	6	2		
42		15.0	12.5	7.5	12.5	20.0	5.0	7.5	15.0	5.0	-0.400	2.540
IA51	Synthesis	2	7	3	5	2	7	3	6	5		
39		5.0	17.5	7.5	12.5	5.0	17.5	7.5	15.0	12.5	0.275	2.592
IA61	Evaluation	2	2	3	6	6	6	4	8	3		
21		5.0	5.0	7.5	15.0	15.0	15.0	10.0	20.0	7.5	0.600	2.240
UNVNONSC	Valid Cases: 41 (89.1%) Missing Cases: 5 (10.9%)											
IA11	Knowledge	5	2	3	3	3	4	4	4	13		
28		12.2	4.9	7.3	7.3	7.3	9.8	9.8	9.8	31.7	1.000	2.898
IA31	Application	1	2	3	5	4	4	11	3	8		
45		2.4	4.9	7.3	12.2	9.8	9.8	26.8	7.3	19.5	1.122	2.249
IA41	Analysis	2	3	6	4	4	4	6	8	4		
42		4.9	7.3	14.6	9.8	9.8	9.8	14.6	19.5	9.8	0.561	2.440
IA51	Synthesis	2	8	3	2	5	6	7	5	3		
39		4.9	19.5	7.3	4.9	12.2	14.6	17.1	12.2	7.3	0.171	2.469
IA61	Evaluation	1	5	4	10	1	10	3	4	3		
21		2.4	12.2	9.8	24.4	2.4	24.4	7.3	9.8	7.3	0.073	2.195
PUBSC	Valid Cases: 52 (100%) Missing Cases: 0 (0.0%)											
IA11	Knowledge	3	3	1	3	3	7	10	7	15		
25		5.8	5.8	1.9	5.8	5.8	13.5	19.2	13.5	28.8	1.577	2.436
IA31	Application	1	7	6	2	3	3	7	11	12		
45		1.9	13.5	11.5	3.8	5.8	5.8	13.5	21.2	23.1	1.135	2.657
IA41	Analysis	3	7	7	6	8	7	4	4	3		
42		5.8	13.5	13.5	11.5	15.4	13.5	9.6	9.6	7.7	-0.096	2.345
IA51	Synthesis	1	3	3	4	5	7	11	11	7		
39		1.9	5.8	5.8	7.7	9.6	13.5	21.2	21.2	13.5	1.288	2.145
IA61	Evaluation	2	4	2	6	3	5	17	6	7		
21		3.8	7.7	3.8	11.5	5.8	9.6	32.7	11.5	13.5	..058	2.270
PUBNONSC	Valid CAses: 42 (100%) Missing Cases: 0 (0.0%)											
IA11	Knowledge	1	3	-	3	6	7	4	10	8		
28		2.4	7.1	-	7.1	14.3	16.7	9.5	23.8	19.0	1.452	2.200
IA31	Application	1	2	5	4	2	6	8	5	9		
45		2.4	4.8	11.9	9.5	4.8	14.3	19.0	11.9	21.4	1.167	2.357
IA41	Analysis	4	2	7	5	4	4	9	5	2		
42		9.5	4.8	16.7	11.9	9.5	9.5	21.4	11.9	4.8	0.095	2.377
IA51	Synthesis	-	3	4	7	3	6	6	5	8		
39		-	7.1	9.5	16.7	7.1	14.3	14.3	11.9	19.0	0.976	2.279
IA61	Evaluation	1	4	5	3	4	6	6	7	6		
21		2.4	9.5	11.9	7.1	9.5	14.3	14.3	16.7	14.3	0.810	2.402
OVERALL	Valid Cases: 175 (94.6%) Missing Cases: 10 (5.4%)											
IA11	Knowledge	13	10	4	10	13	21	23	30	51		
28		7.4	5.7	2.3	5.7	7.4	12.0	13.1	17.1	29.1	1.491	2.553
IA31	Application	7	14	18	14	11	21	30	22	38		
45		4.0	8.0	10.3	8.0	6.3	12.0	17.1	12.6	21.7	1.023	2.500
IA41	Analysis	15	17	23	20	24	17	23	24	12		
42		8.6	9.7	13.1	11.4	13.7	9.7	13.1	13.7	6.9	0.034	2.423
IA51	Synthesis	5	21	13	18	15	26	27	27	23		
39		2.9	12.0	7.4	10.3	8.6	14.9	15.4	15.4	13.1	0.720	2.389
IA61	Evaluation	6	15	14	25	14	27	30	25	19		
71		3.4	8.6	8.0	14.3	8.0	15.4	17.1	14.3	10.9	0.663	2.288

[a] IMSL element identification
[b] Q-statement number
[c] Number of persons who placed Q-statement in a particular envelope
[d] Percent, adjusted to exclude missing cases
[e] UNVPURSC and UNVAPPSC combined

were the analysis, synthesis, and evaluation behaviors.

Table 30 shows that all groups believed Q13(valuing) to be less important than the other Q-statements in the table. The public groups, both science and nonscience, were stronger in this belief than were the university pure and applied groups. The UNVNONSC group placed a low level of importance on Q13 but not to the same extent as did the other groups. The PUBSC group and the UNVNONSC group felt strongly about Q19(application); however, the PUBSC group gave it a positive rating while the UNVNONSC group gave it a negative rating. By the same token, Q27(synthesis) was rated positively by the UNVAPPSC group and negatively by the UNVPURSC group. The respondents (OVERALL) tended to value the Q-statements dealing with cognitive behaviors in the Generalizations component of the Organization of Knowledge dimension. They tended to value the affective behavior the least.

Table 31 indicates that all groups placed considerable more importance on Q41(knowledge) than on Q25(synthesis). The science oriented groups tended to place less importance on Q29(behaving) than did the nonscience oriented groups. Likewise, the PUBSC and PUBNONSC groups did not place as much importance on Q34(advocating), whereas the UNVPURSC and UNVAPPSC groups did--the UNVNONSC group was ambivalent. The knowledge behavior in the Discipline component of the Organization of Knowledge dimension was generally considered

Table 30

Descriptive Statistics for Responses to Q-statements of the Generalizations Component of the Organization of Knowledge Dimension

Q-statement	Behavior	Responses -4	-3	-2	-1	0	+1	+2	+3	+4	Mean	SD
UNVPURSC	Valid Cases: 21 (91.3%) Missing Cases: 2 (8.7%)											
IA223[a]	Comprehension	2[c]	1	-	2	2	6	2	3	3		
44[b]		9.5[d]	4.8	-	9.5	9.5	28.6	9.5	14.3	14.3	[illegible]	2.414
IA32	Application	1	2	3	3	2	2	1	3	4		
19		4.8	9.5	14.3	14.3	9.5	9.5	4.8	14.3	19.0	0.476	2.657
IA52	Synthesis	3	2	5	3	3	3	-	1	1		
27		14.3	9.5	23.8	14.3	14.3	14.3	-	4.8	4.8	[illegible]	2.191
IA62	Evaluation	1	2	2	3	5	4	3	-	1		
23		4.8	9.5	9.5	14.3	23.8	19.0	14.3	-	4.8	[illegible]	1.957
IB12	Valuing	5	4	3	2	1	2	-	3	1		
13		23.8	19.0	14.3	9.5	4.8	9.5	-	14.3	4.8	-1.190	2.695
UNVAPPSC	Valid Cases: 19 (86.4%) Missing Cases: 3 (13.6%)											
IA223	Comprehension	1	-	4	1	2	3	2	6	-		
44		5.3	-	21.1	5.3	10.5	15.8	10.5	31.6	-	[illegible]	2.241
IA32	Application	-	1	4	-	2	5	-	5	2		
19		-	5.3	21.1	-	10.5	26.3	-	26.3	10.5	[illegible]	2.258
IA52	Synthesis	-	2	2	3	2	2	3	3	2		
27		-	10.5	10.5	15.8	10.5	10.5	15.8	15.8	10.5	0.632	2.290
IA62	Evaluation	-	1	2	4	2	4	1	1	4		
23		-	5.3	10.5	21.1	10.5	21.1	5.3	5.3	21.1	[illegible]	2.257
IB12	Valuing	3	3	7	2	1	2	-	-	1		
13		15.8	15.8	36.8	10.5	5.3	10.5	-	-	5.3	[illegible]	2.006
UNVSC[e]	Valid Cases: 40 (88.9%) Missing Cases: 5 (11.1%)											
IA223	Comprehension	3	1	4	3	4	9	4	9	3		
44		7.5	2.5	10.0	7.5	10.0	22.5	10.0	22.5	7.5	0.750	2.307
IA32	Application	1	3	7	3	4	7	1	8	6		
19		2.5	7.5	17.5	7.5	10.0	17.5	2.5	20.0	15.0	0.675	2.454
IA52	Synthesis	3	4	7	6	5	5	3	4	3		
27		7.5	10.0	17.5	15.0	12.5	12.5	7.5	10.0	7.5	[illegible]	[illegible]
IA62	Evaluation	1	3	4	7	7	8	4	1	5		
23		2.5	7.5	10.0	17.5	17.5	20.0	10.0	2.5	12.5	[illegible]	[illegible]
IB12	Valuing	8	7	10	4	2	4	-	3	2		
13		20.0	17.5	25.0	10.0	5.0	10.0	-	7.5	5.0	-1.400	[illegible]
UNVNONSC	Valid Cases: 41 (89.1%) Missing Cases: 5 (10.9%)											
IA223	Comprehension	4	5	7	4	4	5	2	9	1		
44		9.8	12.2	17.1	9.8	9.8	12.2	4.9	22.0	2.4	-0.220	[illegible]
IA32	Application	1	2	3	6	4	4	5	12	4		
19		2.4	4.9	7.3	14.6	9.8	9.8	12.2	29.3	9.8	1.073	[illegible]
IA52	Synthesis	1	3	3	3	10	5	8	8	-		
27		2.4	7.3	7.3	7.3	24.4	12.2	19.5	19.5	-	[illegible]	1.963
IA62	Evaluation	2	4	5	5	6	5	8	2	4		
23		4.9	9.8	12.2	12.2	14.6	12.2	19.5	4.9	9.8	[illegible]	[illegible]
IB12	Valuing	7	4	4	7	3	2	1	7	6		
13		17.1	9.8	9.8	17.1	7.3	4.9	2.4	17.1	14.6	-0.146	2.894
PUBSC	Valid Cases: 52 (100%) Missing Cases: 0 (0.0%)											
IA223	Comprehension	3	7	6	3	10	4	7	7	5		
44		5.8	13.5	11.5	5.8	19.2	7.7	13.5	13.5	9.6	0.212	2.468
IA32	Application	3	1	3	7	3	9	6	11	[illegible]		
19		5.8	1.9	5.8	13.5	5.8	17.3	11.5	21.2	17.3	1.192	2.335
IA52	Synthesis	2	3	2	6	10	6	7	11	5		
27		3.8	5.8	3.8	11.5	19.2	11.5	13.5	21.2	9.6	0.885	2.193
IA62	Evaluation	-	2	8	9	8	6	6	9	4		
23		-	3.8	15.4	17.3	15.4	11.5	11.5	17.3	7.7	0.577	2.061
IB12	Valuing	17	13	7	4	2	1	4	2	2		
13		32.7	25.0	13.5	7.7	3.8	1.9	7.7	3.8	3.8	-1.962	2.376
PUBNONSC	Valid Cases: 42 (100%) Missing Cases: 0 (0.0%)											
IA223	Comprehension	4	4	4	3	5	8	2	9	3		
44		9.5	9.5	9.5	7.1	11.9	19.0	4.8	21.4	7.1	0.286	2.521
IA32	Application	4	2	5	2	4	6	4	5	10		
19		9.5	4.8	11.9	4.8	9.5	14.3	9.5	11.9	23.8	0.833	2.713
IA52	Synthesis	3	4	3	3	7	6	4	[illegible]	4		
27		7.1	9.5	7.1	7.1	16.7	14.3	9.5	[illegible]	9.5	0.500	2.452
IA62	Evaluation	2	6	10	7	4	4	2	4	3		
23		4.8	14.3	23.8	16.7	9.5	9.5	4.8	9.5	7.1	-0.500	2.309
IB12	Valuing	17	6	6	5	1	2	2	2	1		
13		40.5	14.3	14.3	11.9	2.4	4.8	4.8	4.8	2.4	-2.071	2.310
OVERALL	Valid Cases: 175 (94.6%) Missing Cases: 10 (5.4%)											
IA223	Comprehension	14	[illegible]	21	13	23	26	15	34	[illegible]		
44		8.0	9.7	12.0	7.4	13.1	14.9	8.6	19.4	6.9	0.251	2.453
IA32	Application	9	8	18	18	15	26	16	36	29		
19		5.1	4.6	10.3	10.3	8.6	14.9	9.1	20.6	16.6	0.960	2.424
IA52	Synthesis	9	14	15	18	32	22	22	31	12		
27		5.1	8.0	8.6	10.3	18.3	12.6	12.6	17.7	6.9	0.463	2.264
IA62	Evaluation	5	15	27	28	25	23	20	16	16		
23		2.9	8.6	15.4	16.0	14.3	13.1	11.4	9.1	9.1	0.160	2.210
IB12	Valuing	49	30	27	20	8	9	7	14	11		
13		28.0	17.1	15.4	11.4	4.6	5.1	4.0	8.0	6.3	-1.434	2.583

[a] THSL element identification
[b] Q-statement number
[c] Number of persons who placed Q-statement in a particular envelope
[d] Percent, adjusted to exclude missing cases
[e] UNVPURSC and UNVAPPSC combined

Table 31

Descriptive Statistics for Responses to Q-statements of the Discipline Component of the Organization of Knowledge Dimension

Q-statement	Behavior	Responses -4	-3	-2	-1	0	+1	+2	+3	+4	Mean	SD
UNVPURSC	Valid Cases: 21 (91.3%) Missing Cases: 2 (8.7%)											
IA13[a]	Knowledge	-	1[c]	1	-	[illegible]	2	6	1	8		
41[b]		-	4.8[d]	4.8	-	[illegible]	9.5	28.6	4.8	38.1	2.095	2.047
IA53	Synthesis	11	5	2	-	[illegible]	[illegible]	-	-	-		
25		52.4	23.8	9.5	-	[illegible]	[illegible]	-	-	-	-2.952	1.532
IB231	Behaving	4	3	2	2	1	3	4	2	-		
29		19.0	14.3	9.5	9.5	4.8	14.3	19.0	9.5	-	-0.667	2.536
IB33	Advocating	1	1	4	1	3	3	4	2	2		
34		4.8	4.8	19.0	4.8	14.3	14.3	19.0	9.5	9.5	0.429	2.315
UNVAPPSC	Valid Cases: 19 (86.4%) Missing Cases: 3 (13.6%)											
IA13	Knowledge	-	-	4	2	1	3	1	1	7		
41		-	-	21.1	10.5	5.3	15.8	5.3	5.3	36.8	1.368	2.477
IA53	Synthesis	6	2	5	1	-	3	-	1	1		
25		31.6	10.5	26.3	5.3	-	15.8	-	5.3	5.3	-1.632	2.499
IB231	Behaving	3	3	4	4	-	4	-	1	-		
29		15.8	15.8	21.1	21.1	-	21.1	-	5.3	-	-1.368	2.006
IB33	Advocating	1	1	1	2	4	3	5	2	-		
34		5.3	5.3	5.3	10.5	21.1	15.8	26.3	10.5	-	0.421	1.953
UNVSC[e]	Valid Cases: 40 (88.9%) Missing Cases: 5 (11.1%)											
IA13	Knowledge	-	1	5	2	3	5	7	2	15		
41		-	2.5	12.5	5.0	7.5	12.5	17.5	5.0	37.5	1.750	2.262
IA53	Synthesis	17	7	7	1	2	4	-	1	1		
25		42.5	17.5	17.5	2.5	5.0	10.0	-	2.5	2.5	-2.325	2.129
IB231	Behaving	7	6	6	6	1	7	4	3	-		
29		17.5	15.0	15.0	15.0	2.5	17.5	10.0	7.5	-	-1.000	2.298
IB33	Advocating	2	2	5	3	7	6	9	4	2		
34		5.0	5.0	12.5	7.5	17.5	15.0	22.5	10.0	5.0	0.425	2.123
UNVNONSC	Valid Cases: 41 (89.1%) Missing Cases: 5 (10.9%)											
IA13	Knowledge	-	3	-	3	3	6	6	8	12		
41		-	7.3	-	7.3	7.3	14.6	14.6	19.5	29.3	1.902	2.095
IA53	Synthesis	11	11	7	2	6	1	-	2	1		
25		26.8	26.8	17.1	4.9	14.6	2.4	-	4.9	2.4	-2.000	2.098
IB231	Behaving	5	3	4	3	6	5	9	5	1		
29		12.2	7.3	9.8	7.3	14.6	12.2	22.0	12.2	2.4	0.049	2.387
IB33	Advocating	2	5	4	9	5	4	2	8	2		
34		4.9	12.2	9.8	22.0	12.2	9.8	4.9	19.5	4.9	0.000	2.335
PUBSC	Valid Cases: 52 (100%) Missing Cases: 0 (0.0%)											
IA13	Knowledge	3	2	2	5	10	8	8	6	8		
41		5.8	3.8	3.8	9.6	19.2	15.4	15.4	11.5	15.4	0.904	2.251
IA53	Synthesis	8	11	7	8	5	4	-	6	3		
25		15.4	21.2	13.5	15.4	9.6	7.7	-	11.5	5.8	-1.019	2.485
IB231	Behaving	4	5	6	9	7	9	3	3	6		
29		7.7	9.6	11.5	17.3	13.5	17.3	5.8	5.8	11.5	-0.077	2.367
IB33	Advocating	4	7	9	9	[illegible]	6	8	4	1		
34		7.7	13.5	17.3	17.3	[illegible]	11.5	15.4	7.7	1.9	-0.500	2.210
PUBNONSC	Valid Cases: 42 (100%) Missing Cases: 0 (0.0%)											
IA13	Knowledge	2	1	4	1	3	8	6	5	12		
41		4.8	2.4	9.5	2.4	7.1	19.0	14.3	11.9	28.6	1.500	2.381
IA53	Synthesis	9	8	6	6	6	-	7	-	-		
25		21.4	19.0	14.3	14.3	14.3	-	16.7	-	-	-1.524	2.075
IB231	Behaving	5	2	9	3	4	4	4	8	3		
29		11.9	4.8	21.4	7.1	9.5	9.5	9.5	19.0	7.1	0.024	2.599
IB33	Advocating	3	5	2	8	8	9	2	3	2		
34		7.1	11.9	4.8	19.0	19.0	21.4	4.8	7.1	4.8	-0.214	2.113
OVERALL	Valid Cases: 175 (94.6%) Missing Cases: 10 (5.4%)											
IA13	Knowledge	5	7	11	11	19	27	27	21	47		
41		2.9	4.0	6.3	6.3	10.9	15.4	15.4	12.0	26.9	1.474	2.266
IA53	Synthesis	45	37	27	17	19	9	7	9	5		
25		25.7	21.1	15.4	9.7	10.9	5.1	4.0	5.1	2.9	-1.669	2.260
IB231	Behaving	21	16	25	21	18	25	20	19	10		
29		12.0	9.1	14.3	12.0	10.3	14.3	11.4	10.9	5.7	-0.234	2.430
IB33	Advocating	11	19	20	29	24	25	21	19	7		
34		6.3	10.9	11.4	16.6	13.7	14.3	12.0	10.9	4.0	-0.103	2.205

[a] TMSL element identification
[b] Q-statement number
[c] Number of persons who placed Q-statement in a particular envelope
[d] Percent, adjusted to exclude missing cases
[e] UNVPURSC and UNVAPPSC combined

important by the respondents (OVERALL). The evaluation behavior was considered to be of little importance. Neither of the two affective behaviors, behaving and advocating, was ranked very highly by the respondents (OVERALL).

Table 32 has three (3) Q-statements about which all groups agreed. Q7(analysis) was not ranked as strongly by the UNVAPPSC group as it was by the other groups. The same was true for Q2(valuing). However, Q2 was somewhat more strongly supported than was Q7. Q8(behaving) was believed to be of less importance by all groups and especially so by the UNVPURSC group. Q15(advocating) was believed to be fairly important by the UNVPURSC and UNVAPPSC groups, of less importance by the PUBSC and PUBNONSC groups, and of least importance by the UNVNONSC group. In the Intellectual Processes dimension the respondents (OVERALL) attached the most importance to the analysis and to the valuing behaviors. Some importance was attached to the advocating behavior but not very much to that of behaving.

Table 33 has only one (1) Q-statement, Q24(synthesis), which all groups of respondents felt strongly about. In this case they saw Q24 as having considerable less importance than the others in the table; the UNVNONSC group did not feel as strongly as did the other groups. Likewise, all groups felt that Q10(evaluation) was less important than other Q-statements, but with the exception of the UNVAPPSC group the expression was not as strong as with Q24. On

Table 32

Descriptive Statistics for Responses to Q-statements of the Intellectual Processes Dimension

Q-statements	Behavior	Responses -4	-3	-2	-1	0	+1	+2	+3	+4	Mean	SD
UNVPURSC	Valid Cases: 21 (91.3%)	Missing Cases: 2 (8.7%)										
IIA41[a]	Analysis	-	1[c]	1	2	5	-	3	4	5	1.476	2.205
7[b]		-	4.8[d]	4.8	9.5	23.8	-	14.3	19.0	23.8		
IIB11	Valuing	1	-	-	-	2	2	1	8	7	2.476	1.965
2		4.8	-	-	-	9.5	9.5	4.8	38.1	33.3		
IIB21	Behaving	3	2	3	3	2	1	4	-	3	-0.286	2.686
8		14.3	9.5	14.3	14.3	9.5	4.8	19.0	-	14.3		
IIB31	Advocating	1	1	2	2	1	3	2	4	5	1.238	2.548
15		4.8	4.8	9.5	9.5	4.8	14.3	9.5	19.0	23.8		
UNVAPPSC	Valid Cases: 19 (86.4%)	Missing Cases: 3 (13.6%)										
IIA41	Analysis	1	1	2	-	5	2	3	3	2	0.737	2.306
7		5.3	5.3	10.5	-	26.3	10.5	15.8	15.8	10.5		
IIB11	Valuing	2	1	2	-	3	-	4	6	1	0.789	2.616
2		10.5	5.3	10.5	-	15.8	-	21.1	31.6	5.3		
IIB21	Behaving	9	5	-	2	1	1	-	1	-	-2.579	2.036
8		47.4	26.3	-	10.5	5.3	5.3	-	5.3	-		
IIB31	Advocating	-	-	2	1	3	3	3	3	4	1.526	1.982
15		-	-	10.5	5.3	15.8	15.8	15.8	15.8	21.1		
UNVSC[e]	Valid Cases: 40 (88.9%)	Missing Cases: 5 (11.1%)										
IIA41	Analysis	1	2	3	2	10	2	6	7	7	1.125	2.255
7		2.5	5.0	7.5	5.0	25.0	5.0	15.0	17.5	17.5		
IIB11	Valuing	3	1	2	-	5	2	5	14	8	1.675	2.422
2		7.5	2.5	5.0	-	12.5	5.0	12.5	35.0	20.0		
IIB21	Behaving	12	7	3	5	3	2	4	1	3	-1.375	2.635
8		30.0	17.5	7.5	12,5	7.5	5.0	10.0	2.5	7.5		
IIB31	Advocating	1	1	4	3	4	6	5	7	9	1.375	2.272
15		2.5	2.5	10.0	7.5	10.0	15.0	12.5	17.5	22.5		
UNVNONSC	Valid Cases: 41 (89.1%)	Missing Cases: 5 (10.9%)										
IIA41	Analysis	1	4	2	1	5	5	5	8	10	1.415	2.429
7		2.4	9.8	4.9	2.4	12.2	12.2	12.2	19.5	24.4		
IIB11	Valuing	1	5	5	1	1	3	7	9	9	1.220	2.632
2		2.4	12.2	12.2	2.4	2.4	7.3	17.1	22.0	22.0		
IIB21	Behaving	12	6	5	4	5	4	3	1	1	-1.537	2.314
8		29.3	14.6	12.2	9.8	12.2	9.8	7.3	2.4	2.4		
IIB31	Advocating	6	4	3	2	9	6	5	3	3	-0.171	2.479
15		14.6	9.8	7.3	4.9	22.0	14.6	12.2	7.3	7.3		
PUBSC	Valid Cases: 52 (100%)	Missing Cases: 0 (0.0%)										
IIA41	Analysis	-	3	4	4	6	7	6	10	12	1.462	2.209
7		-	5.8	7.7	7.7	11.5	13.5	11.5	19.2	23.1		
IIB11	Valuing	1	4	3	6	2	5	10	8	13	1.404	2.395
2		1.9	7.7	5.8	11.5	3.8	9.6	19.2	15.4	25.0		
IIB21	Behaving	9	9	10	5	6	4	8	1	-	-1.250	2.141
8		17.3	17.3	19.2	9.6	11.5	7.7	15.4	1.9	-		
IIB31	Advocating	3	3	4	8	8	5	7	9	5	0.558	2.330
15		5.8	5.8	7.7	15.4	15.4	9.6	13.5	17.3	9.6		
PUBNONSC	Valid Cases: 42 (100%)	Missing Cases: 0 (0.0%)										
IIA41	Analysis	-	2	2	3	7	4	9	4	11	1.548	2.098
7		-	4.8	4.8	7.1	16.7	9.5	21.4	9.5	26.2		
IIB11	Valuing	1	2	1	2	5	7	7	5	12	1.667	2.183
2		2.4	4.8	2.4	4.8	11.9	16.7	16.7	11.9	28.6		
IIB21	Behaving	12	4	7	3	6	1	4	5	-	-1.262	2.490
8		28.6	9.5	16.7	7.1	14.3	2.4	9.5	11.9	-		
IIB31	Advocating	3	2	4	5	3	7	9	7	2	0.548	2.276
15		7.1	4.8	9.5	11.9	7.1	16.7	21.4	16.7	4.8		
OVERALL	Valid Cases: 175 (94.6%)	Missing Cases: 10 (5.4%)										
IIA41	Analysis	2	11	11	10	28	18	26	29	40	1.394	2.233
7		1.1	6.3	6.3	5.7	16.0	10.3	14.9	16.6	22.9		
IIB11	Valuing	6	12	11	9	13	17	29	36	42	1.468	2.397
2		3.4	6.9	6.3	5.1	7.4	9.7	16.6	20.6	24.0		
IIB21	Behaving	45	26	25	17	20	11	19	8	4	-1.349	2.368
8		25.7	14.9	14.3	9.7	11.4	6.3	10.9	4.6	2.3		
IIB31	Advocating	13	10	15	18	24	24	26	26	19	0.571	2.379
15		7.4	5.7	8.6	10.3	13.7	13.7	14.9	14.9	10.9		

[a] TMSL element identification
[b] Q-statement number
[c] Number of persons who placed Q-statement in a particular envelope
[d] Percent, adjusted to exclude missing cases
[e] UNVPURSC and UNVAPPSC combined

Table 33

Descriptive Statistics for Responses to Q-statements of the Values and Ethics Dimension

Q-statement	Behavior	Responses -4	-3	-2	-1	0	+1	+2	+3	+4	Mean	SD
UNVPURSC	Valid Cases: 21 (91.3%) Missing Cases: 2 (8.7%)											
111A11[a]	Knowledge	2[c]	-	1	3	3	4	5	1	2	0.571	2.204
12[b]		9.5[d]	-	4.8	14.3	14.3	19.0	23.8	4.8	9.5		
111A21	Comprehension	-	1	2	2	4	4	5	1	2	0.762	1.895
32		-	4.8	9.5	9.5	19.0	19.0	23.8	4.8	9.5		
111A51	Synthesis	2	5	4	2	5	3	-	-	-	-1.429	1.660
24		9.5	23.8	19.0	9.5	23.8	14.3	-	-	-		
111A61	Evaluation	2	3	5	2	1	4	2	2	-	-0.714	2.239
10		9.5	14.3	23.8	9.5	4.8	19.0	9.5	9.5	-		
111B11	Valuing	1	2	2	2	4	-	3	3	4	0.724	2.610
6		4.8	9.5	9.5	9.5	19.0	-	14.3	14.3	19.0		
UNVAPPSC	Valid Cases: 19 (86.4%) Missing Cases: 3 (13.6%)											
111A11	Knowledge	2	2	4	4	3	-	3	-	1	-0.842	2.167
12		10.5	10.5	21.1	21.1	15.8	-	15.8	-	5.3		
111A21	Comprehension	2		2	2	2	3	4	1	-	-0.474	2.270
32		10.5	15.8	10.5	10.5	10.5	15.8	21.1	5.3	-		
111A51	Synthesis	4	3	5	3	1	2	1	-	-	-1.789	1.813
24		21.1	15.8	26.3	15.8	5.3	10.5	5.3	-	-		
111A61	Evaluation	4	4	-	2	2	5	1	1	-	-1.053	2.345
10		21.1	21.1	-	10.5	10.5	26.3	5.3	5.3	-		
111B11	Valuing	2	7	5	-	-	2	1	2	-	-1.526	2.294
6		10.5	36.8	26.3	-	-	10.5	5.3	10.5	-		
UNVSC[e]	Valid Cases: 40 (88.9%) Missing Cases: 5 (11.1%)											
111A11	Knowledge	4	2	5	7	6	4	8	1	3	-0.100	2.274
12		10.0	5.0	12.5	17.5	15.0	10.0	20.0	2.5	7.5		
111A21	Comprehension	2	4	4	4	6	7	9	2	2	0.175	2.147
32		5.0	10.0	10.0	10.0	15.0	17.5	22.5	5.0	5.0		
111A51	Synthesis	6	8	9	5	6	5	1	-	-	-1.600	1.722
24		15.0	20.0	22.5	12.5	15.0	12.5	2.5	-	-		
111A61	Evaluation	6	7	5	4	3	9	3	3	-	-0.875	2.267
10		15.0	17.5	12.5	10.0	7.5	22.5	7.5	7.5	-		
111B11	Valuing	3	9	7	2	4	2	4	5	4	-0.350	2.685
6		7.5	22.5	17.5	5.0	10.0	5.0	10.0	12.5	10.0		
UNVNONSC	Valid Cases: 41 (89.1%) Missing Cases: 5 (10.9%)											
111A11	Knowledge	2	2	4	6	4	3	6	8	6	0.854	2.435
12		4.9	4.9	9.8	14.6	9.8	7.3	14.6	19.5	14.6		
111A21	Comprehension	5	2	8	3	4	8	7	-	4	-0.171	2.407
32		12.2	4.9	19.5	7.3	9.8	19.5	17.1	-	9.8		
111A51	Synthesis	5	5	10	4	5	5	3	2	2	-0.829	2.279
24		12.2	12.2	24.4	9.8	12.2	12.2	7.3	4.9	4.9		
111A61	Evaluation	4	9	4	8	5	5	3	3	-	-0.951	2.097
10		9.8	22.0	9.8	19.5	12.2	12.2	7.3	7.3	-		
111B11	Valuing	6	6	7	5	4	4	3	4	2	-0.756	2.468
6		14.6	14.6	17.1	12.1	9.8	9.8	7.3	9.8	4.9		
PUBSC	Valid Cases: 52 (100%) Missing Cases: 0 (0.0%)											
111A11	Knowledge	9	15	9	3	7	6	1	-	2	-1.654	2.066
12		17.3	28.8	17.3	5.8	13.5	11.5	1.9	-	3.8		
111A21	Comprehension	8	13	7	7	5	4	4	3	1	-1.288	2.243
32		15.4	25.0	13.5	13.5	9.6	7.7	7.7	5.8	1.9		
111A51	Synthesis	9	11	15	7	4	2	1	1	2	-1.750	1.969
24		17.3	21.2	28.8	13.5	7.7	3.8	1.9	1.9	3.8		
111A61	Evaluation	2	6	8	5	9	11	5	4	2	-0.135	2.083
10		3.8	11.5	15.4	9.6	17.3	21.2	9.6	7.7	3.8		
111B11	Valuing	4	10	7	9	5	9	5	3	-	-0 788	2.052
6		7.7	19.2	13.5	17.3	9.6	17.3	9.6	5.8	-		
PUBNONSC	Valid Cases: 42 (100%) Missing Cases: 0 (0.0%)											
111A11	Knowledge	5	8	1	6	6	5	4	5	2	-0.381	2.489
12		11.9	19.0	2.4	14.3	14.3	11.9	9.5	11.9	4.8		
111A21	Comprehension	5	9	4	8	4	2	6	2	2	-0.833	2.378
32		11.9	21.4	9.5	19.0	9.5	4.8	14.3	4.8	4.8		
111A51	Synthesis	8	11	6	5	5	3	3	1	-	-1.667	1.996
24		19.0	26.2	14.3	11.9	11.9	7.1	7.1	2.4	-		
111A61	Evaluation	6	6	8	3	6	4	2	3	4	-0.667	2.563
10		14.3	14.3	19.0	7.1	14.3	9.5	4.8	7.1	9.5		
111B11	Valuing	5	10	6	11	2	1	1	5	1	-1.214	2.258
6		11.9	23.8	14.3	26.2	4.8	2.4	2.4	11.9	2.4		
OVERALL	Valid Cases: 175 (94.6%) Missing Cases: 10 (5.4%)											
111A11	Knowledge	20	27	19	22	23	18	19	14	13	-0.406	2.468
12		11.4	15.4	10.9	12.6	13.1	10.3	10.9	8.0	7.4		
111A21	Comprehension	20	28	23	22	19	21	26	7	9	-0.583	2.347
32		11.4	16.0	13.1	12.6	10.9	12.0	14.9	4.0	5.1		
111A51	Synthesis	28	35	40	21	20	15	8	4	4	-1.480	2.017
24		16.0	20.0	22.9	12.0	11.4	8.6	4.6	2.3	2.3		
111A61	Evaluation	18	28	[illegible]	20	23	29	13	13	6	-0.617	2.258
10		10.3	16.0	14.3	11.4	13.1	16.6	7.4	7.4	3.4		
111B11	Valuing	18	35	77	27	15	16	13	17	7	-0.783	2.353
6		10.3	20.0	15.4	15.4	8.6	9.1	7.1	9.7	4.0		

[a]IHSL element identification
[b]Q-statement number
[c]Number of persons who placed Q-statement in a par[illegible] envelope
[d]Percent, adjusted to exclude missing cases
[e]UNVPURSC and UNVAPPSC combined

Q-statements Q12(knowledge), Q32(comprehension), and Q6(valuing) the groups disagreed. The UNVPURSC group saw more importance in these three (3) than did the UNVAPPSC group. Only the UNVPURSC group rated Q32 positively. Both the UNVNONSC and UNVPURSC groups gave a small positive rating to Q12. The Q-statements of the Values and Ethics dimension were valued as being less important by the respondents (OVERALL) as compared to other dimensions. Q24 was the least valued with all other Q-statements valued slightly more.

Table 34 has only Q20(analysis) for which all groups believed the same way. All groups played down its importance with respect to the other Q-statements. The PUBSC group placed more importance in Q40(synthesis) than did the other groups, especially the UNVPURSC group. Q38(application) was valued relatively highly by the PUBSC and PUBNONSC groups. The UNVPURSC group tended to agree, but the UNVAPPSC group disagreed. Q3(comprehension) was believed to be less important than other Q-statements by all groups except the UNVAPPSC group. The UNVPURSC and UNVAPPSC groups did not place as much importance in Q37(knowledge) as in some of the other Q-statements, but the other groups did especially the PUBSC group. No Q-statement was ranked strongly in either direction on the Process of Inquiry dimension. Two (2) behaviors were valued slightly, knowledge and application. The other cognitive behaviors

Table 34

Descriptive Statistics for Responses to Q-statements of the Process of Inquiry Dimension

Q-statement	Behavior	Responses -4	-3	-2	-1	0	+1	+2	+3	+4	Mean	SD
UNVPUBSC	Valid Cases: 21 (91.3%) Missing Cases: 2 (8.7%)											
IVA11[a]	Knowledge	2[c]	1	5	5	1	1	1	4	1	-0.333	2.456
37[b]		9.5[d]	4.8	23.8	23.8	4.8	4.8	4.8	19.0	4.8		
IVA214	Comprehension	1	3	1	-	2	5	6	1	2	0.619	2.334
3		4.8	14.3	4.8	-	9.5	23.8	28.6	4.8	9.5		
IVA31	Application	2	5	2	2	-	-	2	4	4	0.143	3.119
38		9.5	23.8	9.5	9.5	-	-	9.5	19.0	19.0		
IVA41	Analysis	-	2	7	2	2	2	2	1	3	-0.048	2.397
20		-	9.5	33.3	9.5	9.5	9.5	9.5	4.8	14.3		
IVA51	Synthesis	5	4	4	2	3	2	-	-	1	-1.714	2.125
40		23.8	19.0	19.0	9.5	14.3	9.5	-	-	4.8		
UNVAPPSC	Valid Cases: 19 (86.4%) Missing Cases: 3 (13.6%)											
IVA11	Knowledge	3	1	2	2	3	4	2	1	1	-0.316	2.382
37		15.8	5.3	10.5	10.5	15.8	21.1	10.5	5.3	5.3		
IVA214	Comprehension	2	3	1	2	4	1	2	3	1	-0.158	2.544
3		10.5	15.8	5.3	10.5	21.1	5.3	10.5	15.8	5.3		
IVA31	Application	3	4	2	1	1	2	2	1	3	-0.421	2.950
38		15.8	21.1	10.5	5.3	5.3	10.5	10.5	5.3	15.8		
IVA41	Analysis	2	3	-	5	2	4	-	2	1	-0.421	2.341
20		10.5	15.8	-	26.3	10.5	21.1	-	10.5	5.3		
IVA51	Synthesis	4	1	3	4	1	-	2	3	2	-0.632	2.712
40		21.1	5.3	15.8	21.1	5.3	-	10.5	15.8	5.3		
UNVSC[e]	Valid Cases: 40 (88.9%) Missing Cases: 5 (11.1%)											
IVA11	Knowledge	5	2	7	7	4	5	3	5	2	-0.325	2.390
37		12.5	5.0	17.5	17.5	10.0	12.5	7.5	12.5	5.0		
IVA214	Comprehension	3	6	2	2	6	6	8	4	3	0.250	2.436
3		7.5	15.0	5.0	5.0	15.0	15.0	20.0	10.0	7.5		
IVA31	Application	5	9	4	3	1	2	4	5	7	-0.125	3.014
38		12.5	22.5	10.0	7.5	2.5	5.0	10.0	12.5	17.5		
IVA41	Analysis	2	5	7	7	4	6	2	3	4	-0.225	2.348
20		5.0	12.5	17.5	17.5	10.0	15.0	5.0	7.5	10.0		
IVA51	Synthesis	9	5	7	6	4	2	2	3	2	-1.200	2.452
40		22.5	12.5	17.5	15.0	10.0	5.0	5.0	7.5	5.0		
UNVNONSC	Valid Cases: 41 (89.1%) Missing Cases: 5 (10.9%)											
IVA11	Knowledge	2	2	1	5	6	7	6	9	3	0.902	2.154
37		4.9	4.9	2.4	12.2	14.6	17.1	14.6	22.0	7.3		
IVA214	Comprehension	5	3	5	5	8	6	4	4	1	-0.341	2.243
3		12.2	7.3	12.2	12.2	19.5	14.6	9.8	9.8	2.4		
IVA31	Application	1	5	5	7	8	2	1	8	4	0.195	2.390
38		2.4	12.2	12.2	17.1	19.5	4.9	2.4	19.5	9.8		
IVA41	Analysis	4	4	7	3	11	5	5	2	-	-0.585	2.000
20		9.8	9.8	17.1	7.3	26.8	12.2	12.2	4.9	-		
IVA51	Synthesis	5	6	4	6	5	4	5	2	4	-0.390	2.529
40		12.2	14.6	9.8	14.6	12.2	9.8	12.2	4.9	9.8		
PUBSC	Valid Cases: 52 (100%) Missing Cases: 0 (0.0%)											
IVA11	Knowledge	2	2	3	2	12	7	7	9	8	1.115	2.184
37		3.8	3.8	5.8	3.8	23.1	13.5	13.5	17.3	15.4		
IVA214	Comprehension	3	6	8	10	9	4	2	5	5	-0.250	2.334
3		5.8	11.5	15.4	19.2	17.3	7.7	3.8	9.6	9.6		
IVA31	Application	1	4	5	3	2	6	10	10	11	1.365	2.385
38		1.9	7.7	9.6	5.8	3.8	11.5	19.2	19.2	21.2		
IVA41	Analysis	5	7	5	13	5	7	7	2	1	-0.635	2.096
20		9.6	13.5	9.6	25.0	9.6	13.5	13.5	3.8	1.9		
IVA51	Synthesis	3	7	5	6	5	11	5	4	6	0.154	2.420
40		5.8	13.5	9.6	11.5	9.6	21.2	9.6	7.7	11.5		
PUBNONSC	Valid Cases: 42 (100%) Missing Cases: 0 (0.0%)											
IVA11	Knowledge	-	3	8	4	4	7	8	6	2	0.476	2.086
37		-	7.1	19.0	9.5	9.5	16.7	19.0	14.3	4.8		
IVA214	Comprehension	2	6	8	6	3	8	4	1	4	-0.310	2.300
3		4.8	14.3	19.0	14.3	7.1	19.0	9.5	2.4	9.5		
IVA31	Application	3	1	3	3	6	8	4	6	8	1.000	2.399
38		7.1	2.4	7.1	7.1	14.3	19.0	9.5	14.3	19.0		
IVA41	Analysis	4	11	4	4	7	4	6	1	1	-0.905	2.218
20		9.5	26.2	9.5	9.5	16.7	9.5	14.3	2.4	2.4		
IVA51	Synthesis	4	5	8	5	3	2	6	6	3	-0.190	2.578
40		9.5	11.9	19.0	11.9	7.1	4.8	14.3	14.3	7.1		
OVERALL	Valid Cases: 175 (94.6%) Missing Cases: 10 (5.4%)											
IVA11	Knowledge	9	9	19	18	26	26	24	29	15	0.583	2.252
37		5.1	5.1	10.9	10.3	14.9	14.9	13.7	16.6	8.6		
IVA214	Comprehension	13	21	23	23	26	24	18	14	13	-0.171	2.320
3		7.4	12.0	13.1	13.1	14.9	13.7	10.3	8.0	7.4		
IVA31	Application	10	19	17	16	17	18	19	29	30	0.663	2.597
38		5.7	10.9	9.7	9.1	9.7	10.3	10.9	16.6	17.1		
IVA41	Analysis	15	27	23	27	27	22	20	8	6	-0.594	2.158
20		8.6	15.4	13.1	15.4	15.4	12.6	11.4	4.6	3.4		
IVA51	Synthesis	21	23	24	23	17	19	18	15	15	-0.366	2.520
40		12.0	13.1	13.7	13.1	9.7	10.9	10.3	8.6	8.6		

[a] IMSL element identification
[b] Q-statement number
[c] Number of persons who placed Q-statement in a particular envelope
[d] Percent, adjusted to exclude missing cases
[e] UNVPUBSC and UNVAPPSC combined

involving comprehension, analysis, and synthesis were not valued too highly.

Table 35 indicates that the respondents (OVERALL) did not place as much value in the Q-statements on this dimension as in some of the other dimensions. Q1(valuing) and Q35(behaving) were valued the least by all of the groups. The UNVPURSC group believed that Q30(analysis) had some importance, but none of the other groups rated it very highly. Q33(advocating) was valued quite strongly by the UNVAPPSC group and somewhat by the UNVPURSC group but not by the UNVNONSC, PUBSC, or the PUBNONSC groups. The importance of the Q-statements pertaining to the Human Endeavor dimension was played down by the respondents (OVERALL). The valuing, behaving, and analysis behaviors were the least valued on this dimension.

Table 36 shows that all groups had stronger feelings about Q26(evaluation) than some of the other Q-statements. They placed it as being least important of all other behaviors on this dimension. All groups gave a similar rating to Q31(analysis). All groups were in agreement on Q43(comprehension), but in this case they gave it a more positive rating than Q26 or Q31. The UNVPURSC, UNVAPPSC, and PUBNONSC groups gave Q34 a fairly high positive rating. The UNVPURSC and UNVNONSC groups agreed that there was more value in Q22(knowledge) than did the other groups. Q18(application) was not valued as much by the UNVPURSC and

Table 35

Descriptive Statistics for Responses to Q-statements of the Human Endeavor Dimension

Q-statement	Behavior	-4	-3	-2	-1	0	+1	+2	+3	+4	Mean	SD
UNVPURSC	Valid Cases: 21 (91.3%) Missing Cases: 2 (8.7%)											
VA41[a]	Analysis	1[c]	3	1	3	1	5	5	1	1		
30[b]		4.8[d]	14.3	4.8	14.3	4.8	23.8	23.8	4.8	4.8	0.190	2.226
VB11	Valuing	3	3	3	3	3	2	3	-	1		
1		14.3	14.3	14.3	14.3	14.3	9.5	14.3	-	4.8	-0.857	2.287
VB21	Behaving	4	2	4	1	2	2	3	3	-		
35		19.0	9.5	19.0	4.8	9.5	9.5	14.3	14.3	-	-0.667	2.556
VB31	Advocating	2	2	2	4	1	-	4	4	2		
33		9.5	9.5	9.5	19.0	4.8	-	19.0	19.0	9.5	0.286	2.686
UNVAPPSC	Valid Cases: 19 (86.4%) Missing Cases: 3 (13.6%)											
VA41	Analysis	4	4	-	1	2	1	5	1	1		
30		21.1	21..	-	5.3	10.5	5.3	26.3	5.3	5.3	-0.579	2.795
VB11	Valuing	3	1	4	2	3	3	2	-	1		
1		15.8	5.3	21.1	10.5	15.8	15.8	10.5	-	5.3	-0.737	2.257
VB21	Behaving	6	1	2	1	2	1	4	1	1		
35		31.6	5.3	10.5	5.3	10.5	5.3	21.1	5.3	5.3	-0.842	2.814
VB31	Advocating	-	1	1	2	2	-	4	6	3		
33		-	5.3	5.3	10.5	10.5	-	21.1	31.6	15.8	1.632	2.140
UNVSC[e]	Valid Cases: 40 (88.9%) Missing Cases: 5 (11.1%)											
VA41	Analysis	5	7	1	4	3	6	10	2	2		
30		12.5	17.5	2.5	10.0	7.5	15.0	25.0	5.0	5.0	-0.175	2.510
VB11	Valuing	6	4	7	5	6	5	5	-	2		
1		15.0	10.0	17.5	12.5	15.0	12.5	12.5	-	5.0	-0.800	2.244
VB21	Behaving	10	3	6	2	4	3	7	4	1		
35		25.0	7.5	15.0	5.0	10.0	7.5	17.5	10.0	2.5	-0.750	2.648
VB31	Advocating	2	3	3	6	3	-	8	10	5		
33		5.0	7.5	7.5	15.0	7.5	-	20.0	25.0	12.5	0.925	2.505
UNVNONSC	Valid Cases: 41 (89.1%) Missing Cases: 5 (10.9%)											
VA41	Analysis	5	6	5	5	3	6	4	5	2		
30		12.2	14.6	12.2	12.2	7.3	14.6	9.8	12.2	4.9	-0.390	2.509
VB11	Valuing	6	10	5	6	5	6	2	1	-		
1		14.6	24.4	12.2	14.6	12.2	14.6	4.9	2.4	-	-1.390	1.973
VB21	Behaving	17	4	3	6	1	2	3	1	4		
35		41.5	9.8	7.3	14.6	2.4	4.9	7.3	2.4	9.8	-1.585	2.784
VB31	Advocating	10	1	2	4	3	9	5	5	2		
33		24.4	2.4	4.9	9.8	7.3	22.0	12.2	12.2	4.9	-0.220	2.669
PUBSC	Valid Cases: 52 (100%) Missing Cases: 0 (0.0%)											
VA41	Analysis	13	11	4	7	7	4	2	3	1		
30		25.0	21.2	7.7	13.5	13.5	7.7	3.8	5.8	1.9	-1.519	2.279
VB11	Valuing	14	5	7	3	5	4	4	4	6		
1		26.9	9.6	13.5	5.8	9.6	7.7	7.7	7.7	11.5	-0.769	2.874
VB21	Behaving	25	4	1	4	5	2	7	3	1		
35		48.1	7.7	1.9	7.7	9.6	3.8	13.5	5.8	1.9	-1.712	2.674
VB31	Advocating	13	4	5	3	6	8	5	2	6		
33		25.0	7.7	9.6	5.8	11.5	15.4	9.6	3.8	11.5	-0.558	2.775
PUBNONSC	Valid Cases: 42 (100%) Missing Cases: 0 (0.0%)											
VA41	Analysis	11	9	8	5	3	2	4	-	-		
30		26.2	21.4	19.0	11.9	7.1	4.8	9.5	-	-	-1.952	1.925
VB11	Valuing	11	5	6	5	4	2	4	3	2		
1		26.2	11.9	14.3	11.9	9.5	4.8	9.5	7.1	4.8	-1.167	2.565
VB21	Behaving	11	3	5	5	6	2	1	2	7		
35		26.2	7.1	11.9	11.9	14.3	4.8	2.4	4.8	16.7	-0.714	2.891
VB31	Advocating	6	7	5	3	3	6	6	2	4		
33		14.3	16.7	11.9	7.1	7.1	14.3	14.3	4.8	9.5	-0.429	2.642
OVERALL	Valid Cases: 175 (94.6%) Missing Cases: 10 (5.4%)											
VA41	Analysis	34	33	18	21	16	18	20	10	5		
30		19.4	18.9	10.3	12.0	9.1	10.3	11.4	5.7	2.9	-1.051	2.408
VB11	Valuing	37	24	25	19	20	17	15	8	10		
1		21.1	13.7	14.3	10.9	11.4	9.7	8.6	4.6	5.7	-1.017	2.462
VB21	Behaving	63	14	15	17	16	9	18	10	13		
35		36.0	8.0	8.6	9.7	9.1	5.1	10.3	5.7	7.4	-1.223	2.763
VB31	Advocating	31	25	15	16	15	23	24	19	17		
33		17.7	8.6	8.6	9.1	8.6	13.1	13.7	10.9	9.7	-0.109	2.698

[a] IMSL element identification
[b] Q-statement number
[c] Number of persons who placed Q-statement in a particular envelope
[d] Percent, adjusted to exclude missing cases
[e] UNVPURSC and UNVAPPSC combined

Table 36

Descriptive Statistics for Responses to Q-statements of the Interaction of Science and Technology Dimension

Q-statement	Behavior	Responses -4	-3	-2	-1	0	+1	+2	+3	+4	Mean	SD
UNVPURSC	Valid Cases: 21 (91.3%) Missing Cases: 2 (8.7%)											
VIA111[a]	Knowledge	2[c]	1	1	-	1	4	-	3	9	1.714	2.613
22[b]		9.5[d]	4.8	4.8	-	4.8	19.0	-	14.3	42.9		
VIA21	Comprehension	-	1	-	3	4	2	2	8	1	1.333	1.906
43		-	4.8	-	14.3	19.0	9.5	9.5	38.1	4.8		
VIA31	Application	4	1	1	4	4	-	2	3	2	-0.190	2.713
18		19.0	4.8	4.8	19.0	19.0	-	9.5	14.3	9.5		
VIA41	Analysis	3	1	2	5	2	1	2	4	1	-0.143	2.555
31		14.3	4.8	9.5	23.8	9.5	4.8	9.5	19.0	4.8		
VIA61	Evaluation	5	3	4	6	-	2	1	-	-	-1.857	1.769
26		23.8	14.3	19.0	28.6	-	5.5	4.8	-	-		
UNVAPPSC	Valid Cases: 19 (86.4%) Missing Cases: 3 (13.6%)											
VIA111	Knowledge	-	3	5	1	2	3	1	2	2	-0.053	2.415
22		-	15.8	26.3	5.3	10.5	15.8	5.3	10.5	10.5		
VIA21	Comprehension	1	-	1	3	2	2	5	1	4	1.158	2.267
43		5.3	-	5.3	15.8	10.5	10.5	26.3	5.3	21.1		
VIA31	Application	1	2	1	3	4	2	1	2	3	0.368	2.477
18		5.3	10.5	5.3	15.8	21.1	10.5	5.3	10.5	15.8		
VIA41	Analysis	-	3	2	4	3	2	3	2	-	-0.158	1.979
31		-	15.8	10.5	21.1	15.8	10.5	15.8	10.5	-		
VIA61	Evaluation	4	2	1	2	4	-	3	1	2	-0.474	2.756
26		21.1	10.5	5.3	10.5	21.1	-	15.8	5.3	10.5		
UNVSC[e]	Valid Cases: 40 (88.9%) Missing Cases: 5 (11.1%)											
VIA111	Knowledge	2	4	6	1	3	7	1	5	11	0.875	2.747
22		5.0	10.0	15.0	2.5	7.5	17.5	2.5	12.5	27.5		
VIA21	Comprehension	1	1	1	6	6	4	7	9	5	1.250	2.060
43		2.5	2.5	2.5	15.0	15.0	10.0	17.5	22.5	12.5		
VIA31	Application	5	3	2	7	8	2	3	5	5	0.075	2.586
18		12.5	7.5	5.0	17.5	20.0	5.0	7.5	12.5	12.5		
VIA41	Analysis	3	4	4	9	5	3	5	6	1	-0.150	2.271
31		7.5	10.0	10.0	22.5	12.5	7.5	12.5	15.0	2.5		
VIA61	Evaluation	9	5	5	8	4	2	4	1	2	-1.200	2.366
26		22.5	12.5	12.5	20.0	10.0	5.0	10.0	2.5	5.0		
UNVNONSC	Valid Cases: 41 (89.1%) Missing Cases: 5 (10.9%)											
VIA111	Knowledge	4	2	3	6	4	8	3	7	4	0.415	2.449
22		9.8	4.9	7.3	14.6	9.8	19.5	7.3	17.1	9.8		
VIA21	Comprehension	3	6	6	1	2	2	10	4	7	0.463	2.776
43		7.3	14.6	14.6	2.4	4.9	4.9	24.4	9.8	17.1		
VIA31	Application	9	2	5	3	3	5	5	1	8	-0.122	2.943
18		22.0	4.9	12.2	7.3	7.3	12.2	12.2	2.4	19.5		
VIA41	Analysis	5	5	8	5	7	3	5	2	1	-0.805	2.193
31		12.2	12.2	19.5	12.2	17.1	7.3	12.2	4.9	2.4		
VIA61	Evaluation	7	7	6	8	2	3	3	3	2	-1.049	2.428
26		17.1	17.1	14.6	19.5	4.9	7.3	7.3	7.3	4.9		
PUBSC	Valid Cases: 52 (100%) Missing Cases: 0 (0.0%)											
VIA111	Knowledge	4	6	11	3	7	9	7	1	4	-0.327	2.299
22		7.7	11.5	21.2	5.8	13.5	17.3	13.5	1.9	7.7		
VIA21	Comprehension	5	4	5	3	5	7	6	9	8	0.635	2.650
43		9.6	7.7	9.6	5.8	9.6	13.5	11.5	17.3	15.4		
VIA31	Application	4	4	10	3	4	2	4	8	13	0.673	2.861
18		7.7	7.7	19.2	5.8	7.7	3.8	7.7	15.4	25.0		
VIA41	Analysis	8	8	10	7	6	9	4	-	-	-1.269	1.921
31		15.4	15.4	19.2	13.5	11.5	17.3	7.7	-	-		
VIA61	Evaluation	11	3	6	8	7	6	2	5	4	-0.615	2.576
26		21.2	5.8	11.5	15.4	13.5	11.5	3.8	9.6	7.7		
PUBNONSC	Valid Cases: 42 (100%) Missing Cases: 0 (0.0%)											
VIA111	Knowledge	5	6	[illegible]	4	1	6	8	4	2	-0.226	2.540
22		11.9	14.3	[illegible]	9.5	2.4	14.3	19.0	9.5	4.8		
VIA21	Comprehension	2	1	4	4	2	5	8	13	3	1.167	2.241
43		4.8	2.4	9.5	9.5	4.8	11.9	19.0	31.0	7.1		
VIA31	Application	4	7	1	5	4	5	3	6	[illegible]	0.310	2.772
18		9.5	16.7	2.4	11.9	9.5	11.9	7.1	14.3	16.7		
VIA41	Analysis	3	6	9	5	7	6	4	2	-	-0.786	1.957
31		7.1	14.3	21.4	11.9	16.7	14.3	9.5	4.8	-		
VIA61	Evaluation	8	9	5	7	6	1	2	3	1	-1.381	2.252
26		19.0	21.4	11.9	16.7	14.3	2.4	4.8	7.1	2.4		
OVERALL	Valid Cases: 175 (94.6%) Missing Cases: 10 (5.4%)											
VIA111	Knowledge	15	18	26	14	15	30	19	17	21	0.131	2.528
22		8.6	10.3	14.9	8.0	8.6	17.1	10.9	9.7	12.0		
VIA21	Comprehension	11	12	16	14	15	18	31	35	23	0.863	2.464
43		6.3	6.9	9.1	8.0	8.6	10.3	17.7	20.0	13.1		
VIA31	Application	22	16	18	18	19	14	15	20	33	0.263	2.792
18		12.6	9.1	10.3	10.3	10.9	8.0	8.6	11.4	18.9		
VIA41	Analysis	19	23	31	26	25	21	18	10	2	-0.759	2.100
31		10.9	13.1	17.7	14.9	14.3	12.0	10.3	5.7	1.1		
VIA61	Evaluation	35	24	22	31	19	12	11	12	9	-1.034	2.416
26		20.0	13.7	12.6	17.7	10.9	6.9	6.3	6.9	5.1		

[a] IHSL element identification
[b] Q-statement number
[c] Number of persons who placed Q-statement in a particular envelope
[d] Percent, adjusted to exclude missing cases
[e] UNVPURSC and UNVAPPSC combined

UNVNONSC groups as it was by the UNVAPPSC, PUBSC, and PUBNONSC groups. On the Interaction of Science and Technology dimension the behaviors involving knowledge, comprehension, and application were valued more highly by the respondents (OVERALL) than were the behaviors involving analysis and evaluation.

Of all Q-statements in the SLQ, Table 37 shows that Q4(comprehension) was believed to be more important by all groups. Each of the groups also believed Q11(evaluation) was important but not nearly as strongly as for Q4. The university groups, both science and nonscience, rated down rather strongly the importance of Q17(behaving), and the public groups, science and nonscience, tended to agree. The respondents (OVERALL) rated highly the comprehension behavior on the Interaction of Science and Society dimension. They also gave a positive rating to the evaluation behavior. They tended to play down the importance of the two affective Q-statements, Q17(behaving) and Q5(advocating).

Table 38 has only one (1) Q-statement with which all groups agreed. Q16(valuing) was believed to have more importance by all of the groups than the other Q-statements on this dimension. The PUBNONSC group was quite strong in its preference for Q16. There was disagreement among groups on all other Q-statements. The UNVPURSC and UNVAPPSC groups attached less importance to Q9(application) than did the other groups. The PUBNONSC group valued Q14(behaving) to

Table 37

Descriptive Statistics for Responses to Q-statements of the Interaction of Science and Society Dimension

Q-statement	Behavior	Responses -4	-3	-2	-1	0	+1	+2	+3	+4	Mean	SD
UNVPURSC	Valid Cases: 21 (91.3%) Missing Cases: 2 (8.7%)											
VIIA21[a]	Comprehension	-	-	-	3[c]	2	1	3	2	10	2.381	1.936
4[b]		-	-	-	14.3[d]	9.5	4.8	14.3	9.5	47.6		
VIIA61	Evaluation	1	1	1	3	2	4	2	6	1	0.857	2.220
11		4.8	4.8	4.8	14.3	9.5	19.0	9.5	28.6	4.8		
VIIB21	Behaving	2	5	4	-	4	2	4	-	-	-1.000	2.121
17		9.5	23.8	19.0	-	19.0	9.5	19.0	-	-		
VIIB31	Advocating	1	[illegible]	-	2	2	3	4	3	3	0.810	2.502
5		4.8	14.3	-	9.5	9.5	14.3	19.0	14.3	14.3		
UNVAPPSC	Valid Cases: 19 (86.4%) Missing Cases: 3 (13.6%)											
VIIA21	Comprehension	-	-	1	-	1	1	4	2	10	2.789	1.686
4		-	-	5.3	-	5.3	5.3	21.1	10.5	52.6		
VIIA61	Evaluation	2	2	2	-	3	3	-	4	3	0.474	2.796
11		10.5	10.5	10.5	-	15.8	15.8	-	21.1	15.8		
VIIB21	Behaving	5	4	2	1	4	-	1	2	-	-1.526	2.389
17		26.3	21.1	10.5	5.3	21.1	-	5.3	10.5	-		
VIIB31	Advocating	2	2	-	5	1	3	3	2	1	0.000	2.404
5		10.5	10.5	-	26.3	5.3	15.8	15.8	10.5	5.3		
UNVSC[e]	Valid Cases: 40 (88.9%) Missing Cases: 5 (11.1%)											
VIIA21	Comprehension	-	-	1	3	3	2	7	4	20	2.575	1.810
4		-	-	2.5	7.5	7.5	5.0	17.5	10.0	50.0		
VIIA61	Evaluation	3	3	3	3	5	7	2	10	4	0.675	2.485
11		7.5	7.5	7.5	7.5	12.5	17.5	5.0	25.0	10.0		
VIIB21	Behaving	7	9	6	1	8	2	5	2	-	-1.250	2.239
17		17.5	22.5	15.0	2.5	20.0	5.0	12.5	5.0	-		
VIIB31	Advocating	3	5	-	7	3	6	7	4	4	0.425	2.459
5		7.5	12.5	-	17.5	7.5	15.0	17.5	12.5	10.0		
UNVNONSC	Valid Cases: 41 (89.1%) Missing Cases: 5 (10.9%)											
VIIA21	Comprehension	-	1	-	-	4	3	6	6	21	2.780	1.651
4		-	2.4	-	-	9.8	7.3	14.6	14.6	51.2		
VIIA61	Evaluation	2	3	2	6	4	3	4	7	10	1.098	2.577
11		4.9	7.3	4.9	14.6	9.8	7.3	9.8	17.1	24.4		
VIIB21	Behaving	9	10	1	4	5	5	2	2	3	-1.098	2.606
17		22.0	24.4	2.4	9.8	12.2	12.2	4.9	4.9	7.3		
VIIB31	Advocating	4	3	5	2	6	5	6	5	5	0.366	2.557
5		9.8	7.3	12.2	4.9	14.6	12.2	14.6	12.2	12.2		
PUBSC	Valid Cases: 52 (100%) Missing Cases: 0 (0.0%)											
VIIA21	Comprehension	2	2	-	3	2	5	3	14	21	2.308	2.236
4		3.8	3.8	-	5.8	3.8	9.6	5.8	26.9	40.4		
VIIA61	Evaluation	6	4	-	7	6	5	6	9	9	0.712	2.681
11		11.5	7.7	-	13.5	11.5	9.6	11.5	17.3	17.3		
VIIB21	Behaving	5	5	10	6	8	4	8	4	[illegible]	-0.404	2.286
17		9.6	9.6	19.2	11.5	15.4	7.7	15.4	7.7	3.8		
VIIB31	Advocating	13	3	5	13	6	4	5	2	1	-1.154	2.244
5		25.0	5.8	9.6	25.0	11.5	7.7	9.6	3.8	1.9		
PUBNONSC	Valid Cases: 42 (100%) Missing Cases: 0 (0.0%)											
VIIA21	Comprehension	-	1	-	4	2	3	4	10	18	2.524	1.864
4		-	2.4	-	9.5	4.8	7.1	9.5	23.8	42.9		
VIIA61	Evaluation	3	2	5	5	8	2	3	5	9	0.619	2.603
11		7.1	4.8	11.9	11.9	19.0	4.8	7.1	11.9	21.4		
VIIB21	Behaving	5	6	5	6	6	4	3	3	4	-0.452	2.510
17		11.9	14.3	11.9	14.3	14.3	9.5	7.1	7.1	9.5		
VIIB31	Advocating	6	7	4	6	4	2	8	3	2	-0.571	2.520
5		14.3	16.7	9.5	14.3	9.5	4.8	19.0	7.1	4.8		
OVERALL:	Valid Cases: 175 (94.6%) Missing Cases: 10 (5.4%)											
VIIA21	Comprehension	2	4	1	10	11	13	20	34	80	2.531	1.917
4		1.1	2.3	0.6	5.7	6.3	7.4	11.4	19.4	45.7		
VIIA61	Evaluation	14	12	10	21	23	17	15	31	32	0.771	2.578
11		8.0	6.9	5.7	12.0	13.1	9.7	8.6	17.7	18.3		
VIIB21	Behaving	26	30	22	17	27	15	18	11	9	-0.771	2.417
17		14.9	17.1	12.6	9.7	15.4	8.6	10.3	6.3	5.1		
VIIB31	Advocating	26	18	14	28	19	17	26	15	12	-0.297	2.508
5		14.9	10.3	8.0	16.0	10.9	9.7	14.9	8.6	6.9		

[a] IMSL element identification
[b] Q-statement number
[c] Number of persons who placed Q-statement in a particular envelope
[d] Percent, adjusted to exclude missing cases
[e] UNVPURSC and UNVAPPSC combined

Table 38

Descriptive Statistics for Responses to Q-statements of the Interaction of Science, Technology, and Society Dimension

Q-statement	Behavior	Responses -4	-3	-2	-1	0	+1	+2	+3	+4	Mean	SD
UNVPURSC	Valid Cases: 21 (91.3%) Missing Cases: 2 (8.7%)											
VIIIA31[a] 9[b]	Application	3[c]	1	7	4	3	-	1	1	1	-1.143	2.128
		14.3[d]	4.8	33.3	19.0	14.3	-	4.8	4.8	4.8		
VIIIB11 26	Valuing	-	3	-	3	3	2	5	2	3	0.857	2.265
		-	14.3	-	14.3	14.2	9.5	23.8	9.5	14.3		
VIIIB21 14	Behaving	-	3	1	2	2	2	1	3	7	1.333	2.652
		-	14.3	4.8	9.5	9.5	9.5	4.8	14.3	33.3		
VIIIB31 36	Advocating	6	5	1	5	1	-	1	1	1	-1.762	2.385
		28.6	23.8	4.8	23.8	4.8	-	4.8	4.8	4.8		
UNVAPPSC	Valid Cases: 19 (86.4%) Missing Cases: 3 (13.6%)											
VIIIA31 9	Application	4	5	-	4	2	1	-	2	1	-1.263	2.557
		21.1	26.3	-	21.1	10.5	5.3	-	10.5	5.3		
VIIIB11 16	Valuing	1	2	3	1	2	-	3	4	3	0.684	2.730
		5.3	10.5	15.8	5.3	10.5	-	15.8	21.1	15.8		
VIIIB21 14	Behaving	2	2	1	-	3	4	-	[illegible]	6	0.789	2.898
		10.5	10.5	5.3	-	15.8	21.1	-	[illegible]	[illegible]		
VIIIB31 36	Advocating	2	2	2	3	2	1	6	-	[illegible]	-0.211	2.371
		10.5	10.5	10.5	15.8	10.5	5.3	31.6	-	[illegible]		
UNVSC[e]	Valid Cases: 40 (88.9%) Missing Cases: 5 (11.1%)											
VIIIA31 9	Application	7	6	7	8	5	1	1	3	2	-1.200	2.312
		17.5	15.0	17.5	20.0	12.5	2.5	2.5	7.5	5.0		
VIIIB11 16	Valuing	1	5	3	4	5	2	8	6	6	[illegible].775	2.465
		2.5	12.5	7.5	10.0	12.5	5.0	20.0	15.0	15.0		
VIIIB21 14	Behaving	2	5	2	2	5	6	1	4	13	1.0[illegible]	2.749
		5.0	12.5	5.0	5.0	12.5	15.0	2.5	10.0	32.5		
VIIIB31 36	Advocating	8	7	3	8	3	1	7	1	2	-1.0[illegible]	2.475
		20.0	17.5	7.5	20.0	7.5	2.5	17.5	2.5	5.0		
UNVNONSC	Valid Cases: 41 (89.1%) Missing Cases: 5 (10.9%)											
VIIIA31 9	Application	-	5	6	6	2	5	7	4	6	0.5[illegible]	2.388
		-	12.2	14.6	14.6	4.9	12.2	17.1	9.8	14.6		
VIIIB11 16	Valuing	3	3	7	2	10	6	-	5	5	[illegible].098	2.427
		7.3	7.3	17.1	4.9	24.4	14.6	-	12.2	12.2		
VIIIB21 14	Behaving	7	3	4	5	1	2	4	6	9	0.341	3.046
		17.1	7.3	9.8	12.2	2.4	4.9	9.8	14.6	22.0		
VIIIB31 36	Advocating	5	5	4	7	4	4	3	3	6	-0.371	2.673
		12.2	12.2	9.8	17.1	9.8	9.8	7.3	7.3	14.6		
PUBSC	Valid Cases: 52 (100%) Missing Cases: 0 (0.0%)											
VIIIA31 9	Application	2	7	5	2	2	7	9	12	6	0.846	2.531
		3.8	13.5	9.6	3.8	3.8	13.5	17.3	23.1	11.5		
VIIIB11 16	Valuing	2	5	4	4	8	5	6	7	11	0.5[illegible]4	2.515
		3.8	9.6	7.7	7.7	15.4	9.6	11.5	13.5	21.2		
VIIIB21 14	Behaving	11	3	5	4	4	5	3	8	9	0.077	3.002
		21.2	5.8	9.6	7.7	7.7	9.6	5.8	15.4	17.3		
VIIIB31 36	Advocating	8	9	9	10	6	4	2	2	2	-1.250	2.150
		15.4	17.3	17.3	19.2	[illegible]	7.7	3.8	3.8	3.8		
PUBNONSC	Valid Cases: 42 (100%) Missing Cases: 0 (0.0%)											
VIIIA31 9	Application	3	1	5	2	8	7	4	7	5	0.690	2.342
		7.1	2.4	11.9	4.8	19.0	16.7	9.5	16.7	11.9		
VIIIB11 [illegible]	Valuing	2	5	1	3	2	4	4	8	13	1.429	2.697
		4.8	11.9	2.4	7.1	4.8	9.5	9.5	19.0	31.0		
VIIIB21 14	Behaving	12	1	2	5	7	5	1	4	5	-0.500	2.831
		28.6	2.4	4.8	11.9	16.7	11.9	2.4	9.5	11.9		
VIIIB31 36	Advocating	1	6	-	6	7	9	5	3	5	0.476	2.222
		2.4	14.3	-	14.3	16.7	21.4	11.9	7.1	11.9		
OVERALL	Valid Cases: 175 (94.6%) Missing Cases: 10 (5.4%)											
VIIIA31 9	Application	12	19	23	18	17	20	21	26	19	0.269	2.517
		6.9	10.9	13.1	10.[illegible]	9.7	11.4	12.0	14.9	10.9		
VIIIB11 16	Valuing	8	18	15	[illegible]	25	17	18	26	35	0.811	2.549
		4.6	10.3	8.6	[illegible]	14.3	9.7	10.3	14.9	20.0		
VIIIB21 14	Behaving	32	12	13	[illegible]	17	18	9	22	36	0.229	2.943
		18.3	6.9	7.4	[illegible]	9.7	10.3	5.1	12.6	20.6		
VIIIB31 36	Advocating	22	27	16	[illegible]	20	18	[illegible]	9	15	-0.531	2.454
		12.6	15.4	9.1	[illegible]	11.4	10.3	[illegible]	5.1	8.6		

[a]IHSL element identification
[b]Q-statement number
[c]Number of persons who placed Q-statement in a particular envelope
[d]Percent, adjusted to exclude missing cases
[e]UNVPURSC and UNVAPPSC combined

a lesser extent than did the other groups. In fact the UNVPURSC group gave Q14 a fairly strong rating. Q36(advocating) was given a low rating by the UNVPURSC group and the PUBSC group. The UNVAPPSC and UNVNONSC groups tended to agree, but the PUBNONSC group did not. The respondents (OVERALL) valued the behaviors of application, valuing, and behaving more than they did the advocation behavior on the Interaction of Science, Technology, and Society dimension.

Considering all ten (10) tables together along with the preceeding comments about each one, the respondents (OVERALL) rated the knowledge, comprehension, and application behaviors more highly than the other behaviors. They were supportive of nearly all of the Q-statements in the Factual and Generalizations components of the Organization of Knowledge dimension; the Intellectual Processes dimension; and the Interaction of Science, Technology, and Society dimension. They played down the importance of the Discipline component of the Organization of Knowledge dimension; the Values and Ethics dimension; and the Human Endeavor dimension. They had mixed feelings on each of the other dimensions depending upon the particular behaviors involved.

Looking at the individual groups, it is seen that all groups tended to place more value in the knowledge and comprehension behaviors than the other behaviors. The UNVNONSC, PUBSC, and PUBNONSC groups tended to rate the application behavior more highly than did the UNVPURSC and

UNVAPPSC groups. All groups expressed negative beliefs toward the synthesis behavior, and most were negative toward the evaluation behavior. In the affective domain valuing and behaving were rated negatively by the majority of the groups. In two instances the UNVAPPSC group rated the advocating behavior in a strong positive manner.

Correlational Analysis of INFORMATION SHEET and SLQ Data

Intercorrelations and correlations of the data were developed. The data generated by the INFORMATION SHEET were intercorrelated; the data generated by the SLQ were intercorrelated; and the INFORMATION SHEET and SLQ data were correlated. The SPSS (Nie, et al., 1975) subprogram PEARSON CORR was used to develop the correlation coefficients. Missing data (those coded as No Response) were handled by pairwise deletion. As a result the number of persons per each correlation varied from 147 to 176.

To determine if a particular correlation coefficient was or was not significant, reference was made to a table which specifies the necessary correlation coefficient size in order that the coefficient be significant (Guilford and Fruchter, 1973, p. 516). This table was chosen because it accounts for both the number of persons upon which each coefficient was based and the number of variables which were correlated.

The intercorrelations of the INFORMATION SHEET variables produced few significant correlation coefficients ($\underline{df}$ = 150; number of variables = 25; for $p \leq 0.05$ r_{xy} = 0.450). Of the significant correlations none became the basis for new insights (Table 39).

Table 39

Intercorrelations of INFORMATION SHEET Variables

	SCHLEVEL	OWNSCHYR	MOTSCHYR	DIPDEG	JHS8	SHPHYS
OWNSCHYR	0.6258					
FATSCHYR			0.6698			
DIPDEG	0.6101	0.8810				
JHS7					0.6600	
SHCHEM						0.4561
CLBIOSCI		0.5285		0.5002		
CLPHYSCI	0.4583	0.5388		0.4837		

The intercorrelations of the Q-statements are presented in Appendix G. Of these only one (1) was significant, IA32(Q19) with IVA31(Q38) at r_{xy} = 0.4762. From the table the degrees of freedom value used was 150; the number of variables used was twenty-five (25); for $p \leq 0.05$ the value of r_{xy} had to be 0.450 or greater. The actual degrees of freedom value was 174 and the actual number of variables correlated was forty-five (45). Guilford and Fruchter's table does not go beyond twenty-five (25) variables, so the more conservative degrees of freedom value was used to offset the more liberal $\underline{r}_{xy}$ value for twenty-five (25) variables.

The correlation coefficients between the INFORMATION SHEET variables and the SLQ Q-statements were not significant. The same table values were used as was used in the preceeding paragraph. In this case the actual number of variables which were correlated was sixty-nine (69).

The values of the STATUS variable (see page 122 of Chapter III) were transformed into separate variables as UNVPURSC, UNVAPPSC, UNVNONSC, PUBSC, and PUBNONSC. This was accomplished with the internal programming capabilities of the SPSS system. In addition the respondents were accounted for by the variables in a dichotomized manner. That is, zero (0) was coded for the person if he did not belong to a particular group, and one (1) was coded for a person if he did belong to a particular group. This caused:

(1) UNVPURSC to have 23 cases;

(2) UNVAPPSC to have 22 cases;

(3) UNVNONSC to have 46 cases;

(4) PUBSC to have 52 cases; and

(5) PUBNONSC to have 42 cases.

These five (5) variables were correlated with the forty-five (45) Q-statements to determine what relationships might exist. Table 40 presents the results of this analysis.

Table 40

Correlation Coefficients between Groups and Selected Q-statements[a]

Q-statements		UNVPURSC	UNVAPPSC	UNVNONSC	PUBSC	PUBNONSC
IA11[b]	28[c]	-0.0851	0.2141	-0.1068	0.0218	-0.0086
IA52	27	-0.2393	0.0261	0.0240	0.1215	0.0092
IB12	13	0.0350	-0.0267	0.2766	-0.1331	-0.1390
IA53	25	-0.2104	0.0057	-0.0813	0.1873	0.0361
IIIA11	12	0.1466	-0.0619	0.2830	-0.3297	0.0057
IIIA21	32	0.2122	0.0163	0.0974	-0.1960	-0.0601
IIIB11	6	0.2356	-0.1106	0.0063	-0.0016	-0.1033
VA41	30	-0.1910	0.0687	0.1523	-0.1267	-0.2109
VB31	33	0.0541	0.2257	-0.0228	-0.1085	-0.0668
VIA111	22	0.2319	-0.0255	0.0621	-0.1182	-0.0930
VIIB31	5	0.1634	0.0415	0.1466	-0.2227	-0.0616
VIIIA31	9	-0.2077	-0.2130	0.0591	0.1496	0.0945
VIIIB31	36	-0.1857	0.0458	0.0815	-0.1910	0.2314

[a]Q-statements with correlation $\geq |0.2|$ with any one of the five groups

[b]TMSL element identification

[c]Q-statement number

Correlation coefficients for the five (5) groups were presented if a correlation coefficient on a Q-statement was $|0.2|$ or greater for one (1) of the groups.

An examination of Table 40 reveals that the Intellectual Processes dimension and the Process of Inquiry dimension had no Q-statements which could be included. No groups resulted in all positive or all negative correlation coefficients. The UNVNONSC and PUBSC groups had coefficients greater than |0.2| on Q12; the UNVNONSC coefficient was positive, but the PUBSC coefficient was negative. The UNVPURSC and UNVAPPSC groups had negative coefficients greater than |0.2| on Q9. The UNVPURSC and UNVAPPSC groups had common signs on only three (3) Q-statements. The UNVPURSC and PUBSC groups had common signs on only two (2) Q-statements, and the UNVAPPSC and PUBSC groups had common signs on seven (7) Q-statements. The UNVNONSC and PUBNONSC groups had common signs on five (5) Q-statements. The magnitudes of the correlation coefficients for each of the groups with the Q-statements were not very similar. In most cases where the magnitudes were somewhat similar the signs were opposite.

No pronounced relationships seemed to exist based upon this analysis. If anything differences between the groups were highlighted more than were any commonalities.

Factor Analysis of the Placement of the Q-statements

This section deals with the results of the factor analysis of the placement of the Q-statements by the respondents. The factor analysis of the data was made using the SPSS (Nie, et al., 1975) subprogram FACTOR. Orthogonal, principal component solutions were developed with the diagonal elements of the correlation matrix replaced by R^2 estimates of communality. An iterative process was used to improve the R^2 estimates of communality.

Three factor analyses were performed. First, the data were factor analyzed with all the respondents grouped together (OVERALL: 175 persons). Second, the data of the science oriented respondents (UNVPURSC, UNVAPPSC, and PUBSC: 92 persons) were factor analyzed. Third, the data of the nonscience oriented respondents (UNVNONSC and PUBNONSC: 83 persons) were factor analyzed.

The results of these factor analyses are presented in Appendix H. After examining the iterated factor matrix with forty-five (45) factors, a seven (7) factor solution was developed for each group. The OVERALL seven (7) factor solution accounted for 39.7% of the variance in the rankings of the forty-five (45) Q-statements. The science oriented seven (7) factor solution accounted for 43.8% of the variance in the rankings of the forty-five (45) Q-statements. The nonscience oriented seven (7) factor solution accounted for 43.6% of the variance in the ranking of the forty-five (45) Q-statements. Factor scores for the OVERALL seven (7) factor solution were punched on cards for each person to be used in additional analyses.

Tables 41-50 present the results of the factor analyses. Factors I, III, IV, V, and VI were common to each of the three (3) groups. Factor II was common to the OVERALL group and the nonscience oriented group. Factor VII existed only for the OVERALL group. The science oriented group had two (2) factors unique to it, and the nonscience oriented group had one (1) factor unique to it.

The arbitrary criterion for using any particular Q-statement to represent a factor was a factor loading of .40 or greater for at least one of the groups on the particular factor. The criteria used to specify that a Q-statement in a particular factor loaded significantly for all groups were:

(1) the minimum factor loading for any one group could not be less than .30;

(2) the factor loadings for at least two groups had to be .35 or greater; and

(3) the signs of the factor loadings were the same for all groups.

The essence of this section is to:

(1) name the inferred dimension;

(2) describe the inferred dimension of scientific literacy; and

(3) discuss the highlights of each factor.

The factors which were common to more than one group are discussed first. This is followed by a discussion of the factors which were unique to a particular group.

The Problem Statement for this study was stated in terms of science and nonscience orientation groups. It was for this reason that the factor analyses were performed with respect to the science oriented group and the nonscience oriented group. Although this study was developed on the basis of science oriented and nonscience oriented groups, other personal characteristics (sex, age, education, etc.) may have been as much or more of an influence on the development of the factors. The regression analysis produced some insights into these effects.

Factor I

The Q-statements specified in Table 41 as common to all groups are:

MOST HIGH SCHOOL GRADUATES SHOULD...

IVA51(Q40)	be able to combine some major ideas and methods of science to gain new ideas.
IVA11(Q37)	know something about using major ideas and methods of science together to gain new ideas.

IA53(Q25) be able to combine some new findings in some fields of science to think of possible offshoots.

IA51(Q39) be able to combine facts to better understand matter, energy, and life.

Table 41

Factor Loadings of Q-statements Chosen to Represent Factor I

Element Identification	Q-statement Number	OVERALL(1)[a]	SCIENCE(2)	NONSCIENCE(4)
IVA51[c]	40	.71[b]	.65	.70
IVA11[c]	37	.60	.54	.66
IA53[c]	25	.56	.43	.39
IA51[c]	39	.40	.49	.32
VB21	35	-.26	-.10	-.56
VIIB31	5	-.26	-.55	-.06
VIIB21	17	-.15	.05	-.43
% of variance		9.1	7.5	6.2

[a]Identifies the factor number for respective factor solutions in Appendix H

[b]Factor Loadings rounded to nearest hundreth

[c]Considered common to the groups

The inferred dimension of scientific literacy was named "Scientific Inquiry." The theme of this factor seemed to be that of producing new knowledge through a synthesizing type of activity. The two (2) strong loading Q-statements came from the TMSL Process of Inquiry dimension. The two (2) lesser loading common Q-statements represented two (2) synthesizing behaviors from the TMSL Organization of Knowledge dimension. The regression analysis showed that the UNVPURSC group was a negative predictor of this factor. Thus it was inferred that most of the respondents in the UNVPURSC did not believe that scientific inquiry was important for all persons.

The factor loadings on the common Q-statements were fairly large and in close agreement. This suggested that the respective factors for each of the groups were actually the same factor. The percents of variance suggested that the factor was about the same in the science oriented group as in the nonscience oriented group. This factor existed for the science oriented group, for the nonscience oriented group, and for the groups combined. The factor structure was independent of the groups.

<u>Factor II</u>

The Q-statements specified in Table 42 as common to the two groups are:

MOST HIGH SCHOOL GRADUATES SHOULD...

VIIIB11(Q16)	rate highly the need for society to keep up with science and technology.
IIIA21(Q32)	understand how several values guide scientists in their work.
IIIA11(Q12)	know about several values which guide scientists in their work.

IB33(Q34) support ways to help people understand new gains in some fields of science.

Table 42

Factor Loadings of Q-statements Chosen to Represent Factor II

Element Identification	Q-statement Number	OVERALL(2)[a]	SCIENCE	NONSCIENCE(5)
VIIIB11[c]	16	.50[b]	-	.54
IIIA11[c]	12	-.42	-	-.57
IIIA21[c]	32	-.47	-	-.42
IB33[c]	34	.39	-	.54
VIIB31	5	.24	-	.58
IB231	29	.44	-	.17
IIB31	15	.40	-	.21
% of variance		6.8		5.1

[a]Identifies the factor number for respective factor solutions in Appendix H

[b]Factor Loadings rounded to nearest hundreth

[c]Considered common to the groups

This inferred dimension of scientific literacy was named "Maintaining Current Awareness." The theme of this factor seemed to be the valuing of people keeping in touch with and maintaining an understanding of new developments in science and technology. The positive loading Q-statements on this factor taken together dealt with science, technology, and society staying abreast of one another. The ʮo (2) negative loading Q-statements implied that the concern was not so much with values but with "concrete" aspects, for example, gained knowledge in science and new inventions in technology.

The results of the regression analysis indicated that characteristics of individuals were more related than were science or nonscience orientation to the development of this factor. The mothers' and respondents' last year of school completed were the major predictors of this factor.

Factor III

The Q-statements specified in Table 43 as common to all groups are:

MOST HIGH SCHOOL GRADUATES SHOULD...

IIIB11(Q6)	rate highly for their own use some values which guide scientists in their work.
VIA61(Q26)	be able to judge the worth of some results from science and from technology with different guidelines.

The inferred dimension of scientific literacy was named "Valuing Methods of Science." The theme of this factor seemed to be a personal valuing of methods which scientists use in their work. Four (4) of the positive loading Q-statements in this factor were from the TMSL Intellectual Processes dimension. The strongest loading positive Q-statement described the values which underlie intellectual processes of science.

Table 43

Factor Loadings of Q-statements Chosen to Represent Factor III

Element Identification	Q-statement Number	OVERALL(3)[a]	SCIENCE(5)	NONSCIENCE(3)
IIIB11[c]	6	.53[b]	.67	.45
IIB11	2	.49	.28	.53
VIA61[c]	26	-.42	-.31	-.47
IIB21	8	.41	.53	.26
IIB31	15	.26	.04	.57
IIA41	7	.19	.40	.21
% of variance		5.6	5.4	6.7

[a]Identifies the factor number for respective factor solutions in Appendix H

[b]Factor Loadings rounded to nearest hundreth

[c]Considered common to the groups

The percents of variance were similar on this factor. This along with the factor loadings for the Q-statements suggested strongly that respective factors of each group were the same factor. The results of the regression analysis indicated that the UNVPURSC group was a major predictor of this factor.

Factor IV

The Q-statements specified in Table 44 as common to all groups are:

MOST HIGH SCHOOL GRADUATES SHOULD...

IVA31(Q38)	be able to use major ideas and methods of science together in their daily lives.
IA32(Q19)	be able to use some major ideas about matter, energy, and life in their daily lives.
VIIIA31(Q9)	be able to use some new results from science and technology to think of possible changes in their lives.

Table 44

Factor Loadings of Q-statements Chosen to Represent Factor IV

Element Identification	Q-statement Number	OVERALL(4)[a]	SCIENCE(1)	NONSCIENCE(1)
IVA31[c]	38	.60[b]	.45	.44
IA32[c]	19	.50	.37	.35
IIA41	7	.44	.29	.62
VIIIA31[c]	9	.36	.43	.63
VIA31	18	.37	.68	.23
VA41	30	-.29	-.54	-.33
IIIA11	12	-.22	-.53	-.35
IIIA21	32	-.24	-.53	-.13
VB11	1	-.48	-.22	-.30
VIA111	22	-.20	-.44	-.11
IVA214	3	-.19	-.44	-.04
% of variance		5.2	10.4	8.7

[a]Identifies the factor number for respective factor solutions in Appendix H

[b]Factor Loadings rounded to nearest hundreth

[c]Considered common to the groups

This inferred dimension of scientific literacy was named "Personal Application of Science." The theme of this factor seemed to be application of scientific knowledge and methods of science in daily living. Four (4) of the Q-statements involving the application behavior loaded positively for all groups. Three (3) of these were considered common to the groups.

The respective factor loadings for each group suggested strongly that the respective factors for each group were the same factor. The percents of variance for the two (2) orientation groups were large. These factors actually explained the most variance in each of the respective seven (7) factor solutions. The results of the regression analysis showed that age of the respondents was a major predictor of this factor as opposed to science or nonscience orientation.

Factor V

The Q-statements specified in Table 45 as common to all groups are:

MOST HIGH SCHOOL GRADUATES SHOULD...

VIA41(Q31) be able to detect some of the differences in the results of science and technology.

VIA111(Q22) know something about how the goals of science and technology differ.

VIA21(Q43) understand something of the effects science and technology have on each other.

Table 45

Factor Loadings of Q-statements
Chosen to Represent Factor V

Element Identification	Q-statement Number	OVERALL(5)[a]	SCIENCE(6)	NONSCIENCE(2)
VIA41[c]	31	.53[b]	.33	.55
VIA111[c]	22	.52	.41	.51
VIA21[c]	43	.47	.59	.56
IA13	41	.27	-.08	.46
VB11	1	-.17	-.43	-.16
IA53	25	-.22	-.40	-.19
IA61	21	.19	.40	.11
IA223	44	.04	.41	-.03
% of variance		4.7	4.4	7.8

[a]Identifies the factor number for respective factor solutions in Appendix H

[b]Factor Loadings rounded to nearest hundreth

[c]Considered common to the groups

The inferred dimension of scientific literacy was named "Distinguishing Between Science and Technology." The theme seemed to be that of distinguishing between science and technology in terms of goals and results. It also included understanding how science and technology affect one another. All three (3) common loading Q-statements came from the TMSL Interaction of Science and Technology dimension.

Some of the loadings on the Q-statements were small. The percent of variance for the nonscience oriented group is apparently greater than that for the science oriented group. Even though the respective factors for each group were thought to be the same factor, the strength of association between respective factors for this factor was not as strong as it was on Factors I, III, and IV. The regression analysis indicated that membership in the PUBSC group was a predictor of this factor more so than membership in the other groups.

Factor VI

The Q-statement specified in Table 46 as common to all groups is:

MOST HIGH SCHOOL GRADUATES SHOULD...

IA11(Q28) know several facts about matter, energy, and life.

The inferred dimension of scientific literacy was named "Utilizing Factual Knowledge." The theme of this factor seemed to be knowing and using for various purposes factual knowledge about nature. The common loading Q-statement dealt with knowing facts about nature. However, the next two (2) strong loading Q-statements also dealt with using and synthesizing this factual knowledge.

The factor loadings were such that the respective factors of each group were thought to be the same factor. The strength of association was not believed to be as strong

Table 46

Factor Loadings of Q-statements Chosen to Represent Factor VI

Element Identification	Q-statement Number	OVERALL(6)[a]	SCIENCE(3)	NONSCIENCE(6)
IA11[c]	28	.63[b]	.51	.46
IA31	45	.48	.66	.27
IA51	39	.41	.26	.48
IA13	41	.40	.55	.01
VIA31	18	.23	.21	.44
VIIA21	4	-.13	-.22	-.44
IIIA21	32	-.14	.02	-.41
% of variance		4.5	6.2	4.6

[a]Identifies the factor number for respective factor solutions in Appendix H

[b]Factor Loadings rounded to nearest hundreth

[c]Considered common to the groups

for these factors as it was for Factors I, III, IV, and V.

Factor VII

The Q-statements specified in Table 47 as representing Factor VII are:

MOST HIGH SCHOOL GRADUATES SHOULD...

VIIIB31(Q36) support changing what society rates highly as mankind increases control of the environment.

VIIB31(Q5) support societal conditions which help science.

IA61(Q21) be able to judge the worth of some uses of matter, energy, and life using facts.

Table 47

Factor Loadings of Q-statements Chosen to Represent Factor VII

Element Identification	Q-statement Number	OVERALL(7)[a]	SCIENCE	NONSCIENCE
VIIIB31	36	.48[b]	-	-
VIIB31	5	.46	-	-
IA61	21	-.43	-	-
% of variance		3.9		

[a]Identifies the factor number for the respective factor solution in Appendix H

[b]Factor Loadings rounded to nearest hundreth

The inferred dimension of scientific literacy was named "Mutual Involvement of Science and Society." The theme of this factor seemed to be that of society examining its values as science provides mankind with more capabilities. Also, society should establish conditions within which science can thrive. The two (2) positive loading Q-statements of this factor involved the TMSL advocating behavior. This suggested action beyond the personal level, for instance political activity.

There were no factors for the science or nonscience oriented groups which were the same as this OVERALL factor. Since it was the seventh factor of the OVERALL factor solution, it had the smallest percent of variance of all the factors. Because the two (2) orientation groups did not have this factor in their respective factor solutions, the notion is reinforced that something different than the classification of science or nonscience orientation may be operating to cause the factor to be developed in the situation where the two (2) groups were combined. The regression analysis indicated that the UNVNONSC group was a predictor of this factor with educational levels and particular science courses as the underlying variables.

Factors Unique to a Particular Group

The Q-statements presented in Table 48 represent a factor identified in only the science oriented group's factor solution; they are:

MOST HIGH SCHOOL GRADUATES SHOULD...

VIIIB21(Q14)	show that they believe science and technology cannot cure all of mankind's problems.
IB33(Q34)	support ways to help people understand new gains in some fields of science.
VB21(Q35)	show that they accept scientists as people.

The inferred dimension of scientific literacy was named "Science as a Human Endeavor." The theme of this factor

Table 48

Factor Loadings of Q-statements Chosen to Represent a Separate Science Oriented Factor

Element Identification	Q-statement Number	OVERALL	SCIENCE (7)[a]	NONSCIENCE
VIIIB21	14	-	.69[b]	-
IB33	34	-	-.45	-
VB21	35	-	.42	-
% of variance			4.1	

[a]Identifies the factor number for the respective factor solution in Appendix H

[b]Factor Loadings rounded to nearest hundreth

seemed to be playing down the "omnipotency" of science, technology, and scientists. It was reasonable that a factor of this type would be apropos to the science oriented group.

The Q-statements presented in Table 49 represent a factor identified in only the nonscience oriented group's factor solution; they are:

MOST HIGH SCHOOL GRADUATES SHOULD...

IA62(Q23) be able to judge the worth of some uses of matter, energy, and life using major ideas.

IA61(Q21) be able to judge the worth of some uses of matter, energy, and life using facts.

Table 49

Factor Loadings of Q-statements Chosen to Represent a Separate Nonscience Oriented Factor

Element Identification	Q-statement Number	OVERALL	SCIENCE	NONSCIENCE(7)[a]
IA62	23	-	-	.61[b]
IA61	21	-	-	.56
% of variance				4.4

[a]Identifies the factor number for the respective factor solution in Appendix H

[b]Factor Loadings rounded to nearest hundreth

The inferred dimension of scientific literacy was named "Using Natural Resources." The theme of this factor seemed to be that of the scientifically literate person using his knowledge to judge decisions which are made with regard to the utilization and control of aspects of nature. These Q-statements, both evaluative behaviors of the cognitive domain, represented the Factual and Generalizations components of the TMSL Organization of Knowledge dimension.

Table 50 presents the Q-statements which were chosen to represent Factor 4 of the science oriented group's factor solution. This factor was not interpretable.

Table 50

Factor Loadings of Q-statements Chosen to Represent a Non-Interpretable Science Oriented Factor

Element Identification	Q-statement Number	OVERALL	SCIENCE(4)[a]	NONSCIENCE
IB12	13	-	-.47[b]	-
VB11	1	-	.46	-
IB231	29	-	.44	-
VIIA61	11	-	-.43	-
IA11	28	-	.42	-
% of variance			5.7	

[a]Identifies the factor number for the respective factor solution in Appendix H

[b]Factor Loadings rounded to nearest hundreth

Summary of the Factor Analysis Results

The factor analysis of the data generated by the SLQ for all of the respondents combined produced seven (7) factors. From these factors seven (7) inferred dimensions of scientific literacy were developed and named. They were:

I. Scientific Inquiry

II. Maintaining Current Awareness

III. Valuing Methods of Science

IV. Personal Application of Science

V. Distinguishing Between Science and Technology

VI. Utilizing Factual Knowledge

VII. Mutual Involvement of Science and Society

It was determined that the science oriented group and the nonscience oriented group could be identified with inferred dimensions I, III, IV, V, and VI. The nonscience oriented group, but not the science oriented group, could be identified with number II. The science oriented group had two (2) unique factors. One was inferred to be a dimension of scientific literacy named "Science as a Human Endeavor." The other factor was not interpretable. The nonscience oriented group had one (1) factor unique to it. It was inferred to be a dimension of scientific literacy named "Using Natural Resources."

The Test of Null Hypotheses 1 (a) and (b)

Hypothesis 1 was presented in two (2) parts on pages 24 and 25 of Chapter I as a research hypothesis. For testing purposes it was restated in the null hypothesis form.

Null Hypothesis 1 (a) There are no significant differences in the factor scores of the science oriented group of persons and the nonscience oriented group of persons on each of the inferred dimensions of scientific literacy.

Null Hypothesis 1 (b) There are no significant differences in the factor scores of the subgroups of the two orientation groups of persons on each of the inferred dimensions of scientific literacy.

Central to the development of the preceeding section was the idea that Factors I, III, IV, V, and VI were common to the OVERALL group, the science oriented group, and the nonscience oriented group. Furthermore, Factor II could be identified in the factor solution of the OVERALL group and in the factor solution of the nonscience oriented group. Only the OVERALL Factor VII could not be identified in the respective factor solutions of the science oriented group and the nonscience oriented group.

It should be recognized that since the OVERALL group is actually made up of the science oriented group and the nonscience oriented group, all seven (7) OVERALL factors should exist to some extent within the factor solutions of the science oriented group and the nonscience oriented group. It was upon this basis that the tests of Null Hypothesis 1 (a) and Null Hypothesis 1 (b) were performed. It was decided that the factor scores for a given OVERALL factor could be treated as values of a variable representing that factor. These factor scores had been generated by the SPSS (Nie, et al., 1975) subprogram FACTOR.

To test Null Hypothesis 1 (a) seven (7) analyses of variance were performed treating each of the seven (7)

OVERALL factors as a dependent variable and ORIENT (see page 122 of Chapter III) as the independent variable. To test Null Hypothesis 1 (b) seven (7) similar analyses of variance were performed using STATUS (see page 122 of Chapter III) as the independent variable. When a significant F-ratio ($p \leq 0.05$) was encountered Scheffe' posteriori contrast tests were performed following the analyses of variance.

This section is presented in seven (7) segments--one for each OVERALL factor. In each segment a table with the means and standard deviations for the factor is presented. The total of the group's factor score means on a given factor was 0.0 since factor scores were standardized. The two (2) analysis of variance tables are presented along with a summary of the Scheffe' contrast tests where they were appropriate. A conclusion is made with regard to the rejection or nonrejection of Null Hypothesis 1 (a) and Null Hypothesis 1 (b) for the particular factor. The regression analysis showed that the rejection of these null hypotheses could not always be explained on the basis of group membership alone.

Factor I: Scientific Inquiry

Table 51

Means and Standard Deviations of Scientific Inquiry Factor Scores

Groups	Group Size	Mean	SD
UNVPURSC	21	- .622[b]	.756[b]
UNVAPPSC	19	- .079	.853
UNVSC[a]	40	- .364	.839
UNVNONSC	41	- .008	.925
PUBSC	52	.293	.833
PUBNONSC	42	- .008	.844
OVERALL	175	0.000	.884

[a]UNVPURSC and UNVAPPSC combined

[b]Rounded to nearest thousandth

Table 52

ANOVA for Scientific Inquiry Factor Scores with ORIENT

Source	df	SS	MS	F	p
Between	1	0.010	0.010	0.013	0.590
Within	173	136.021	0.786		
Total	174	136.032			

Table 53

ANOVA for Scientific Inquiry
Factor Scores with STATUS

Source	df	SS	MS	F	p
Between	4	12.714	3.179	4.38	0.002
Within	170	123.318	0.725		
Total	174	136.032			

The results of the Scheffe' a posteriori contrast tests at $p \leq 0.1$ which followed the ANOVA presented in Table 53 were:

UNVPURSC	UNVAPPSC	PUBNONSC	UNVNONSC	PUBSC
-0.622	-0.079	-0.008	-0.008	0.283

Each value above is a mean from Table 51.

Null Hypothesis 1 (a) was not rejected for Factor I (Table 52). Null Hypothesis 1 (b) was rejected for Factor I since the ANOVA between Factor I and STATUS (Table 53) showed that significant differences existed between some of the subgroup means (Table 51). The Scheffe' contrast tests showed that the difference existed between the UNVPURSC group and the PUBSC group.

Factor II: Maintaining Current Awareness

Table 54

Means and Standard Deviations for Maintaining Current Awareness Factor Scores

Group	Group Size	Mean	SD
UNVPURSC	21	- .281[b]	.785[b]
UNVAPPSC	19	- .003	.944
UNVSC[a]	40	- .149	.864
UNVNONSC	41	- .281	.880
PUBSC	52	.202	.850
PUBNONSC	42	.166	.729
OVERALL	175	0.000	.852

[a]UNVPURSC and UNVAPPSC combined

[b]Rounded to nearest thousandth

Table 55

ANOVA for Maintaining Current Awareness Factor Scores with ORIENT

Source	df	SS	MS	F	p
Between	1	0.472	0.472	0.650	0.427
Within	173	125.698	0.727		
Total	174	126.170			

Table 56

ANOVA for Maintaining Current Awareness
Factor Scores with STATUS

Source	*df*	*SS*	*MS*	*F*	*p*
Between	4	8.181	2.045	2.947	0.022
Within	170	117.990	0.694		
Total	174	126.171			

Null Hypothesis 1 (a) was not rejected for Factor II (Table 55). Null Hypothesis 1 (b) was rejected for Factor II since the ANOVA between Factor II and STATUS (Table 56) showed that significant differences existed between some of the subgroup means (Table 54). However, the Scheffe' contrast tests at $p \leq 0.1$ did not discriminate between them.

Factor III: Valuing Methods of Science

Table 57

Means and Standard Deviations for Valuing Methods of Science Factor Scores

Group	Group Size	Mean	SD
UNVPURSC	21	0.572[b]	0.940[b]
UNVAPPSC	19	-0.320	0.830
UNVSC[a]	40	0.148	0.987
UNVNONSC	41	0.063	0.941
PUBSC	52	-0.135	0.752
PUBNONSC	42	-0.035	0.700
OVERALL	175	0.000	0.846

[a]UNVPURSC and UNVAPPSC combined

[b]Rounded to nearest thousandth

Table 58

ANOVA for Valuing Methods of Science Factor Scores with ORIENT

Source	df	SS	MS	F	p
Between	1	0.028	0.028	0.040	0.666
Within	173	124.470	0.720		
Total	174	124.500			

Table 59

ANOVA for Valuing Methods of Science
Factor Scores with STATUS

Source	df	SS	MS	F	p
Between	4	9.983	2.496	3.705	0.007
Within	170	114.516	0.674		
Total	174	124.499			

The results of the Scheffe' a posteriori contrast tests at $p \leq 0.1$ which followed the ANOVA presented in Table 59 were:

UNVAPPSC	PUBSC	PUBNONSC	UNVNONSC	UNVPURSC
-0.320	-0.135	-0.035	0.063	0.572

Each value above is a mean from Table 57.

Null Hypothesis 1 (a) was not rejected for Factor III (Table 58). Null Hypothesis 1 (b) was rejected for Factor III since the ANOVA between Factor III and STATUS (Table 59) showed that significant differences existed between some of the subgroup means (Table 57). The Scheffe' contrast tests showed that the UNVAPPSC and PUBSC groups were significantly different than the UNVPURSC group.

Factor IV: Personal Application of Science

Table 60

Means and Standard Deviations for Personal Application of Science Factor Scores

Group	Group Size	Mean	SD
UNVPURSC	21	-0.267[b]	0.712[b]
UNVAPPSC	19	-0.442	0.920
UNVSC[a]	40	-0.350	0.811
UNVNONSC	41	0.045	0.757
PUBSC	52	0.167	0.938
PUBNONSC	42	0.083	0.866
OVERALL	175	0.000	0.867

[a]UNVPURSC and UNVAPPSC combined

[b]Rounded to nearest thousandth

Table 61

ANOVA for Personal Application of Science Factor Scores with ORIENT

Source	df	SS	MS	F	p
Between	1	0.655	0.655	0.870	0.355
Within	173	130.268	0.753		
Total	174	130.923			

Table 62

ANOVA for Personal Application of Science Factor Scores with STATUS

Source	df	SS	MS	F	p
Between	4	7.029	1.757	2.411	0.050
Within	170	123.894	0.729		
Total	174	130.923			

Null Hypothesis 1 (a) was not rejected for Factor IV (Table 61). Null Hypothesis 1 (b) was rejected for Factor IV since the ANOVA between Factor IV and STATUS (Table 62) showed that significant differences existed between some of the subgroups means (Table 60). However, the Scheffe' contrast tests at $p \leq 0.1$ did not discriminate between them.

Factor V: Distinguishing Between Science and Technology

Table 63

Means and Standard Deviations for Distinguishing Between Science and Technology Factor Scores

Group	Group Size	Mean	SD
UNVPURSC	21	0.362[b]	0.836[b]
UNVAPPSC	19	0.078	0.806
UNVSC[a]	40	0.227	0.824
UNVNONSC	41	0.171	0.920
PUBSC	52	-0.214	0.777
PUBNONSC	42	-0.117	0.797
OVERALL	175	0.000	0.842

[a]UNVPURSC and UNVAPPSC combined

[b]Rounded to nearest thousandth

Table 64

ANOVA for Distinguishing Between Science and Technology Factor Scores with ORIENT

Source	df	SS	MS	F	p
Between	1	0.100	0.100	0.140	0.673
Within	173	123.267	0.712		
Total	174	123.367			

Table 65

ANOVA for Distinguishing Between Science and Technology Factor Scores with STATUS

Source	df	SS	MS	F	p
Between	4	7.031	1.758	2.569	0.039
Within	170	116.336	0.684		
Total	174	123.367			

Null Hypothesis 1 (a) was not rejected for Factor V (Table 64). Null Hypothesis 1 (b) was rejected for Factor V since the ANOVA between Factor V and STATUS (Table 65) showed that significant differences existed between some of the subgroup means (Table 63). However, the Scheffe' contrast tests at $p \leq 0.1$ did not discriminate between them.

Factor VI: Utilizing Factual Knowledge

Table 66

Means and Standard Deviations for Utilizing Factual Knowledge Factor Scores

Group	Group Size	Mean	SD
UNVPURSC	21	-0.073[b]	1.081[b]
UNVAPPSC	19	0.393	0.549
UNVSC[a]	40	0.149	0.891
UNVNONSC	41	-0.209	0.972
PUBSC	52	-0.018	0.884
PUBNONSC	42	0.085	0.590
OVERALL	175	0.000	0.851

[a]UNVPURSC and UNVAPPSC combined

[b]Rounded to nearest thousandth

Table 67

ANOVA for Utilizing Factual Knowledge Factor Scores with ORIENT

Source	*df*	*SS*	*MS*	*F*	*p*
Between	1	0.574	0.574	0.792	0.378
Within	173	125.311	0.724		
Total	174	125.885			

Table 68

ANOVA for Utilizing Factual Knowledge Factor Scores with STATUS

Source	df	SS	MS	F	p
Between	4	5.170	1.292	1.820	0.126
Within	170	120.715	0.710		
Total	174	125.885			

Null Hypothesis 1 (a) was not rejected for Factor VI (Table 67). Null Hypothesis 1 (b) was not rejected for Factor VI since significant differences were not found to exist between the subgroups when the ANOVA was performed between Factor VI and STATUS (Table 68).

Factor VII: Mutual Involvement of Science and Society

Table 69

Means and Standard Deviations for Mutual Involvement of Science and Society Factor Scores

Group	Group Size	Mean	SD
UNVPURSC	21	0.104[b]	0.796
UNVAPPSC	19	-0.078	0.812
UNVSC[a]	40	-0.018	0.799
UNVNONSC	41	-0.368	0.754
PUBSC	52	0.306	0.666
PUBNONSC	42	-0.036	0.872
OVERALL	175	0.000	0.802

[a]UNVPURSC and UNVAPPSC combined

[b]Rounded to nearest thousandth

Table 70

ANOVA for Mutual Involvement of Science and Society Factor Scores with ORIENT

Source	df	SS	MS	F	p
Between	1	6.342	6.342	10.390	0.002
Within	173	105.601	0.610		
Total	174	111.943			

Table 71

ANOVA for Mutual Involvement of Science and Society Factor Scores with STATUS

Source	*df*	*SS*	*MS*	*F*	*p*
Between	4	10.840	2.710	4.557	0.002
Within	170	101.103	0.595		
Total	174	111.944			

The results of the Scheffe' a posteriori contrast tests at $p \leq 0.1$ which followed the ANOVA presented in Table 71 were:

UNVNONSC	UNVAPPSC	PUBNONSC	UNVPURSC	PUBSC
-0.368	-0.078	-0.036	0.104	0.306

Each value above is a mean from Table 69.

Null Hypothesis 1 (a) was rejected for Factor VII (Table 70). The mean for SCIENCE was 0.181, and the mean for NONSCIENCE was -0.200. Null Hypothesis 1 (b) was rejected for Factor VII since the ANOVA between Factor VII and STATUS (Table 71) showed that significant differences existed between some of the subgroup means (Table 69). The Scheffe' contrast tests showed that the significant differences existed between the UNVNONSC group and the PUBSC group.

Summary of the Test of Null Hypotheses 1 (a) and (b)

Table 72 presents a summary of the results of the analyses of variance which were used to test Null Hypotheses 1 (a) and (b).

Table 72

Summary of the Tests of Null Hypotheses 1 (a) and (b)

Factor Name	Null Hypothesis 1 (a)	Null Hypothesis 1 (b)	Scheffe' $p \leq 0.1$
I. Scientific Inquiry	not rejected	rejected	UNVPURSC < PUBSC
II. Maintaining Current Awareness	not rejected	rejected	nonseparable
III. Valuing Method of Science	not rejected	rejected	UNVAPPSC and PUBSC < UNVPURSC
IV. Personal Application of Science	not rejected	rejected	nonseparable
V. Distinguishing Between Science and Technology	not rejected	rejected	nonseparable
VI. Utilizing Factual Knowledge	not rejected	not rejected	nonseparable
VII. Mutual Involvement of Science and Society	rejected (science > nonscience)	rejected	UNVNONSC < PUBSC

For Scientific Inquiry the Scheffe' contrast tests showed that the university pure science group was significantly different than the public science group. For Valuing Methods of Science the university pure science group was significantly different than both the university applied science group and the public science group. The public science group was predominately composed of applied science persons (see Table 5 of Chapter III). Therefore on these two (2) dimensions the differences seemed to exist between a pure science orientation and an applied science orientation. The public nonscience group did not show up in the Scheffe' contrast tests although the university nonscience group did on Mutual Involvement of Science and Society. This suggested that possibly the public nonscience group was more diverse than was the university nonscience group.

The Test of Null Hypothesis 2

Hypothesis 2 was presented on page 25 of Chapter I as a research hypothesis. For testing purposes it was restated in the null hypothesis form.

Null Hypothesis 2. There are no significant predictors or combinations of predictors among the variables: (a) amount of previous education; (b) amount of previous science education; (c) amount of previous education of parents or guardians; (d) age; and (e) sex of the persons in the science oriented and nonscience oriented groups of persons and the inferred dimensions of scientific literacy.

It was decided that a stepwise regression would be an appropriate analysis to use to test Null Hypothesis 2. The factor scores which had been produced by the SPSS (Nie, et al., 1975) subprogram FACTOR for the OVERALL seven (7) factor solution were treated as values of the variables representing the factors. These factor variables were the dependent variables. The independent variables were listed in general terms in the statement of Null Hypothesis 2. Specifically the variables which were used were:

variable in general	study variable
amount of previous education	OWNSCHYR

variable in general	study variable
amount of previous science education	SHGENSCI, SHERTSCI, SHBIOL, SHCHEM, SHPHYS, CLBIOSCI, CLPHYSCI, CLERTSCI, CLENGSCI
amount of previous education of parents or guardians	MOTSCHYR, FATSCHYR
age	AGE
sex	SEX

It has been suggested that personal characteristics might have been as much or more related to the development of the factors as was being science or nonscience oriented. To better understand this possibility the regression analysis was performed twice, once with the independent variables previously listed and once with the values of the variable STATUS included. These values were not used as such. Instead they were converted into dichotomous variables (see page 165) such that they represented membership in the various five (5) groups.

The regression analyses were performed three times on the data:

(1) for all respondents grouped together (OVERALL);

(2) for the science oriented respondents (SCIENCE); and

(3) for the nonscience oriented respondents (NONSCIENCE).

Tables 74-81 present the results of the regression analyses in terms of each factor for which an OVERALL inferred dimension of scientific literacy was developed. The criteria used to select variables for entry into the tables were:

(1) each variable had a significant F-ratio; and

(2) each variable had an $\underline{R}^2$ change value not less than approximately 0.04.

Table 73 presents the correlation coefficients between all variables selected for entry into Tables 74-81. In the regression analysis listwise deletion of data was used; this left data from 134 respondents. As a result the correlations in Table 73 and those listed in the correlational analysis section (see pages 163-167) will not be identical.

<u>Factor I: Scientific Inquiry</u>

The university pure science group variable (UNVPURSC) was a negative predictor of this factor for OVERALL and for SCIENCE (Table 74). When the group membership variables were not included in the regression analysis the last year of school completed by the respondents (OWNSCHYR) entered as a negative predictor for SCIENCE just as it had been when the group membership variables were included. This was not surprising since UNVPURSC and OWNSCHYR were positively correlated at 0.363. <u>Null Hypothesis 2</u> was not rejected for OVERALL or for NONSCIENCE. It was rejected for SCIENCE.

Table 73

Intercorrelation Coefficients between Regression Analysis Predictor Variables

	UNVAPPSC	UNVNONSC	PUBSC	PUBNONSC	OWNSCHYR	MOTSCHYR	FATSCHYR
UNVPURSC	-.122[a]	-.228	-.270	-.223	.363	.006	-.014
UNVAPPSC		-.168	-.199	-.164	.243	-.042	-.072
UNVNONSC			-.372	-.307	.380	-.003	.154
PUBSC				-.364	-.211	.075	.017
PUBNONSC					-.613	-.057	-.116
OWNSCHYR						.031	.149
MOTSCHYR							.617
FATSCHYR							
SHGENSCI							
SHERTSCI							
SHCHEM							
SHPHYS							
CLBIOSCI							
CLERTSCI							
CLENGSCI							
AGE							
SEX							

[a] Rounded to nearest thousandth

Table 73 (continued)

	SHGENSCI	SHERTSCI	SHCHEM	SHPHYS	CLBIOSCI	CLERTSCI	CLENGSCI
UNVPURSC	-.021	.071	.006	.096	.370	.266	-.093
UNVAPPSC	-.036	.076	.157	.147	.104	.120	.217
UNVNONSC	.059	-.134	.039	.048	-.076	-.072	-.178
PUBSC	-.092	.038	.231	.248	.086	-.061	.343
PUBNONSC	.082	-.014	-.399	-.495	-.391	-.158	-.258
OWNSCHYR	-.097	.085	.288	.320	.511	.321	.056
MOTSCHYR	-.266	.002	.116	.028	.121	.020	.055
FATSCHYR	-.104	.119	.014	-.074	.159	.157	.010
SHGENSCI		.226	-.054	-.033	.005	.002	-.153
SHERTSCI			.061	.130	.203	.223	.031
SHCHEM				.415	.228	.110	.220
SHPHYS					.113	.106	.355
CLBIOSCI						.294	-.194
CLENGSCI							.139
AGE							
SEX							

Table 73 (continued)

	AGE	SEX	FACTOR I	FACTOR II	FACTOR III	FACTOR IV
UNVPURSC	.086	.116	-.278	-.150	.262	-.139
UNVAPPSC	.187	.129	.016	-.044	-.114	-.184
UNVNONSC	.068	-.047	.014	-.140	.010	.131
PUBSC	-.045	.064	.215	.117	-.114	.067
PUBNONSC	-.213	-.202	-.030	.167	-.027	.030
OWNSCHYR	.132	.225	-.164	-.220	.119	-.063
MOTSCHYR	-.213	-.108	-.091	-.330	.051	-.014
FATSCHYR	-.138	-.076	.054	-.257	.118	-.113
SHGENSCI	.009	.113	.064	.059	.068	.144
SHERTSCI	-.060	.147	.010	-.019	-.112	.050
SHCHEM	-.033	.122	.036	-.017	.045	.072
SHPHYS	.108	.319	-.04	-.048	-.080	.030
CLBIOSCI	.027	.033	-.001	-.180	.116	-.126
CLERTSCI	-.034	.175	.082	-.100	.133	-.127
CLENGSCI	.080	.318	.095	.051	-.086	-.023
AGE		.076	-.078	-.008	.065	-.208
SEX			.127	.060	.062	-.076

Table 73 (continued)

	FACTOR V	FACTOR VI	FACTOR VII
UNVPURSC	.140	-.041	.032
UNVAPPSC	-.018	.184	-.008
UNVNONSC	.186	-.134	-.272
PUBSC	-.219	-.064	.227
PUBNONSC	-.053	.120	.004
OWNSCHYR	.165	-.102	-.185
MOTSCHYR	.028	-.035	-.088
FATSCHYR	.120	-.134	-.073
SHGENSCI	-.019	-.070	.110
SHERTSCI	-.100	.103	.074
SHCHEM	.055	-.032	.103
SHPHYS	.074	.098	.160
CLBIOSCI	.073	-.033	-.019
CLERTSCI	-.008	.031	-.169
CLENGSCI	-.110	.052	.067
AGE	.152	.078	.039
SEX	.027	.014	.078

Table 74

Stepwise Regression Results for Scientific Inquiry

Variable	F	R Simple	R Multiple	R^2	R^2 Change	B
With Groups:						
OVERALL						
UNVPURSC	11.097[a]	-0.278	0.278	0.078	0.078	-0.725
SCIENCE						
UNVPURSC	7.691[b]	-0.409	0.409	0.167	0.167	-0.726
CLERTSCI	5.050	0.089	0.454	0.206	0.039	0.286
OWNSCHYR	3.933	-0.349	0.500	0.250	0.044	-0.088
NONSCIENCE	NOTHING					
Without Groups:						
OVERALL	NOTHING					
SCIENCE						
OWNSCHYR	12.074[c]	-0.349	0.349	0.122	0.122	-0.146
CLERTSCI	3.458	0.089	0.405	0.164	0.042	0.247
NONSCIENCE	NOTHING					

[a] $F = 3.92$; $df = 1,132$; $p \leq 0.05$

[b] $F = 2.75$; $df = 3,67$; $p \leq 0.05$

[c] $F = 3.13$; $df = 2,68$; $p \leq 0.05$

For Scientific Inquiry the groups' factor score means, the results of the Scheffe' contrast tests, and the negative prediction by the UNVPURSC group variable indicated that membership in subgroups was more related to the development of this factor than simply being science oriented or nonscience oriented. It was inferred from these analyses that the university pure science respondents with the higher level of schooling tended to play down the importance of personal involvement in scientific inquiry for the high school graduates in general. This effect was reduced when the respondents had college earth science courses in their educational backgrounds.

Factor II: Maintaining Current Awareness

Table 75 shows that the last year of school completed by the mothers of the respondents (MOTSCHYR) was a negative predictor in the OVERALL, SCIENCE, and NONSCIENCE groups. The last year of school completed by the respondents (OWNSCHYR) was a negative predictor of Factor II for the OVERALL group. For SCIENCE the public science group membership variable (PUBSC) was a positive predictor. For NONSCIENCE the public nonscience group membership variable (PUBNONSC) was a positive predictor as was having had a senior earth science course (SHERTSCI). Null Hypothesis 2 was rejected for the OVERALL, SCIENCE, and NONSCIENCE groups.

Table 75

Stepwise Regression Results for Maintaining Current Awareness

Variable	F	R Simple	R Multiple	R^2	R^2 Change	B
With Groups:						
OVERALL						
MOTSCHYR	16.221[a]	-0.330	0.330	0.109	0.109	-0.096
OWNSCHYR	6.803	-0.220	0.391	0.153	0.044	-0.056
SCIENCE						
MOTSCHYR	8.961[b]	-0.316	0.316	0.100	0.100	-0.090
PUBSC	5.021	0.226	0.402	0.162	0.062	0.429
NONSCIENCE						
MOTSCHYR	10.888[c]	0.357	0.357	0.127	0.127	-0.130
PUBNONSC	3.982	0.281	0.442	0.195	0.068	0.380
SHERTSCI	3.943	0.202	0.496	0.246	0.050	0.782
Without Groups:						
OVERALL	SAME AS ABOVE					
SCIENCE						
MOTSCHYR	7.652[d]	-0.316	0.316	0.100	0.100	-0.086
NONSCIENCE						
MOTSCHYR	9.635[e]	-0.357	0.357	0.127	0.127	-0.124
SHERTSCI	4.575	0.202	0.441	0.195	0.068	0.840
CLBIOSCI	3.483	-0.283	0.490	0.240	0.045	-0.265

[a] $F = 3.07$; $df = 2,131$; $p \leq = 0.05$
[b] $F = 3.14$; $df = 2,68$; $p \leq = 0.05$
[c] $F = 2.76$; $df = 3,59$; $p \leq = 0.05$
[d] $F = 3.98$; $df = 1,69$; $p \leq = 0.05$
[e] $F = 2.76$; $df = 3,59$; $p \leq = 0.05$

The regression analysis demonstrated that individual characteristics of respondents had more to do with the significant differences which existed between the groups' factor score means than did group membership. Table 12 (see page 132) showed that the PUBSC and PUBNONSC groups had the lowest mean and the largest standard deviation values of all groups for OWNSCHYR. It appeared that the public science and nonscience respondents with lower and more diverse educational levels and whose mothers had completed fewer years of school tended to support the Maintaining Current Awareness dimension. From this it was inferred that respondents who had completed fewer years of school desired to upgrade their general science knowledge. Also, respondents whose mothers had completed fewer years of school were encouraged to continue to learn.

The regression analysis also indicated that those public nonscience respondents who had studied earth science in high school but who had not studied a biological science in college were more concerned about Maintaining Current Awareness. It could have been in fact that these were persons who had not even gone to college. An alternative to this inference was posited. Those public nonscience respondents with an earth science background in high school were more concerned about current awareness than those respondents with a college biological science background.

Factor III: Valuing Methods of Science

The university pure science group membership variable (UNVPURSC) was a positive predictor of Valuing Methods of Science in the OVERALL and the SCIENCE groups (Table 76). When the group membership variables were not included the last year of school completed by fatners of the respondents (FATSCHYR) and that completed by the respondents (OWNSCHYR) were both positive predictors in the SCIENCE group. Also, a high school physics background was a negative predictor. Null Hypothesis 2 was not rejected for the OVERALL group. It was rejected for the SCIENCE group but not for the NONSCIENCE group.

The groups' factor score means, the Scheffe' contrast tests, and the results of the regression analysis indicated that university pure science respondents felt most high school graduates should value methods of science. However, the university applied science and public science respondents considered this less important for most high school graduates. This suggested that subgroup membership was more related to the development of the factor than was science/ nonscience orientation.

In the SCIENCE group it appeared that university pure science respondents who had higher levels of education, and whose fathers had higher levels of education, tended to value methods of science. But, it also appeared that university pure science respondents who had high school physics

Table 76

Stepwise Regression Results for Valuing Methods of Science

Variable	F	R Simple	R Multiple	R^2	R^2 Change	B
With Groups:						
OVERALL						
UNVPURSC	9.742[a]	0.262	0.262	0.069	0.069	0.666
SCIENCE						
UNVPURSC	10.803[b]	0.369	0.369	0.136	0.136	0.722
FATSCHYR	6.153	0.260	0.451	0.204	0.068	0.062
SHPHYS	4.263	-0.249	0.501	0.251	0.048	-0.555
NONSCIENCE	NOTHING					
Without Groups:						
OVERALL	NOTHING					
SCIENCE						
FATSCHYR	5.013[c]	0.260	0.295	0.067	0.067	0.059
SHPHYS	5.514	-0.249	0.362	0.131	0.063	-0.661
OWNSCHYR	3.495	0.212	0.417	0.174	0.043	0.072
NONSCIENCE	NOTHING					

[a] $F = 3.92$; $df = 1,132$; $p \leq = 0.05$

[b] $F = 2.75$; $df = 3,67$; $p \leq = 0.05$

[c] $F = 2.75$; $df = 3,67$; $p \leq = 0.05$

in their educational background did not value methods of science for most high school graduates. The studying of physics is sometimes construed as in effect becoming more specialized in science. Therefore, possibly the results of the analysis were saying that university pure science respondents with broader science backgrounds (that is, not including physics) tended to value methods of science for most high school graduates.

Factor IV: Personal Application of Science

Personal Application of Science was predicted by an individual characteristic of the respondents rather than by group membership. Table 77 shows that the age of the respondents (AGE) was a negative predictor for the OVERALL and NONSCIENCE groups. The public science group membership variable was a positive predictor in the SCIENCE group analysis, but when group membership variables were not included, the last year of school completed by the respondents (OWNSCHYR) entered as a negative predictor. For the NONSCIENCE group senior high chemistry (SHCHEM) and senior high earth science (SHERTSCI) were positive predictors. Null Hypothesis 2 was rejected for the OVERALL, SCIENCE, and NONSCIENCE groups.

The regression analysis indicated that an individual characteristic of the respondents was more related to the development of the factor than was group membership. Since age (AGE) was a negative OVERALL predictor, it appeared that

Table 77

Stepwise Regression Results for Personal Application of Science

Variable	F	R Simple	R Multiple	R^2	R^2 Change	B
With Groups:						
OVERALL						
AGE	5.985[a]	-0.208	0.208	0.043	0.043	-0.140
SCIENCE						
PUBSC	4.766[b]	0.254	0.254	0.065	0.065	0.481
NONSCIENCE						
SHCHEM	6.982[c]	0.288	0.288	0.083	0.083	0.521
SHERTSCI	3.687	0.245	0.394	0.155	0.072	0.754
AGE	3.588	-0.265	0.451	0.204	0.048	-0.142
Without Groups:						
OVERALL	SAME AS ABOVE					
SCIENCE						
OWNSCHYR	4.727[d]	-0.253	0.253	0.064	0.064	-0.089
NONSCIENCE	SAME AS ABOVE					

[a] F = 3.92; df = 1,132; $p \leq = 0.05$

[b] F = 3.98; df = 1,69; $p \leq = 0.05$

[c] F = 2.76; df = 3,59; $p \leq = 0.05$

[d] F = 3.98; df = 1,69; $p \leq = 0.05$

younger respondents tended to value this dimension. In particular, in the NONSCIENCE group it appeared that younger respondents (more recently educated) with high school chemistry and earth science in their educational backgrounds tended to place higher value on personal application of science. It might be argued that the recent curriculum developments in science have had an effect on these younger respondents.

The public science respondents with lower educational levels tended to value Personal Application of Science for most high school graduates. The converse would be that their counterparts, the university pure and applied science respondents, did not value personal application of science as highly for most high school graduates. The summary of the descriptive statistics for SLQ data (see pages 162-163) supported this.

Factor V: Distinguishing Between Science and Technology

The regression analysis results (Table 78) showed that the public science group membership variable (PUBSC) negatively predicted Factor V for the OVERALL group; whereas, the university pure science group membership variable (UNVPURSC) positively predicted for the SCIENCE group. When the group membership variables were not included college level engineering science (CLENGSCI) entered as a negative predictor and sex (SEX) entered as a positive predictor

Table 78

Stepwise Regression Results for
Distinguishing Between Science and Technology

Variable	F	R Simple	R Multiple	R^2	R^2 Change	B
With Groups:						
OVERALL						
PUBSC	6.632[a]	-0.219	0.219	0.048	0.048	-0.404
SCIENCE						
UNVPURSC	5.641[b]	0.275	0.275	0.076	0.076	0.526
NONSCIENCE						
AGE	7.397[c]	0.309	0.309	0.095	0.095	0.203
FATSCHYR	8.380	0.288	0.427	0.182	0.087	0.072
SEPHYS	5.353	0.232	0.500	0.250	0.068	0.444
Without Groups:						
OVERALL	NOTHING					
SCIENCE						
CLENGSCI	5.730[d]	-0.216	0.216	0.047	0.047	-0.197
SEX	3.777	0.144	0.31[illegible]	0.097	0.050	0.718
NONSCIENCE	SAME AS ABOVE					

[a] $F = 3.92$; $df = 1,132$; $p \leq = 0.05$

[b] $F = 3.98$; $df = 1,69$; $p \leq = 0.05$

[c] $F = 2.76$; $df = 3,59$; $p \leq = 0.05$

[d] $F = 3.13$; $df = 2,68$; $p \leq = 0.05$

for the SCIENCE group. For the NONSCIENCE group age (AGE), the last year of school completed by the fathers of the respondents (FATSCHYR), and high school physics in the educational backgrounds of the respondents (SHPHYS) were all positive predictors. Null Hypothesis 2 was not rejected for the OVERALL group. It was rejected for the SCIENCE and NONSCIENCE groups.

The results of the regression analysis and the groups' factor score means suggested that subgroup membership was more related to the development of the factor than was science/nonscience orientation. In the SCIENCE group it was observed that those respondents who had taken few college level engineering courses (the UNVPURSC group) tended to value most high school graduates being able to distinguish between science and technology. But, those respondents who had taken several college level engineering courses (the PUBSC group) tended not to value this dimension for most high school graduates. Since the university applied science group factor score mean was less than that of the university pure science group factor score mean and since the public science factor score mean was negative, it was inferred that pure science respondents were more concerned than were applied science respondents that most high school graduates be able to distinguish between science and technology. The positive sex predictor in the SCIENCE group reflected the fact that this group was predominately composed of males (see Table 7 on page 126).

In the NONSCIENCE group the positive predictors indicated that older respondents who had high school physics in their educational backgrounds and whose fathers had higher levels of education tended to value distinguishing between science and technology. It could be said that younger respondents who did not have high school physics in their educational backgrounds and whose fathers had lower levels of education tended not to see reason for distinguishing between science and technology. This latter statement is supported by the findings of Etzioni and Nunn (1974). They found that "the overwhelming majority of the public seems to confuse science and technology and sees science in a very technological instrumental light." See page 16 of Chapter I.

Factor VI: Utilizing Factual Knowledge

There were no predictors of Factor VI for the OVERALL group (Table 79). The university applied science group membership variable (UNVAPPSC) was a positive predictor for the SCIENCE group, but when the group membership variables were not included, no variables replaced it. In the NONSCIENCE group the public nonscience group membership variable (PUBNONSC) was a positive predictor. When the group membership variables were removed, the last year of school completed by the respondents (OWNSCHYR) and also that of their

Table 79

Stepwise Regression Results for Utilizing Factual Knowledge

Variable	F	R Simple	R Multiple	R^2	R^2 Change	B
With Groups:						
OVERALL	NOTHING					
SCIENCE						
UNVAPPSC	4.426[a]	0.245	0.245	0.060	0.060	0.612
NONSCIENCE						
MOTSCHYR	2.907[b]	-0.247	0.247	0.061	0.061	-0.065
PUBNONSC	10.816	0.243	0.337	0.114	0.052	0.681
SHPHYS	10.276	0.230	0.495	0.245	0.131	0.664
Without Groups:						
OVERALL	NOTHING					
SCIENCE	NOTHING					
NONSCIENCE						
MOTSCHYR	3.764[c]	-0.247	0.247	0.061	0.061	-0.077
SHERTSCI	2.394	0.181	0.332	0.110	0.049	0.603
SHPHYS	7.195	0.230	0.393	0.154	0.044	0.552
OWNSCHYR	5.875	-0.206	0.482	0.232	0.078	-0.071

[a] $F = 3.98$; $df = 1,69$; $p \leq = 0.05$

[b] $F = 2.76$; $df = 3,59$; $p \leq = 0.05$

[c] $F = 2.52$; $df = 4,58$; $p \leq = 0.05$

mothers (MOTSCHYR) entered as negative predictors. Senior high earth science (SHERTSCI) and chemistry (SHCHEM) were positive predictors. Null Hypothesis 2 was not rejected for the OVERALL group nor for the SCIENCE group. It was rejected for the NONSCIENCE group.

The positive prediction by the university applied science group membership variable of Factor VI, Utilizing Factual Knowledge, seemed to add credibility to the name of this inferred dimension. That is, application (applied science) and utilization (utilizing factual knowledge) are somewhat synonymous.

In the NONSCIENCE group public nonscience respondents who had lower levels of education and whose mothers also had lower levels of education tended to value the dimension Utilizing Factual Knowledge. Examining the Q-statements which represented this dimension (see pages 179-180) it was observed that knowing facts (Q28) had the largest factor loading. This tended to complement and to support the inferences which were made on the Maintaining Current Awareness dimension. That is, the respondents with fewer years of school completed desired to upgrade their factual knowledge. Also, those respondents whose mothers had completed fewer years of school were encouraged to continue learning.

In addition, in the NONSCIENCE group it appeared that those public nonscience respondents who had taken an earth science and/or a physics course in high school tended to value Utilizing Factual Knowledge. Those respondents who had higher levels of education, whose mothers had higher levels of education, and who generally did not take high school earth science and/or physics tended not to value Utilizing Factual Knowledge. It seemed reasonable that these descriptors could be generally applicable to the university nonscience respondents. Moreover, since the public nonscience group membership variable positively predicted Factor VI, this left only the university nonscience group membership variable as the counterpart in the NONSCIENCE group.

Factor VII: Mutual Involvement of Science and Soceity

Table 80 shows that the university nonscience group membership variable (UNVNONSC) was a negative predictor of Factor VII for the OVERALL and NONSCIENCE groups. College level earth science (CLERTSCI) was a negative predictor for the SCIENCE group. When the group membership variables were not included, the last year of school completed by the respondents (OWNSCHYR) entered as a negative predictor of Factor VII for the OVERALL group while senior high physics (SHPHYS) entered as a positive predictor. For the NONSCIENCE group senior high general science (SHGENSCI) was a positive predictor, while the last year of school completed by the respondents (OWNSCHYR) and by their mothers (MOTSCHYR) was a negative predictor. Null Hypothesis 2

Table 80

Stepwise Regression Results for Mutual Involvement of Science and Society

Variable	F	R Simple	R Multiple	R^2	R^2 Change	B
With Groups:						
OVERALL						
UNVNONSC	10.558[a]	-0.272	0.272	0.074	0.074	-0.461
SCIENCE						
CLERTSCI	6.313[b]	-0.290	0.290	0.084	0.084	-0.245
NONSCIENCE						
SHGENSCI	6.319[c]	0.325	0.325	0.106	0.106	0.445
UNVNONSC	3.959	-0.250	0.405	0.164	0.059	-0.3[illegible]
MOTSCHYR	3.101	-0.256	0.454	0.206	0.042	-0.061
Without Groups:						
OVERALL						
OWNSCHYR	8.958[d]	-0.185	0.185	0.034	0.034	-0.060
SHPHYS	7.711	0.160	0.297	0.088	0.054	0.378
SCIENCE	SAME AS ABOVE					
NONSCIENCE						
SHGENSCI	5.497[e]	0.325	0.325	0.105	0.105	0.420
OWNSCHYR	3.167	-0.253	0.393	0.154	0.049	-0.042
MOTSCHYR	3.062	-0.256	0.443	0.196	0.042	-0.061

[a] $F = 3.92$; $df = 1,132$; $p \leq = 0.05$
[b] $F = 3.98$; $df = 1,69$; $p \leq = 0.05$
[c] $F = 2.76$; $df = 3,59$; $p \leq = 0.05$
[d] $F = 3.07$; $df = 2,131$; $p \leq = 0.05$
[e] $F = 2.76$; $df = 3,59$; $p \leq = 0.05$

was rejected for the OVERALL, SCIENCE, and NONSCIENCE groups.

The Mutual Involvement of Science and Society dimension was the only dimension for which the two (2) orientation groups were statistically different. However, the Scheffe' contrast tests and the results of the regression analysis showed that it was more than just a science/nonscience orientation.

The regression analysis and the groups' factor score means indicated that the respondents in the university, pure and applied science groups and in the public nonscience group valued Mutual Involvement of Science and Society more than did the university nonscience respondents. When the group membership variables were removed, respondents in the OVERALL group who had higher levels of education and who generally had not taken high school physics did not value this factor highly. These characteristics were descriptive of university nonscience respondents whose group membership had originally been the OVERALL negative predictor.

For the SCIENCE group it was inferred from the results of the regression analysis that respondents who had not taken many earth science courses at the college level tended to value the dimension. An alternative inference was posited. Respondents in the SCIENCE group who had not gone to college tended to value the dimension. This inference seemed weaker than the first.

In the NONSCIENCE group it was inferred that the public nonscience respondents valued the dimension more than did the university nonscience respondents. This was supported by the groups' factor score means. From this perspective it was seen that the public nonscience respondents who had completed fewer years of school and whose mothers had completed fewer years of school tended to value the dimension. This was additionally supported in that those respondents who valued the dimension had taken high school courses in general science. Table 20 on page 137 confirmed that the public nonscience group had the largest mean value in terms of those respondents who had studied general science at the high school level.

Summary of the Test of Null Hypothesis 2

Table 81 presents a summary of the results of the regression analyses used to test Null Hypothesis 2.

Table 81

Summary of the Test of Null Hypothesis 2

Factor Name	OVERALL	SCIENCE	NONSCIENCE
I. Scientific Inquiry	not rejected	rejected	not rejected
II. Maintaining Current Awareness	rejected	rejected	rejected

Table 81 (continued)

Factor Name	OVERALL	SCIENCE	NONSCIENCE
III. Valuing Methods of Science	not rejected	rejected	not rejected
IV. Personal Application of Science	rejected	rejected	rejected
V. Distinguishing Between Science and Technology	not rejected	rejected	rejected
VI. Utilizing Factual Knowledge	not rejected	not rejected	rejected
VII. Mutual Involvement of Science and Society	rejected	rejected	rejected

General Summary of the Data Analyses

The following observations were made with regard to the sorting of the SLQ by all respondents. In general the respondents rated knowledge, comprehension, and application TMSL behaviors more highly than the other TMSL behaviors. They were more supportive of the Factual and Generalizations components of the Organization of Knowledge dimension; the Intellectual Processes dimension; and the Interaction of Science, Technology, and Society dimension. In general they placed less importance on the Discipline component of the Organization of Knowledge dimension; the Values and Ethics dimension; and the Human Endeavor dimension.

Overall Q-statements representing TMSL elements IA11, IA31, IA13, IIA41, IIB11, and VIIA21 received the highest relative ratings. Those which received the lowest relative ratings represented elements IB12, IA53, IIB21, IIIA51, VA41, VB11, VB21, and VIA61.

Comparing the names of the OVERALL seven (7) inferred dimensions to the summary above with regard to the sorting of the SLQ and the Theoretical Model of Scientific Literacy, the following observations were made. The Scientific Inquiry, Maintaining Current Awareness, Valuing Methods of Science, Personal Application of Science, and Utilizing Factual Knowledge inferred dimensions connoted the three (3) TMSL behaviors which were more highly valued--namely knowledge, comprehension, and application. Likewise, the Maintaining Current Awareness, Valuing Methods of Science, Distinguishing Between Science and Technology, Utilizing Factual Knowledge, and Mutual Involvement of Science and Society inferred dimensions connoted those TMSL dimensions which were more highly valued--namely Organization of Knowledge; Intellectual Processes; Interaction of Science and Technology; Interaction of Science and Society; and Interaction of Science, Technology, and Society.

Three (3) major generalizations were developed from the results of the data analysis.

> I. Membership in subgroups of the science oriented group or the nonscience oriented group was more related to respondents' perceptions of scientific literacy than was membership in either the science oriented group or the nonscience oriented group.

In the Descriptive Statistics for SLQ Data section it was found that the sign of the groups' means on a given Q-statement was the same on only twenty-four (24) of the forty-five (45) Q-statements. In addition the magnitudes of the groups' means were often quite different. In the Correlational Analysis of INFORMATION SHEET and SLQ Data section the summary of Table 40 (see pages 166-167) indicated that differences between the five (5) groups were more apparent than were commonalities. The test of Null Hypothesis 1 (b) was rejected on six (6) of the seven (7) OVERALL inferred dimensions. Twice the significant differences seemed to be between a pure science orientation and an applied science orientation. The regression analysis showed that the OVERALL group factor scores was predicted by a group membership variable on five (5) inferred dimensions. The same was true for the SCIENCE group factor scores on six (6) inferred dimensions and for the NONSCIENCE group factor scores on three (3) inferred dimensions.

II. Individual characteristics of respondents were related to respondents' perceptions of scientific literacy.

In the regression analysis age of the respondents (AGE) predicted the OVERALL group factor scores on one (1) inferred dimension and the NONSCIENCE group factor scores on two (2) inferred dimensions. The sex of the respondents (SEX) predicted the SCIENCE group factor scores on one (1) inferred dimension. The last year of school completed by the respondents (OWNSCHYR) predicted the OVERALL group factor scores on two (2) inferred dimensions, the SCIENCE group factor scores on three (3) inferred dimensions, and the NONSCIENCE group factor scores on two (2) inferred dimensions.

The last year of school completed by the mother of the respondents (MOTSCHYR) predicted the OVERALL group and the SCIENCE group factor scores on one (1) inferred dimension and the NONSCIENCE group factor scores on three (3) inferred dimensions. The last year of school completed by the fathers of the respondents (FATSCHYR) predicted the SCIENCE group and NONSCIENCE group factor scores on one (1) inferred dimension each.

III. The science courses which respondents had taken were related to the respondents' perceptions of scientific literacy.

The SCIENCE group factor scores was predicted by college level earth science (CLERTSCI) and by college level engineering courses (CLENGSCI) on one (1) inferred dimension each. The NONSCIENCE group factor scores was predicted by college level biological sciences (CLBIOSCI) on one (1) inferred dimension.

Senior high earth science (SHERTSCI) predicted the NONSCIENCE group factor scores on three (3) inferred dimensions. Senior high physics (SHPHYS) predicted the OVERALL group and the SCIENCE group factor scores on one (1) inferred dimension each. Senior high general science (SHGENSCI) and senior high chemistry (SHCHEM) predicted the NONSCIENCE group factor scores on one (1) inferred dimension each.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Overview of the Study

The study of science is an important component in the school curriculum. It serves at least three purposes:

1. to prepare future scholars for the different disciplines of science;
2. to help individuals attain the necessary backgrounds for entry into technological occupations and professions; and
3. to provide an aspect of the individual's general education which will promote effective citizenship.

This study focused on the last purpose which is often described by the umbrella term "scientific literacy." A review of the literature related to the teaching of science revealed a need to define scientific literacy.

A theoretical definition of scientific literacy was developed in order to:

1. have a valid, comprehensive, and functional definition at the present time.

2. facilitate communication in reference to the educational goal of developing scientifically literate citizens.
3. provide a basis for developing science education programs which will enable students to attain appropriate levels of scientific literacy.
4. provide a basis for developing an instrument to assess student achievement in the identified dimensions of scientific literacy.

This theoretical definition was called A Theoretical Model of Scientific Literacy (TMSL).

The TMSL provided the theoretical basis for the development of the forty-five (45) statements which eventually comprised the Scientific Literacy Q-set (SLQ). A questionnaire, the INFORMATION SHEET, was developed to seek information from persons concerning:

1. amount of previous education;
2. amount of previous science education;
3. amount of previous education of parents or guardian;
4. occupation;
5. age; and
6. sex.

After piloting and refining the two instruments, they were used to collect data to satisfy the problems posited for the study. These were:

1. To infer dimensions of scientific literacy with regard to a theoretical definition of scientific literacy for each of two groups of persons, science oriented and nonscience oriented, and for the two groups combined.

2. (a) To compare the strength of agreement of the science oriented group of persons and the nonscience oriented group of persons with the overall inferred dimensions of scientific literacy of the two orientation groups combined.

   (b) To compare the strength of agreement of the subgroups of the two orientation groups (university pure science, university applied science, university nonscience, public science, and public nonscience) with the overall inferred dimensions of scientific literacy of the two orientation groups combined.

3. To determine what relationships exist between the inferred dimensions of scientific literacy with regard to a theoretical definition of scientific literacy for the groups of science oriented and nonscience oriented persons and the variables: (a) amount of previous education; (b) amount of previous science education; (c) amount of previous education of parents or guardians; (d) age; and

(e) sex.

The sample of persons was drawn from assistant, associate, and full professors at The Ohio State University and from persons residing within Franklin County, Ohio. Science oriented persons were defined as persons whose occupations required training in a science or science-related field. Nonscience persons were defined as persons whose occupations required no such training. Thirty-seven (37) university pure science, thirty-eight (38) university applied science, and one hundred (100) public science persons constituted the science oriented group. Seventy-five (75) university nonscience and one hundred (100) public nonscience persons constituted the nonscience oriented group. The university persons were randomly selected from The Ohio State University <u>1975-1976 Faculty and Staff Directory</u>. The public persons were randomly selected from the 1975 <u>R. L. Polk Directory for the City of Columbus, Ohio</u>.

The SLQ, the INFORMATION SHEET, and ancillary materials were mailed to the 350 persons on April 4, 1976. On May 14, 1976 the data collection period was concluded; there were 185 respondents. It was determined that forty (40) persons had not received the materials; therefore, there was a 60% response. Statistical tests indicated that the responses from the five (5) groups were representative of each group as it had been sampled originally.

A separate sample of thirty-eight (38) persons was developed which was representative of the study sample. The SLQ was sorted by these persons in a test-retest situation with one (1) to eight (8) weeks between sorts. Person's r was used to calculate correlation coefficients; the average coefficient was 0.487.

The data were computer analyzed. Descriptive statistics, intercorrelations, and correlations of the data were generated. The responses to the SLQ were factor analyzed to satisfy Problem 1. Analysis of variance was used to test the null hypotheses posited to satisfy Problem 2 (a) and (b). Regression analysis was used to test the null hypothesis posited to satisfy Problem 3. Factor scores from the factor solution for all respondents grouped together were used as the dependent variables in the tests of the null hypotheses.

Discussion of the Results

The Inferred Dimensions of Scientific Literacy

The factor analysis with all respondents grouped together produced seven (7) factors. These were developed as inferred dimensions of scientific literacy and were named. These follow along with citings from Chapter II of persons who either posited or investigated similar dimensions.

I. Scientific Inquiry - The theme of this inferred dimension seemed to be that of producing new knowledge through a synthesizing type of activity. (NSTA, 1971; Klopfer, 1969; Pella, 1975; Robinson, 1968; Kimball, 1967-1968; Pella, O'Hearn, and Gale, 1966; Cossman, 1969; Gallagher, 1969; Korth, 1969)

II. Maintaining Current Awareness - The theme of this inferred dimension seemed to be the valuing of people keeping touch with and maintaining an understanding of new developments in science and technology. (Haney, 1966; NSTA, 1971; Koelsche and Morgan, 1964; Goldberg, 1966; Richardson and Showalter, 1967; Wood, Pella, and O'Hearn, 1967-1968; Pella, O'Hearn, and Gale, 1966; Pella, 1975; Gallagher, 1969)

III. Valuing Methods of Science - The theme of this inferred dimension seemed to be a personal valuing of methods which scientists use in their work. (Carelton, 1963; Haney, 1966; NSTA, 1971; Kimball, 1967-1968; Showalter, 1974; Wood, Pella, and O'Hearn, 1967-1968; Pella, 1967; Evans, 1970; Pella, 1975; Leake and Hinerman, 1973; Jones, 1969; Gallagher, 1969; Korth, 1969; Robinson, 1968)

IV. Personal Application of Science - The theme of this inferred dimension seemed to be application of scientific knowledge and methods of science in daily living. (Haney, 1966; NSTA, 1971; Showalter, 1974; Evans, 1970; Pella, 1975; Leake and Hinerman, 1973; Jones, 1969; Gallagher, 1969; Stauss, 1968; Helgeson, 1968; Carey, 1968)

V. Distinguishing Between Science and Technology - The theme of this inferred dimension seemed to be that of distinguishing between science and technology in terms of goals and results. (NSTA, 1971; Hurd, 1970; Showalter, 1974; Klopfer, 1969; Wood, Pella, and O'Hearn, 1967-1968; Pella, O'Hearn, and Gale, 1966; Pella, 1967; Fox, 1969; Korth, 1969)

VI. Utilizing Factual Knowledge - The theme of this inferred dimension seemed to be knowing and using for various purposes factual knowledge about nature. (Haney, 1966; NSTA, 1971; Koelsche and Morgan, 1964; Goldberg, 1966; Wood, Pella, and O'Hearn, 1967-1968; Pella, 1975; Leake and Hinerman, 1973; Gallagher, 1969; Showalter, 1974; Jones, 1969; Cossman, 1969; Korth, 1969; Voelker, 1968; Pella and Ziegler, 1967)

VII. Mutual Involvement of Science and Society - The theme of this inferred dimension seemed to be that of society examining its values as science provides mankind with more capabilities. Also, society should establish conditions within which science can thrive. (NSTA, 1971; Hurd, 1970; Daugs, 1970; Showalter, 1974; Klopfer, 1969; Wood, Pella, and O'Hearn, 1967-1968; Pella, O'Hearn, and Gale, 1966; Pella, 1967; Tyler, 1973; Cossman, 1969; Fox, 1969; Gallagher, 1969; Korth, 1969; Boles, 1968)

Inferred dimensions I, III, IV, V, and VI were identified in the factor solution using responses from the science oriented group. A noninterpretable factor and an interpretable factor were also produced. The latter was named "Science as a Human Endeavor." The theme of this inferred dimension seemed to be playing down the "omnipotency" of science, technology, and scientists. (NSTA, 1971; Robinson, 1968; Kimball, 1967-1968; Hurd, 1970; Pella, 1975; Cossman, 1969; Daugs, 1970; Gallagher, 1969; Ulhorn, 1970; Schmidt, 1970)

Inferred dimensions I, II, III, IV, V, and VI were identified in the factor solution using responses from the nonscience oriented group. Another factor was also produced. It was named "Using Natural Resources." The theme of this inferred dimension seemed to be one of the scientifically literate person using his knowledge to judge decisions made with regard to aspects of nature. (Klopfer, 1969; Pella, 1975)

With regard to the TMSL the respondents generally rated knowledge, comprehension, and application behaviors more highly than other TMSL behaviors. They were more supportive of the Factual and Generalizations components of the Organization of Knowledge dimension; the Intellectual Processes dimension; and the Interaction of Science, Technology, and Society dimension. In general they placed considerably less importance on the Discipline component of the Organization of Knowledge dimension; the Values and Ethics dimension; and the Human Endeavor dimension.

An examination of the Theoretical Model of Scientific Literacy major classes (behaviors) which were represented in the Q-statements common to each group for a particular inferred dimension (see Tables 41-47) revealed that knowledge, application, synthesis, and advocating were represented three (3) times each. Comprehension, evaluation, and valuing were represented two (2) times each; analysis was represented once, and behaving was not represented.

The inferred dimensions of scientific literacy Scientific Inquiry, Maintaining Current Awareness, Valuing Methods of Science, Distinguishing Between Science and Technology, and Mutual Involvement of Science and Society approximated several Theoretical Model of Scientific Literacy dimensions. They were Organization of Knowledge, Intellectual Processes, Process of Inquiry, Interaction of Science and Technology, and Interaction of Science and Society.

Generalizations from the Results of the Tests of Null Hypotheses 1 (a) and (b) and Null Hypothesis 2

Three (3) major generalizations seemed to be well supported by the results of the data analysis (see pages 232-234). By examining the results of all the data analyses in Chapter IV, additional generalizations were made. These were supportive of the three (3) major generalizations. The additional, supporting generalizations are presented in this section and are discussed in relationship to other research findings.

I. Membership in subgroups of the science oriented group or the nonscience oriented group was more related to respondents' perceptions of scientific literacy than was membership in either the science oriented group or the nonscience oriented group.

I.1 University pure science respondents seemed to value most high school graduates valuing methods of science and being able to distinguish between science and technology; respondents from more traditional physical science disciplines (physics, chemistry) seemed to value to a lesser extent the personal involvement of most high school graduates with science than did respondents from other science disciplines (earth sciences, life sciences).

I.2 University applied science respondents seemed to value most high school graduates knowing and using factual scientific knowledge more so than becoming personally involved with science.

I.3 Public science respondents seemed to value most high school graduates being personally involved with science in their daily lives and maintaining a current awareness of new developments in science and technology more so than being able to distinguish between science and technology.

I.4 University nonscience respondents seemed to place less value both on maintaining a current awareness of new developments in science and technology and mutual involvement of science and society than did other subgroups.

I.5 Public nonscience respondents seemed to value high school graduates maintaining a current awareness of new developments in science and technology and knowing and using factual scientific knowledge.

It appeared that the different emphases on what is important with regard to science for most high school graduates was at least partially related to the respondents' study of science. For example, the university pure science respondents had taken more pure science courses than had the university applied science respondents who had taken more pure science courses than had the public science respondents (see Tables 25, 26, and 27). The same descending relationship existed for the university nonscience and public nonscience respondents. Kimball (1967-1968) found that when this variable was controlled science teachers were no different in their understanding of the "nature of science" than were scientists. The same might be found with regard to persons' perceptions of scientific literacy.

II. Individual characteristics of respondents were related to respondents' perceptions of scientific literacy.

II.1 The age and sex of the respondents per se were weakly related to the respondents' perceptions of scientific literacy.

In terms of age Stauss (1968) did not find age differences within elementary school grade levels to be significantly related to pupils' abilities to achieve mastery of science concepts. Helgeson (1968) and Casey (1968) found maturity across elementary school grade levels to be positively correlated with pupils' abilities to master science concepts. In these studies it appeared that age was a factor in the mastery of science concepts only in the sense that it was a variable along with other variables which described maturity. Perhaps a similar effect was operating with regard to the age of the respondents and their perceptions of scientific literacy.

In most research studies significant differences are usually found when sex is used as an independent variable. Richardson and Showalter (1967) found in their study that boys had a greater interest in science than did girls and that they generally took more science courses in grades 9-12 than did girls. Comber and Keeves (1973) reported on an international effort to relate factors in the social, economic, and pedagogical domains characteristic of nineteen (19) countries to output factors of those countries' educational systems. Sex differences were reported in the great majority of the countries; boys generally had better cognitive test scores than did girls in the area of science. Richmond (1976) found that in England boys scored significantly higher than did girls on an environmental knowledge inventory. He reported that similar results have been found in the United States and in Australia.

Gallagher (1969) reported that in a study involving 12,800 senior high school seniors girls had more favorable attitudes toward scientists than did boys, but boys had the more favorable attitudes when the consideration was "themselves as scientists." Mead and Métraux (1957) conducted a study involving nearly three (3) times as many students drawn from private and public secondary schools in diverse settings. They found that boys and girls had positive images of scientists when they did not see themselves as being a scientist or being married to one. They also found considerable personal disinterestedness among both boys and girls in science as a school subject.

In the present study 85% of the respondents were male (see Table 7 on page 126). The 15% of the respondents who were female were predominantly in the university and public nonscience groups. The preponderance of males probably masked the relationship between sex and the respondents' perceptions of scientific literacy if in fact they existed. Future research should take this into account.

II.2 An inverse relationship existed between the respondents' general level of education as indicated by the last year of school completed and their valuing of the inferred dimensions of scientific literacy for most high school graduates.

Table 15 page 134 showed that 35% of the public science respondents had advanced degrees but that only one (1) public nonscience respondent did. Therefore, the possibility existed that the valuing of the inferred dimensions for most high school graduates might not have been a function of educational level of the respondents. It might have been a function being associated with the university or not being associated with the university. This inverse relationship should be investigated through additional research.

II.3 Public respondents, both science and nonscience, who had completed fewer years of school and whose parents had completed fewer years of school tended to value more practical aspects of the inferred dimensions of scientific literacy.

Hamilton (1965) and Comber and Keeves (1973) reported positive correlations between parents' educational levels and student achievement in science. Mead and Métraux (1957) related the negative image of science and scientists held by high school students to their parents' attitudes. These findings along with generalization II.3 highlighted the sociological influence on persons' abilities and attitudes.

It appeared that respondents in this present study were influenced to value continued learning beyond formal schooling when their mothers in particular had lower levels of education. This study was not designed to identify relationships between science achievement or attitudes toward science and scientists and perceptions of scientific literacy. Future research could be designed to identify any such relationships in addition to determining what role the educational level of parents plays.

The variables (educational level of persons, educational level of persons' mothers, and educational level of persons' fathers) could be used as independent variables in a blocked design. Three distinct levels of each variable (low, medium, and high) should be used. The effects of each of these three variables and any possible interactions could be investigated by performing analysis of variance. The dependent variables would be factor scores on each of the inferred dimensions developed with all persons grouped together.

III. The science courses which respondents had taken were related to the respondents' perceptions of scientific literacy.

III.1 Public nonscience respondents who had taken high school courses in general science, earth science chemistry, or physics valued most high school graduates keeping abreast of new developments in science and technology and applying science in their daily lives.

Gallagher (1969) reported that students who had studied chemistry and/or physics as opposed to those who had not were more favorable in their attitudes toward science and themselves as scientists. Korth (1969), reporting on the same study, stated that those students who had studied chemistry and/or physics had a better understanding of the nature of the scientific enterprise and a more realistic conception of the characteristics of scientists.

Jaffarian (1968) found (in a study designed to assess students' levels of achievement in scientific literacy as measured by knowledge of both subject matter and the nature of science) that chemistry and physics were being studied almost exclusively by college-bound students and that physics was elected primarily by those students who were planning to major in a science or science-related field.

In terms of unique programs or instructional techniques two studies were described in Chapter II. Richardson and Showalter (1967) studying the effects of a unified science curriculum found that students' interest in science increased after they graduated from high school. Boles (1968) reported that teaching biological concepts through instruction which placed a fair amount of emphasis on the relationships of science to society and the social implications of science produced higher gain scores than when taught in a more traditional way. Students claimed the materials were more interesting and less difficult than other science materials.

The favorable relationships between student attitudes and science courses studied as reported by Gallagher (1969) and Korth (1969) and the findings reported in this study were mutually supportive. Findings similar to Jaffarian's with regard to college-bound high school students studying chemistry and physics also seemed to exist in this study. Figure 9 on page 140 demonstrated that many public nonscience respondents had not studied chemistry or physics.

It appeared that earth science played a key role in generalization III.1 since it was more frequently a predictor of an inferred dimension than were other high school science courses. Given the remarks on page 137 and 140 with regard to the resurgence of earth science in the secondary school curriculum, it appeared that many of the public nonscience respondents were probably educated in schools which had earth science courses. This is additionally supported by Figure 9 on page 140 in that the percentage of public nonscience respondents who took earth science appreciably approached the percentages of science oriented respondents who took earth science. Jaffarians' findings with regard to physics and chemistry and noncollege-bound students suggested an examination of Table 15 on page 134. There it was found that approximately 60% of the public nonscience respondents did not hold more than a high school diploma. Therefore, it seemed reasonable that many of the public nonscience respondents had not been college-bound and had tended to elect science courses other than physics or chemistry.

An examination of the regression analysis showed that for the public nonscience respondents a high school earth science course was a positive predictor of an inferred dimension three (3) times; high school chemistry was a positive predictor one (1) time; high school physics was a positive predictor two (2) times; and high school general science was a positive predictor one (1) time. High school biology was not a predictor since so many of the respondents in each of the five (5) groups had taken such a course; that is, it could not explain enough variance to be included in any equation predicting any of the given factor variables.

An examination of Table 8 on page 128 showed that the great majority of the respondents were too old to have had many, if any, of the National Science Foundation (NSF) science courses. Even though high school science courses were positive predictors for five (5) of the seven (7) inferred dimensions for the public nonscience respondents it appeared reasonable to assume that these were not NSF science courses. This suggested the possibility of future research.

Research similar to this present study should be undertaken with two types of persons. One-half of the sample of persons should have studied science using the ABC curricular materials. The other half of the sample of persons should have studied science using materials that predated the ABC curricular materials. After inferred dimensions of scientific literacy and predictors of those dimensions have been established they could be compared to determine what influence the ABC curricula had on persons' beliefs about what is most important for most high school graduates with regard to science. If differences are found then the stage is set for longitudinal research. In this case the intent of the research would be to determine if the respective opinions of the two groups of persons remain stable into adulthood. If they do not, what changes occur and what causes the changes?

Conclusions

A theoretical definition of scientific literacy was developed and used to infer dimensions of scientific literacy for two groups of persons, science oriented and nonscience oriented, and for the two groups combined. With the two groups combined seven (7) inferred dimensions of scientific literacy were developed.

These inferred dimensions seemed to approximate the Theoretical Model of Scientific Literacy dimensions Organization of Knowledge (mainly the Factual component), Intellectual Processes, Process of Inquiry, Interaction of Science and Technology, and Interaction of Science and Society. The Generalizations and Discipline components of the

Organization of Knowledge dimension; the Values and Ethics dimension; the Human Endeavor dimension; and the Interaction of Science, Technology, and Society dimension from the Theoretical Model of Scientific Literacy were not distinctly represented in the inferred dimensions.

The inferred dimensions of scientific literacy seemed to emphasize the Theoretical Model of Scientific Literacy major classes (behaviors) knowledge, application, synthesis, and advocating. The others were represented to a lesser degree.

It was concluded that all TMSL major classes were viewed as a necessary part of scientific literacy, but knowledge, comprehension, and application were most valued. It was also concluded that the Factual component more so than the Generalizations and Discipline components of Organization of Knowledge, Intellectual Processes, Process of Inquiry, Interaction of Science and Technology, and Interaction of Science and Society TMSL dimensions were the basic theoretical dimensions underlying the inferred dimensions.

The implication for many of the definitions of scientific literacy credited to others persons in Chapter II is that they had many types of statements which simply did not show up in the inferred dimensions of scientific literacy. It would appear that many science educators have been operating from a perspective that is quite different from that of the "layman's" perspective in terms of what is most important with regard to science for most high school graduates.

The layman's perspective appears to be much more pragmatic than that of the science educator's. In terms of developing science curricula this has important ramifications. Since citizens ultimately decide on the education of the nation's youth, many of these ramifications might already be in evidence. Consider the 3R movement in many communities, the basic education laws passed by many state legislatures, and the repeated failure of many school district tax levies. However, there was good reason to believe the layman's perspective established in this study was primarily influenced by science courses which preceeded the ABC curricula courses. The younger generation of adults who have studied several of these newer science courses might present a different layman's perspective. In which case their concerns for education of the nation's youth might be different than those concerns which are presently being expressed.

When a comparison of the strength of agreement on the inferred dimensions of scientific literacy was made with regard to science orientation or nonscience orientation, it was concluded that few differences existed. However, when this same comparison was made for subgroups of the two orientation groups (university pure science, university applied science, university nonscience, public science, and public nonscience), it was concluded that differences existed. Generalizations I.1 through I.5 highlighted these differences.

Generalization I.1 suggested that even within a given subgroup there were differences in agreement on the inferred dimensions of scientific literacy. The same was probably true for the other subgroups. If persons who were represented by the respondents in these subgroups actually share in the desire to have a scientifically literate citizenry, then possibly the Theoretical Model of Scientific Literacy and the results of this study can facilitate the resolution of these differences.

Individual characteristics of respondents (age, sex, and the last year of school completed by the respondents, by their mothers, and by their fathers) were related to the respondents' perceptions of scientific literacy. Age and sex seemed to be weakly related primarily in combination with other variables. Firm conclusions could not be made with regard to sex since the great majority of the respondents were males.

A synthesis of the data analysis results indicated that an inverse relationship existed between respondents' last year of school completed and their valuing of the inferred dimensions. The majority of the public respondents, both science and nonscience, had completed considerably fewer years of school than had the university respondents, both science and nonscience. Not until research is conducted in which balanced stratification of general education is achieved will this inverse relationship be more fully understood.

A relationship between the number of years of school completed by the parents of the respondents and the respondents' perceptions of scientific literacy was most pronounced in the public science and public nonscience groups when the respondents themselves had completed fewer years of school. It appeared that these respondents whose parents had completed fewer years of school tended to value more practical aspects of the inferred dimensions of scientific literacy.

These findings if supported by additional research could set the stage for out-of-school education. It appeared that the less educated public nonscience respondents valued maintaining a current awareness of science and technology. If values are converted into action then persons represented by the respondents of this group might be a ready audience for mass media education. Likewise, evening courses offered through local school districts, junior colleges, or universities might enjoy healthy enrollments if they were pitched toward recent accomplishments in science and technology as opposed to basic science somewhat typical of the existing secondary curricula. The imaginative teacher could build in appropriate science concepts.

Prototypes of this approach already exist.

The data analysis indicated that high school science courses which public nonscience respondents had studied were positively related to their perceptions of scientific literacy. This finding implied that more science courses should be included in students' studies instead of less if the educational goal of a scientifically literate citizenry is truly valued. This would negate the current trend to require only one laboratory science course for graduation from high school.

The data analysis also indicated that the high school science courses which the respondents had studied were probably not the ABC science courses developed through the National Science Foundation. This suggested the need for additional research. It could compare inferred dimensions of scientific literacy and associated predictors for two types of persons. One group of persons should have studied science courses which predated the ABC science courses, and the other group should have studied the ABC science courses. If differences were found between these two groups of persons then longitudinal research should be undertaken to determine if either of these two groups of persons change in their opinions of what is most important with regard to science for most high school graduates.

Recommendations for Future Research

1. The college science portion of the INFORMATION SHEET should be modified to include four (4) columns. The first column should be headed 0 quarter hours and the second column should be headed 1-12 quarter hours.
2. The influence of reading level of the SLQ on the development of inferred dimensions should be investigated.
3. The influence of TMSL cell representation by the SLQ should be investigated by:
   (a) developing a Q-set using the forty-five (45) cells which were not used in this study; or
   (b) randomly selecting cells from the TMSL using different criteria than were used for this study and developing an appropriate Q-set.
4. The effect of changing the number of Q-statements in the SLQ should be investigated. A shortened SLQ would facilitate its use in classroom studies.
5. The relationship between the sex of the persons and the development of inferred dimensions should be investigated in a study which includes nearly equal numbers of males and females.
6. The relationships between the last year of school completed by persons and that of their parents and the development of inferred dimensions should be

investigated in a study which has a balanced stratification of general education design.

7. The relationship between achievement in science and the development of inferred dimensions should be investigated.

8. The relationship between attitudes toward science and the development of inferred dimensions should be investigated.

9. The relationship between having had ABC curricular science courses or having had traditional science courses and the development of inferred dimensions should be investigated.

10. The size of the five subgroups used in this study should be enlarged such that differences within them can be investigated in relationship to the development of inferred dimensions.

11. Studies similar to this one should be undertaken using each of these groups separately and in various combinations:

    (a) university science educators;

    (b) senior high school science teachers;

    (c) junior high school science teachers; and

    (d) elementary school teachers.

12. Research should be undertaken to investigate the use of the Theoretical Model of Scientific Literacy (TMSL) as a basis for instrument development to

assess levels of achievement of the dimensions of scientific literacy.

13. Since the R. L. Polk Company, or other companies, compile directories for other metropolitan areas, this study should be replicated in other areas of the United States.

14. This study should be replicated using the same design and procedures to determine the validity of the present findings.

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Appendix A

A Theoretical Model of Scientific Literacy

Dimensions of Scientific Literacy			
	A.1 Knowledge Knowledge is demonstrated by scientifically literate persons through those behaviors which emphasize remembering, either by recognition or recall. Knowledge in the field of science can be in the form of: (1) specifics; (2) ways and means of dealing with specifics; and (3) generalizations and abstractions.	**A.2 Comprehension** Comprehension is demonstrated by scientifically literate persons if, when confronted with a communication, they know what is being communicated and are capable of making some use of that which is contained within the communication. "Communication" is defined very generally; it can be in oral, written, or concrete form.	**A.3 A** Application i scientificall if, when face etic situatio appropriate a a solution. external prom abstractions apply them.
1.0 Factual Component	I.A.1.1 Scientifically literate persons should know several facts about the three, separate, and identifiable entities in the universe--matter, energy, and life.	I.A.2.1 Scientifically literate persons should understand several relationships between the fundamental entities--matter, energy, and life.	I.A.3.1 Scie persons shoul understanding about nature or to control
I. The Organization of Knowledge Dimension 2.0 Generalizations Component	I.A.1.2 Scientifically literate persons should know several major generalizations in some of the principal fields of science.	I.A.2.2.1 Scientifically literate persons should understand several major generalizations in some of the principal fields of science. I.A.2.2.2 Scientifically literate persons should understand that the product of science is a body of knowledge about the universe, ranging from individual observations to major generalizations. I.A.2.2.3 Scientifically literate persons should understand that as facts are increased through research scientific generalizations often become fewer, clearer, and easier to understand.	I.A.3.2 Scie persons shoul eral appropri elizations wh the environme
3.0 Discipline Component	I.A.1.3 Scientifically literate persons should know something about developments in some of the principal fields of science.	I.A.2.3 Scientifically literate persons should understand several news media reports of new discoveries and advances in some of the principal fields of science.	I.A.3.3 Sci persons shou ports of new of the princ while intera environment.
II. The Intellectual Processes Dimension	II.A.1.1 Scientifically literate persons should know some characteristics of several processes of science.	II.A.2.1 Scientifically literate persons should understand how several processes of science are applied.	II.A.3.1 Sc persons shou eral process problems.

Taxonomies of Educational Objectives

A. Major Classes of the Cognitive Domain

...nsion ...monstrated by ...rate persons ... with a communi- ...hat is being ...s capable of ...that which is ...e communication. ...defined very ...e in oral, ...e form.	**A.3 Application** Application is demonstrated by scientifically literate persons if, when faced with a problem-atic situation, they can apply appropriate abstractions to seek a solution. There must be no external prompting as to which abstractions to apply or how to apply them.	**A.4 Analysis** Analysis is demonstrated by scientifically literate persons if, when presented with "material," they can break it into constituent parts and can detect the relation-ships of the parts or the way in which the parts are organized.	**A.5 Synthesis** Synthesis is demonstrated by scientifically literate persons if, when presented with elements common to some phenomenon, they can combine them in such a way as to constitute a pattern or struc-ture not clearly there before. This could be a creative behavior; however, it does not have to be since the behavior can be performed within a given framework.
...ally literate ...rstand several ...en the funda- ...tter, energy,	<u>I.A.3.1</u> Scientifically literate <u>persons</u> should be able to use their understanding of factual knowledge about nature to explain, to predict, or to control natural phenomena.	<u>I.A.4.1</u> Scientifically literate <u>persons</u> should be able to discern how factual knowledge developed by the scientific community is probable rather than absolute.	<u>I.A.5.1</u> Scientifically literate <u>persons</u> should be able to combine several facts about matter, energy, and life in order to develop generalizations.
...ically literate ...rstand several ...na in some of ...ls of science. ...ically literate ...rstand that the ... is a body of ... universe, rang- ...l observations to ...ons. ...fically literate ...rstand that as ...d through research ...izations often be- ...r, and easier to	<u>I.A.3.2</u> Scientifically literate <u>persons</u> should be able to use sev-eral appropriate scientific gener-alizations while interacting with the environment.	I.A.4.2.1 Scientifically literate persons should be able to discern how scientific generalizations can have static and dynamic qualities. I.A.4.2.2 Scientifically literate persons should be able to discern some differences between theoretical and empirical generalizations.	<u>I.A.5.2</u> Scientifically literate <u>persons</u> should be able to combine several empirical and theoretical generalizations to gain a more complete phenomenological perspec-tive of nature.
...cally literate ...erstand several ... of new discover- ...n some of the ...f science.	I.A.3.3 Scientifically literate persons should be able to use re-ports of new developments in some of the principal fields of science while interacting with the environment.	I.A.4.3 Scientifically literate persons should be able to discern which fields of science to associate with several of the new developments reported by the news media.	<u>I.A.5.3</u> Scientifically literate <u>persons</u> should be able to combine some new developments in a few of the principal fields of science to ascertain potential ramifications.
...ically literate ...erstand how sev- ... science are	II.A.3.1 Scientifically literate persons should be able to use sev-eral processes of science to solve problems.	<u>II.A.4.1</u> Scientifically literate <u>persons</u> should be able to discern when and how to apply several pro-cesses of science for the solution of a particular problem.	II.A.5.1 Scientifically literate persons should be able to combine several processes of science to translate their experiences with the environment into knowledge.

		B. Major Classes of the Affective Domain		
ns nts ey y as ruc- vior; be formed	A.6 Evaluation Evaluation is demonstrated by scientifically literate persons if, when presented with a decision-making situation, they can judge the value of ideas, works, solutions, methods, materials, or the like. The judgments may be either quantitative or qualitative and may be made with criteria which are developed internally or externally to the persons.	B.1 Valuing Valuing is demonstrated by scientifically literate persons in their willingness to attach worth to some thing, phenomenon, or behavior. The act of valuing something in particular is for the most part a social or educational product which has been slowly internalized by the persons.	B.2 Behaving Behaving is demonstrated by scientifically literate persons when they act on or use that which is valued by them. Their actions may extend, may refine, or may deepen their involvement with that which is valued.	B.3 Advocating Advocating is demonstrated by scientifically literate persons if they try to convince others of the worth of a particular course of action. This advocacy may be with respect to that which is valued or with respect to a ramification of that which is valued.
ate bine ergy,	I.A.6.1 Scientifically literate persons should be able to judge the value of the utilization and control of some aspects of nature using their understanding of factual knowledge.	I.B.1.1 Scientifically literate persons should value having an adequate factual knowledge base with regard to matter, energy, and life.	I.B.2.1 Scientifically literate persons should contribute financially to scientific work which attempts to enhance the factual knowledge base about matter, energy, and life.	I.B.3.1 Scientifically literate persons should support Congressional bills which provide expenditures for basic scientific research.
ate bine ical spec-	I.A.6.2 Scientifically literate persons should be able to judge the value of the utilization and control of some aspects of nature using the their understanding of scientific generalizations.	I.B.1.2 Scientifically literate persons should value generalizations as forms of scientific knowledge which are more powerful than the discrete observations from which they were developed.	I.B.2.2 Scientifically literate persons should define some necessary directions that science should pursue based upon the limitations of empirical and theoretical generalizations.	I.B.3.2 Scientifically literate persons should support the usefulness of scientific generalizations for use in identifying promising means to extend the understanding of natural phenomena.
e ine nce tions.	I.A.6.3 Scientifically literate persons should be able to judge the value of impacts upon their lives by some new developments in a few of the principal fields of science.	I.B.1.3 Scientifically literate persons should value allotting time and expending energy to keep their knowledge of science current.	I.B.2.3.1 Scientifically literate persons should allot time and expend energy to keep in touch with a broad variety of scientific developments. I.B.2.3.2 Scientifically literate persons should allot time and expend energy to keep up with at least one area of science which is of particular interest to them.	I.B.3.3 Scientifically literate persons should support means to narrow the gap between frontier research and the general public's understanding of science.
te ne h	II.A.6.1 Scientifically literate persons should be able to judge the value of the utilization and control of some aspects of nature using several processes of science.	II.B.1.1 Scientifically literate persons should value processes of science as modes of inquiry.	II.B.2.1 Scientifically literate persons should display in everyday decision-making a belief in several processes of science.	II.B.3.1 Scientifically literate persons should support knowledge that has been formulated and tested through the use of science processes.

III. The Values and Ethics Dimension	III.A.1.1 Scientifically literate persons should know some characteristics of several values and ethics which underlie science.	III.A.2.1 Scientifically literate persons should understand how several values and ethics underlie science.	III.A.3.1 Scientifically persons should be able to oral values and ethics w lie science while interac the environment.
IV. The Process of Inquiry Dimension	IV.A.1.1 Scientifically literate persons should know some ways in which the generation of new scientific generalizations depends upon the joint use of processes of science and established scientific generalizatons.	IV.A.2.1.1 Scientifically literate persons should understand that the scientific effort stems from a compelling desire of mankind to understand the environment. IV.A.2.1.2 Scientifically literate persons should understand that a basic characteristic of the scientific effort is a faith in the susceptibility of nature to human ordering and understanding. IV.A.2.1.3 Scientifically literate persons should understand that in the search for knowledge the scientific effort is a dynamic, process-oriented activity. IV.A.2.1.4 Scientifically literate persons should understand that in the scientific effort an attempt is constantly made to simplify and to increase the comprehensiveness of scientific generalizations.	IV.A.3.1 Scientifically persons should be able t ly some processes of sci their understanding of s generalizations while in with the environment.
V. The Human Endeavor Dimension	V.A.1.1 Scientifically literate persons should know some characteristics of science as it exists as a human enterprise.	V.A.2.1 Scientifically literate persons should understand some aspects of science as a man-made structure of human origin.	V.A.3.1 Scientifically persons should be able biographical accounts c tist's life to develop tive of his work.
VI. The Interaction of Science and Technology Dimension	VI.A.1.1.1 Scientifically literate persons should know that the primary goal of science is to understand the universe and that the primary goal of technology is to develop utilitarian products. VI.A.1.1.2 Scientifically literate persons should know something about the interrelationships between science and technology.	VI.A.2.1 Scientifically literate persons should understand some aspects of interrelationships between science and technology.	VI.A.3.1 Scientificall persons should be able understandings of scie ledge to operate usefu
VII. The Interaction of Science and Society Dimension	VII.A.1.1 Scientifically literate persons should know some interrelationships between science and society.	VII.A.2.1 Scientifically literate persons should understand some aspects of interrelationships between science and society.	VII.A.3.1 Scientifica persons should be able social, political, and spectives to understan efforts during a given
VIII. The Interaction of Science, Technology, and Society Dimension	VIII.A.1.1 Scientifically literate persons should know something about interrelationships between science, technology, and society.	VIII.A.2.1 Scientifically literate persons should understand some aspects of interrelationships between science, technology, and society.	VIII.A.3.1 Scientific persons should be able recent scientific and developments to sugges effects on vocational al opportunities withi

ate cv-	III.A.3.1 Scientifically literate persons should be able to use several values and ethics which underlie science while interacting with the environment.	III.A.4.1 Scientifically literate persons should be able to discern how the universal characteristic of science is not affected by particular religions, political beliefs, or geographic locales.	III.A.5.1 Scientifically literate persons should be able to combine several values and ethics which underlie science with values and ethics from other sources.
erate the com- nder- erate a isn- man erate in cien- cess- erate in pt is d to of	IV.A.3.1 Scientifically literate persons should be able to use jointly some processes of science with their understanding of scientific generalizations while interacting with the environment.	IV.A.4.1 Scientifically literate persons should be able to discern some of the interdependencies between processes of science and derived scientific generalizations.	IV.A.5.1 Scientifically literate persons should be able to combine some processes of science with their understanding of scientific generalizations to develop generalizations about nature.
ate as-	V.A.3.1 Scientifically literate persons should be able to use some biographical accounts of a scientist's life to develop a perspective of his work.	V.A.4.1 Scientifically literate persons should be able to discern something of what causes scientists to take diverse positions on particular problems which are being studied.	V.A.5.1 Scientifically literate persons should be able to combine some aspects of scientists' work with some given perspectives of the time periods in which they lived to better understand their work.
rate a as- etween	VI.A.3.1 Scientifically literate persons should be able to use their understandings of scientific knowledge to operate useful devices.	VI.A.4.1 Scientifically literate persons should be able to discern products of science from products of technology.	VI.A.5.1 Scientifically literate persons should be able to combine some advancements in science with some prior advancements in technology, and vice versa, to see how each depends upon the other.
erate a as- etween	VII.A.3.1 Scientifically literate persons should be able to use some social, political, and economic perspectives to understand scientific efforts during a given time period.	VII.A.4.1 Scientifically literate persons should be able to discern some beneficial or harmful impacts that science and society have upon each other.	VII.A.5.1 Scientifically literate persons should be able to combine several aspects of society with some scientific developments within that society to identify a few interrelationships between science and society.
terate e as- etween ety.	VIII.A.3.1 Scientifically literate persons should be able to use some recent scientific and technological developments to suggest potential effects on vocational and avocational opportunities within a society.	VIII.A.4.1 Scientifically literate persons should be able to discern how some innovations in science and technology can rearrange political relations through changes in the power and economic balances of the world.	VIII.A.5.1 Scientifically literate persons should be able to combine some roles played by science, technology, and society to solve problems faced by mankind to identify some interrelationships between science, technology, and society.

rate ime h nd	III.A.6.1 Scientifically literate persons should be able to judge the value of the utilization and control of some aspects of nature using several values and ethics which underlie science.	III.B.1.1 Scientifically literate persons should value for their own lives some of the values and ethics which underlie science.	III.B.2.1.1 Scientifically literate persons should accept as evidence only those observations which have been made with the greatest of care possible and reported with the greatest accuracy feasible. III.B.2.1.2 Scientifically literate persons should reject myths, superstitions, and personal opinions in favor of scientific evidence. III.B.2.1.3 Scientifically literate persons should be open-minded, critical, and skeptical to the degree that they question the validity of even their own conclusions. III.B.2.1.4 Scientifically literate persons should weigh evidence in order to accept or reject conclusions in terms of the data that support them.	III.B.3.1 Scientifically literate persons should support a philosophy which demands that observations and conclusions must be subject to objective criticism, analysis, and review by the entire populace.
ate ime ific -	IV.A.6.1 Scientifically literate persons should be able to judge the degree of tentativeness of some scientific generalizations knowing that science is not a static accumulation of information.	IV.B.1.1 Scientifically literate persons should value the process of generating new scientific generalizations via an interplay between processes of science and established scientific generalizations.	IV.B.2.1 Scientifically literate persons should display in their everyday decision-making a belief in the interrelated use of processes of science and established scientific generalizations.	IV.B.3.1 Scientifically literate persons should support science as a means by which knowledge can be generated and mankind's understanding of nature can be enhanced.
e ne k r	V.A.6.1 Scientifically literate persons should be able to judge the morality of scientists' work.	V.B.1.1 Scientifically literate persons should value a scientist's work even though it is later found not to fit within the accepted network of ideas used to explain nature.	V.B.2.1 Scientifically literate persons should accept scientists as people, who like other people are distributed over the whole spectrum of human folly and wisdom.	V.B.3.1 Scientifically literate persons should support efforts to hold scientists responsible for making their work public.
ts ine th nol- each	VI.A.6.1 Scientifically literate persons should be able to judge the worth of some products of science and some products of technology using appropriate criteria.	VI.B.1.1 Scientifically literate persons should value advancements in science and technology keeping pace with one another.	VI.B.2.1 Scientifically literate persons should display in their political decision-making a belief in equitable financing of both the scientific and technological efforts.	VI.B.3.1 Scientifically literate persons should support the need for an adequate supply of scientific and technological manpower.
te e. his n-	VII.A.6.1 Scientifically literate persons should be able to judge the wisdom of governmental decisions using their understanding of interrelationships between science and society.	VII.B.1.1 Scientifically literate persons should value viewing the scientific enterprise within the broad perspectives of society.	VII.B.2.1 Scientifically literate persons should develop intelligent opinions concerning the social and moral responsibilities of science.	VII.B.3.1 Scientifically literate persons should support societal conditions within which science can thrive.
ate e ch- b- y	VIII.A.6.1 Scientifically literate persons should be able to judge some potentials and limitations of science and technology for improving human welfare.	VIII.B.1.1 Scientifically literate persons should value societal innovations keeping pace with scientific and technological innovations in order to improve the condition of mankind.	VIII.B.2.1 Scientifically literate persons should guard against science and technology being seen as a cure-all for all of mankind's problems.	VIII.B.3.1 Scientifically literate persons should support the need to change societal values as mankind's ability to regulate the environment increases.

Appendix B

Sorting Instructions for the

Scientific Literacy Q-set

INSTRUCTIONS FOR USING THE
SMALL CARDS AND SMALL ENVELOPES

To use these cards and envelopes, you will need a flat area like a desk or a table. First, spread the envelopes across the flat area with the envelope marked +4 on the far left and with the envelope marked -4 on the far right. The other envelopes will be spread in the middle. When you are done, your envelopes should be placed as pictured here:

Flat Area

+4	+3	+2	+1	0	-1	-2	-3	-4
MOST IMPORTANT								LEAST IMPORTANT

On each card is a statement. As you follow the instructions, you will be sorting the cards in terms of how important you think each is. The thought to keep in your mind at all times is: "What should be expected of most high school graduates with regard to science?"

Here are some definitions of words used on the cards:
MOST HIGH SCHOOL GRADUATES: nearly all young people who have just graduated from a high school
MATTER: that of which all things are made
LIFE: that which makes an animal or a plant different from matter
ENERGY: that which through some means can affect matter or life
FACTS: the statements that something was done or that something exists
MAJOR IDEAS: that which is the result of combining facts in order to explain something
SCIENCE: the effort to understand matter, energy, and life
FIELDS OF SCIENCE: examples of these are physics, chemistry, biology, and geology
SCIENTIST: a person trained to understand matter, energy, and life
TECHNOLOGY: the use of what is understood about matter, energy, and life to make things
SOCIETY: a group of people who work together to exist
MANKIND: all people in the world
ENVIRONMENT: that which is around or which has an effect on something

DO NOT READ ALL OF THE INSTRUCTIONS NOW. PLEASE FOLLOW THEM ONE STEP AT A TIME.

STEP 1. Read quickly through all of the cards to get a feeling for what they say. You do not have to keep the cards in order.

STEP 2. Sort the cards into three (3) nearly equal piles so that:
(a) those cards on your left are the cards which you believe are MOST IMPORTANT;
(b) those cards on your right are the cards which you believe are LEAST IMPORTANT; and
(c) those cards in the middle are the cards which you do not feel so strongly about.
Dividing the cards this way means only that you like some cards more than you do others.

STEP 3. Spread the cards in the left-hand pile so that you can read them easily. Choose five (5) cards which you believe are the MOST IMPORTANT of all and place them on the +4 envelope.

STEP 4. Spread the cards in the right-hand pile so that you can read them easily. Choose five (5) cards which you believe are the LEAST IMPORTANT of all and place them on the -4 envelope.

STEP 5. Go to the left-hand pile and choose five (5) cards which are the next MOST IMPORTANT. Place them on the +3 envelope.

STEP 6. Go to the right-hand pile and choose five (5) cards which are the next LEAST IMPORTANT. Place them on the -3 envelope.

Note: IF AT ANY TIME YOU CHANGE YOUR MIND ABOUT A CARD YOU HAVE PLACED IN A PILE, FEEL FREE TO CHANGE IT TO ANOTHER PILE.

STEP 7. Go to the left-hand pile and choose five (5) cards to place on the +2 envelope. You may have to take cards from the middle pile in order to have enough.

STEP 8. Go to the right-hand pile and choose five (5) cards to place on the -2 envelope. You may have to take cards from the middle pile in order to have enough.

STEP 9. Go to the left-hand pile and choose five (5) cards to place on the +1 envelope. Again it is alright to take cards from the middle pile.

STEP 10. Go to the right-hand pile and choose five (5) cards to place on the -1 envelope. Again it is alright to take cards from the middle pile.

STEP 11. You should now have five (5) cards left over. Place these on the envelope marked 0.

STEP 12. Read back over each pile, starting on the left-hand side, to make sure that you have placed the cards where you really wanted them. If you change any of the cards around, please make sure there are five (5) cards in each pile when you finish.

STEP 13. Please place the cards in their envelopes; for example, the five (5) MOST IMPORTANT cards go in the +4 envelope. Please fold the flaps in to hold the cards in place.

STEP 14. Please place the small envelopes and the INFORMATION SHEET into the stamped, return envelope and mail it immediately.

THANK YOU AGAIN FOR YOUR COOPERATION

Appendix C

The Scientific Literacy Q-set (SLQ)

MOST HIGH SCHOOL GRADUATES SHOULD... rate highly a scientist's efforts even if his ideas do not fit with those of others. V.B.1.1 — 1	MOST HIGH SCHOOL GRADUATES SHOULD... rate highly for their own use some values which guide scientists in their work. III.B.1. — 6	MOST HIGH SCHOOL GRADUATES SHOULD... be able to judge the worth of governmental decisions using their understanding of how science and society affect each other. VII.A.6.1 — 11
MOST HIGH SCHOOL GRADUATES SHOULD... rate highly methods of science as ways to find out things. II.B.1.1 — 2	MOST HIGH SCHOOL GRADUATES SHOULD... be able to detect how to apply some methods of science in their daily lives. II.A.4.1 — 7	MOST HIGH SCHOOL GRADUATES SHOULD... know about several values which guide scientists in their work. III.A.1.1 — 12
MOST HIGH SCHOOL GRADUATES SHOULD... understand that scientists try to make major ideas about matter, energy, and life thorough. IV.A.2.1.4 — 3	MOST HIGH SCHOOL GRADUATES SHOULD... show in daily decisions that they believe in several methods of science. II.B.2.1 — 8	MOST HIGH SCHOOL GRADUATES SHOULD... rate major ideas more highly than facts as means to explain matter, energy, and life. I.B.1.2 — 13
MOST HIGH SCHOOL GRADUATES SHOULD... understand something of the effects science and society have on each other. VII.A.2.1 — 4	MOST HIGH SCHOOL GRADUATES SHOULD... be able to use some new results from science and technology to think of possible changes in their lives. VIII.A.3.1 — 9	MOST HIGH SCHOOL GRADUATES SHOULD... show that they believe science and technology cannot cure all of mankind's problems. VIII.B.2.1 — 14
MOST HIGH SCHOOL GRADUATES SHOULD... support societal conditions which help science. VII.B.3.1 — 5	MOST HIGH SCHOOL GRADUATES SHOULD... be able to judge the worth of some uses of matter, energy, and life using several values which guide scientists in their work. III.A.6.1 — 10	MOST HIGH SCHOOL GRADUATES SHOULD... support knowledge which is gained by use of methods of science. II.B.3.1 — 15

MOST HIGH SCHOOL GRADUATES SHOULD... rate highly the need for society to keep up with science and technology. VIII.B.1.1 16	MOST HIGH SCHOOL GRADUATES SHOULD... be able to judge the worth of some uses of matter, energy, and life using facts. I.A.6.1 21	MOST HIGH SCHOOL GRADUATES SHOULD... be able to judge the worth of some results from science and from technology with different guidelines. VI.A.6.1 26
MOST HIGH SCHOOL GRADUATES SHOULD... show that they have opinions about what should be done through science. VII.B.2.1 17	MOST HIGH SCHOOL GRADUATES SHOULD... know something about how the goals of science and technology differ. VI.A.1.1.1 22	MOST HIGH SCHOOL GRADUATES SHOULD... be able to combine some major ideas to better understand matter, energy, and life. I.A.5.2 27
MOST HIGH SCHOOL GRADUATES SHOULD... be able to use their science knowledge to operate useful devices. VI.A.3.1 18	MOST HIGH SCHOOL GRADUATES SHOULD... be able to judge the worth of some uses of matter, energy, and life using major ideas. I.A.6.2 23	MOST HIGH SCHOOL GRADUATES SHOULD... know several facts about matter, energy, and life. I.A.1.1 28
MOST HIGH SCHOOL GRADUATES SHOULD... be able to use some major ideas about matter, energy, and life in their daily lives. I.A.3.2 19	MOST HIGH SCHOOL GRADUATES SHOULD... be able to combine several values which guide scientists in their work with values from other sources. III.A.5.1 24	MOST HIGH SCHOOL GRADUATES SHOULD... show desire to keep in touch with new gains in several fields of science. I.B.2.3.1 29
MOST HIGH SCHOOL GRADUATES SHOULD... be able to detect some ways that scientists have used major ideas and methods of science together. IV.A.4.1 20	MOST HIGH SCHOOL GRADUATES SHOULD... be able to combine some new findings in some fields of science to think of possible offshoots. I.A.5.3 25	MOST HIGH SCHOOL GRADUATES SHOULD... be able to detect some reasons why scientists sometimes disagree. V.A.4.1 30

MOST HIGH SCHOOL GRADUATES SHOULD... be able to detect some of the differences in the results of science and technology. VI.A.4.1 31	MOST HIGH SCHOOL GRADUATES SHOULD... support changing what society rates highly as mankind increases control of the environment. VIII.B.3.1 36	MOST HIGH SCHOOL GRADUATES SHOULD... know something of what has happened in some fields of science. I.A 1.3 41
MOST HIGH SCHOOL GRADUATES SHOULD... understand how several values guide scientists in their work. III.A.2.1 32	MOST HIGH SCHOOL GRADUATES SHOULD... know something about using major ideas and methods of science together to gain new ideas. IV.A.1.1 37	MOST HIGH SCHOOL GRADUATES SHOULD... be able to detect conditions which can change what is believed to be a fact. I.A.4.1 42
MOST HIGH SCHOOL GRADUATES SHOULD... support the idea that scientists should let their work be checked by others. V.B.3.1 33	MOST HIGH SCHOOL GRADUATES SHOULD... be able to use major ideas and methods of science together in their daily lives. IV.A.3.1 38	MOST HIGH SCHOOL GRADUATES SHOULD... understand something of the effects science and technology have on each other. VI.A 2.1 43
MOST HIGH SCHOOL GRADUATES SHOULD... support ways to help people understand new gains in some fields of science. I.B.3.3 34	MOST HIGH SCHOOL GRADUATES SHOULD... be able to combine facts to better understand matter, energy, and life. I.A.5.1 39	MOST HIGH SCHOOL GRADUATES SHOULD... understand that new facts often simplify major ideas about matter, energy, and life. I.A.2.2.3 44
MOST HIGH SCHOOL GRADUATES SHOULD... show that they accept scientists as people. V.B.2.1 35	MOST HIGH SCHOOL GRADUATES SHOULD... be able to combine some major ideas and methods of science to gain new ideas. IV.A.5.1 40	MOST HIGH SCHOOL GRADUATES SHOULD... be able to use several facts about matter, energy, and life in their daily lives. I.A.3.1 45

Appendix D

The INFORMATION SHEET

INFORMATION SHEET

A. Please check: (1) ____ female; (2) ____ male

B. Circle the number in front of the choice which includes your age.

(1) 18 - 25 years (3) 36 - 44 years (5) 55 - 65 years
(2) 26 - 35 years (4) 45 - 54 years (6) 66 years or older

C. Are you retired? (1) ____ yes; (2) ____ no

D. Please describe your occupation, or what it was when last employed. Please be complete so that we can determine how much it involves the use of science or technical skills. ____________

____

____

E. What is the name of the last school which you attended? ____________

F. Please circle the last year of school which you completed.

Elementary School:	1	2	3	4	5	6	7	8
Secondary School:	9	10	11	12				
College:	13	14	15	16				
Graduate or Professional School	17	18	19	20	21	22	23	24

G. What was the last year of school which your mother/guardian completed? ____

H. What was the last year of school which your father/guardian completed? ____

I. Please circle the number in front of the highest diploma or degree which you have:

(1) Junior High (2) High School (3) Two Year College (4) Bachelor's (5) Master's
(6) Doctorate (7) Other, please describe: ____________

J. Please check below all of the science courses which you completed in school and indicate the number of quarter hours of science courses which you completed at the college level. Multiply semester hours by 1.5 to get quarter hours.

Junior High School

____ Do not know
____ 7th grade science
____ 8th grade science

9-12th Grade

____ Do not know
____ general science
____ earth science
____ biology
____ chemistry
____ physics
____ other, please describe:

____

College: major ____________; minor ____________

Graduate or Professional School:

major ____________; minor ____________

	Number of Quarter Hours		
	0 - 12	13 - 36	37 or more
Biological sciences	____	____	____
Physical sciences	____	____	____
Earth sciences	____	____	____
Engineering courses	____	____	____
Other	____	____	____
Please describe:			

____

THIS INFORMATION SHEET SHOULD BE PLACED IN THE STAMPED, RETURN ENVELOPE. AFTER YOU HAVE DONE THAT, PLEASE GO TO THE INSTRUCTIONS FOR USING THE SMALL CARDS AND THE SMALL ENVELOPES.

Appendix E

Waiver of the Human Subjects
Consent Form

Protocol No. 76B 061

THE OHIO STATE UNIVERSITY

RESEARCH INVOLVING HUMAN SUBJECTS

PROPOSED USE OF HUMAN SUBJECTS: ACTION OF THE REVIEW COMMITTEE

The Behavioral Sciences Review Committee has taken the following action:

X 1. Approve

2. Approve with Conditions

3. Disapprove

with regard to the employment of human subjects in the proposed research entitled: The Development of a Model to Determine Perceptions of Scientific Literacy.

Arthur L. White/Lawrence L. Gabel is listed as the principal investigator.

The conditions, if any, are attached and are signed by the committee chairperson and by the principal investigator. If disapproved, the reasons are attached and are signed by the committee chairperson and by the medical or other consultant, if any.

Signed ____________________ (medical or other consultant)

Signed [signature] (chairperson)

Date March 4, 1976

PA-025

Research Summary
College of Education
Human Subject Review Committee

Title of Proposed Activity: The Development of a Model to Determine Perceptions of Scientific Literacy

Principal Investigator: Lawrence L. Gabel

Faculty: Faculty of Science and Mathematics Education

Date Submitted: February 23, 1976

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1. Brief statement of problem and primary objectives

The needs for this study have been inferred to be:

1. There is a need to define the construct "scientific literacy" in order to:
   a. have a valid, comprehensive, and functional definition at the present time.
   b. facilitate communication in reference to an educational goal of developing scientifically literate citizens.
   c. provide a basis for developing science education programs which will enable students to attain appropriate levels of scientific literacy.
   d. provide a basis for developing an instrument to assess student achievement in the identified dimensions of scientific literacy.
2. There is a need to seek extensive input from individuals with varied educational, experiential, and environmental backgrounds in the process of defining scientific literacy.
3. There is a need to find correlates of the value positions with regard to scientific literacy for those groups of individuals which provide value positions.

Persons in two occupational groups will be identified, science-oriented and nonscience-oriented, and a sample of persons will be randomly selected from each group. To these persons a questionnaire (pertinent to Need Statement 2) and a Q-set of statements pertaining to scientific literacy (pertinent to Need Statement 3) will be administered. Each person's data, generated via these two instruments, will be used as a part of group data, for example, as a part of the science-oriented group. The research is short term and is designed to clarify the construct "scientific literacy."

2. Description of human subject involvement

The persons in each of the two occupational groups will be randomly selected from two public directories: 1) The Ohio State University Directory: Faculty and Staff, 1975-76 and 2) The 1975-76 R. A. Polk Directory for Franklin County, Ohio. One hundred fifty professors (assistant, associate, and professor) will be selected from the university directory, and two hundred persons will be selected from the county directory. The instruments will be mailed to each person selected for the study. A letter will be included: 1) to briefly explain the nature of the study; 2) to explain that their responses will be with complete anonymity; and 3) to identify the investigator and the means by which further information can be obtained about the study. It should not take longer than forty (40) minutes for the persons to resond to both instruments.

3. <u>Perceived risks</u>

Perceived risks to individuals participating in this study should be minimal or nonexistent because:

1) the information sought from each person is not self-incriminating nor is it self-demeaning.
2) participation by each person is at his or her discretion.
3) each person is informed in the letter accompanying the materials that everything is done with anonymity.
4) Each individual set of data will be identified numerically upon receipt by the investigator and will be coded as such for computer analysis.
5) All data will be grouped for analyses. None will be treated as coming from an individual respondent.

4. <u>Safeguards for subjects</u>

The safeguards for subjects have been described in <u>Part 3</u> as a justification for stating that the perceived risks should be minimal or nonexistent to the participants. As a consequence, this investigator is <u>requesting a waiver</u> of the requirement to use a consent form with each person selected for this study. If this request is denied, the following consent form would be used.

Protocol No.___________

RESEARCH INVOLVING HUMAN SUBJECTS
CONSENT TO SERVE AS A SUBJECT IN RESEARCH

BEHAVIORAL AND SURVEY RESEARCH FORM

I consent to serve as a subject in the research investigation entitled: The Development of a Model to Determine Perceptions of Scientific Literacy.

The nature and general purpose of the research procedure have been explained to me. This research is to be performed by or under the direction of Dr. Arthur White, who is authorized to use the services of others in the performance of the research.

I understand that any further inquiries I make concerning this procedure will be answered. I understand my identity will not be revealed in any publication, document, recording, video-tape, photograph, computer data storage, or in any other way which relates to this research. Finally, I understand that I am free to withdraw my consent and discontinue participation at any time following the notification of the Project Director.

Signed___________________
(Subject)

Date___________________

Time___________________ A.M. P.M.

____
Witness - (Auditor)

Lawrence L. Gabel
Investigator

PA-027

Appendix F

Form Letter Mailed to

Persons in the Study

THE OHIO STATE UNIVERSITY

April 5, 1976

Each day science plays a big role in our lives. There is a need to determine what will best prepare high school graduates to face this. At The Ohio State University we are working on this very important task through dissertation research. We need your help.

We are asking that you do two things with the materials in the packet which you received. You do not have to know about science to work with these materials. It will take about 20 to 40 minutes of your time.

1. Please complete the INFORMATION SHEET. Do not put your name on it; we want the information to be confidential.

2. Follow the step by step INSTRUCTIONS FOR USING THE SMALL CARDS AND SMALL ENVELOPES.

When you finish, please return the materials to us by mail. Use the stamped, self-addressed envelope. Mail the postcard at the same time. It will tell us that you have finished and returned the materials. Please send your completed materials by April 23, 1976. If you have any questions, please do not hesitate to call Mr. Gabel at 422-6717 during the day or 891-4454 during the evening hours.

Thank you very much for your help.

Respectfully yours,

Lawrence L. Gabel
Principal Investigator

Dr. Arthur L. White
Professor of Science Education

College of Education / Faculty of Science and Mathematics Education · 1945 North High Street · Columbus, Ohio 43210 / Phone (614) 422-4121

Appendix G

Intercorrelation Coefficients of the Q-statements

	IA11	IA31	IA41	IA51	IA61	IA223	IA32	IA52	IA62	IB12
IA11	1.00000	0.30347	-0.09379	0.28937	0.10134	-0.03912	0.00041	0.01312	0.03387	-0.27513
IA31	0.30347	1.00000	-0.04850	0.26947	0.15403	0.00562	0.19071	0.13926	0.01806	-0.16129
IA41	-0.09379	-0.04850	1.00000	0.14262	-0.05283	-0.01209	-0.08389	-0.13073	-0.10085	-0.01046
IA51	0.28937	0.26947	0.14262	1.00000	0.08145	-0.00753	0.08735	0.23451	-0.11230	-0.11852
IA61	0.10134	0.15403	-0.05283	0.08145	1.00000	0.18618	0.13741	0.07024	0.27898	-0.11728
IA223	-0.03912	0.00562	-0.01209	-0.00753	0.18618	1.00000	-0.07271	-0.05938	-0.05942	-0.07156
IA32	0.00041	0.19071	-0.08389	0.08735	0.13741	-0.07271	1.00000	0.21389	0.14818	0.05503
IA52	0.01312	0.13926	-0.13073	0.23451	0.07024	-0.05938	0.21389	1.00000	0.19309	0.08471
IA62	0.03387	0.01806	-0.10085	-0.11230	0.27898	-0.05942	0.14818	0.19309	1.00000	0.13912
IB12	-0.27513	-0.16129	-0.01046	-0.11852	-0.11728	-0.07156	0.05503	0.08471	0.13912	1.00000
IA13	0.28236	0.16948	-0.07309	-0.00718	-0.06097	-0.03502	-0.06347	-0.17524	-0.03361	-0.07555
IA53	-0.04832	-0.05932	0.14587	0.19822	-0.08162	-0.02859	0.14403	0.15671	0.04686	-0.07365
IB231	0.04554	-0.01992	-0.05914	-0.08165	-0.09801	-0.11059	-0.08647	-0.10765	-0.11714	-0.12984
IB33	0.05804	0.01711	-0.14237	-0.07313	-0.16864	-0.06319	-0.10075	-0.14699	-0.01901	-0.12795
IIA41	-0.10577	0.12497	-0.09066	-0.11167	0.07677	-0.02764	0.18550	-0.03972	-0.00820	-0.06878
IIB11	-0.05990	-0.07282	-0.06621	-0.10958	-0.09466	0.13159	-0.23300	-0.14066	-0.05708	-0.04835
IIB21	-0.16070	0.02465	-0.03797	-0.13721	-0.10878	0.08048	0.01758	-0.17773	-0.27376	0.13953
IIB31	0.06516	-0.11717	-0.17587	-0.05359	-0.01403	0.14561	-0.09665	-0.11023	-0.06450	-0.05665
IIIA11	-0.04753	-0.23034	0.03116	-0.15093	-0.11491	-0.02197	-0.14774	-0.17089	-0.01964	0.13084
IIIA21	-0.08334	-0.15734	-0.01364	-0.18095	-0.05820	0.13341	-0.08391	-0.07117	-0.03954	0.06039
IIIA51	-0.30782	-0.02744	0.08335	-0.07218	-0.18347	0.02221	-0.05449	0.15722	-0.00717	0.14620
IIIA61	-0.07370	-0.15339	0.01334	-0.06310	0.02846	-0.03478	-0.08641	-0.10795	0.11665	0.17448
IIIB11	-0.03509	-0.21180	-0.20588	-0.04738	-0.10372	0.01139	-0.12438	-0.09449	-0.18134	0.07138
IVA11	-0.00612	-0.02687	0.17218	0.18003	-0.00960	-0.06725	0.08955	0.24327	0.02735	0.07142
IVA214	0.03080	-0.15681	-0.02552	0.00270	-0.05100	0.13585	-0.09521	-0.00231	-0.01400	0.03641
IVA31	-0.14134	0.31721	-0.02829	0.13107	-0.08018	-0.14994	0.47624	0.09711	-0.04263	0.04060
IVA41	0.08985	-0.14978	0.04019	-0.02243	0.11632	-0.11710	-0.05401	-0.08338	0.06948	0.06582
IVA51	-0.02551	0.11536	0.29857	0.40964	-0.08032	-0.06594	0.12649	0.35736	-0.01937	0.04610
VA41	0.08269	-0.20983	0.17072	-0.04348	-0.10957	-0.03186	-0.08208	-0.04517	-0.01249	0.10544
VB11	0.05804	-0.15209	0.05500	-0.09265	-0.11017	-0.04400	-0.23310	-0.10065	-0.05653	-0.14123
VB21	0.01888	0.00823	-0.06065	-0.02692	-0.10740	-0.07224	-0.11287	-0.09920	-0.04684	-0.14570
VB31	-0.04561	-0.12910	0.09374	-0.08230	-0.04133	0.02672	-0.18076	-0.07359	-0.09153	-0.08596
VIA111	-0.07152	-0.12504	-0.06266	-0.18513	0.09116	0.02430	-0.20356	-0.26379	-0.06655	0.14081
VIA21	0.02265	-0.11048	0.04217	-0.02999	0.14157	0.16451	-0.02690	-0.11528	-0.06772	-0.02476
VIA31	0.09710	0.26673	-0.11348	0.23686	-0.01484	-0.01474	0.19942	0.05704	-0.01711	-0.06617
VIA41	0.12847	-0.02939	0.03923	0.01645	0.14649	0.00078	-0.09655	-0.10656	-0.02220	-0.14085
VIA61	-0.08671	-0.00367	-0.00176	-0.06340	0.12471	-0.13236	-0.07872	0.06702	0.15067	-0.08896
VIIA21	-0.15936	-0.11044	-0.08930	-0.13169	0.07120	-0.02858	-0.06093	0.13502	0.03544	0.02250
VIIA61	-0.15835	0.00795	0.03529	0.00541	0.17485	-0.11716	0.03622	-0.07925	0.07202	0.04886
VIIB21	-0.03880	-0.17771	0.00552	-0.16697	0.04933	-0.11733	-0.01314	0.01836	-0.02410	-0.12483
VIIB31	0.01845	-0.08322	-0.12786	-0.20290	-0.15775	-0.17462	-0.08892	-0.15380	-0.11582	0.00924
VIIIA31	-0.06896	0.15060	-0.04298	0.02022	-0.01113	0.02530	0.14775	0.05875	-0.02430	-0.12692
VIIIB11	0.00814	-0.09489	-0.15524	-0.16630	-0.03165	0.09218	-0.11188	-0.08737	0.00743	-0.14691
VIIIB21	-0.10685	-0.01165	-0.06638	-0.03008	-0.04311	-0.06692	-0.09699	-0.10053	-0.05604	0.09252
VIIIB31	-0.20398	0.01511	0.03208	-0.08141	-0.16823	-0.05215	0.04761	0.00005	-0.06903	0.04408

	IA13	IA53	IB231	IB33	IIA41	IIB11	IIB21	IIB31	IIIA11	IIIA21
IA11	0.28236	-0.04832	0.04554	0.05804	-0.10577	-0.05990	-0.16070	0.06516	-0.04753	-0.08334
IA31	0.16948	-0.05932	-0.01992	0.01711	0.12497	-0.07282	0.02465	-0.11717	-0.23034	-0.15734
IA41	-0.07309	0.14587	-0.05914	-0.14237	-0.09066	-0.06621	-0.03797	-0.17587	0.03116	-0.01364
IA51	-0.00718	0.19822	-0.08165	-0.07313	-0.11167	-0.10958	-0.13721	-0.05359	-0.15093	-0.18095
IA61	-0.06097	-0.08162	-0.09801	-0.16864	0.07677	-0.09466	-0.10878	-0.01403	-0.11491	-0.05820
IA223	-0.03502	-0.02859	-0.11059	-0.06319	-0.02764	0.13159	0.08048	0.14561	-0.02197	0.13341
IA32	-0.06347	0.14403	-0.08647	-0.10075	0.18550	-0.23300	0.01758	-0.09665	-0.14774	-0.08391
IA52	-0.17524	0.15071	-0.10765	-0.14699	-0.03972	-0.14866	-0.17773	-0.11023	-0.17089	-0.07117
IA62	-0.03361	0.04686	-0.11714	-0.01901	-0.00820	-0.05708	-0.27376	-0.06450	-0.01964	-0.03954
IB12	-0.07555	-0.07365	-0.12984	-0.12795	-0.06878	-0.04835	0.13953	-0.05665	0.13084	0.06039
IA13	1.00000	-0.16552	0.07769	0.06042	0.07412	0.06103	-0.08682	-0.02391	0.13836	0.01661
IA53	-0.16552	1.00000	-0.00462	-0.15110	0.02748	0.04225	-0.01587	0.00626	-0.16016	-0.13780
IB231	0.07769	-0.00462	1.00000	0.26683	0.00123	0.05418	0.03367	0.06405	-0.12134	-0.22663
IB33	0.06042	-0.15110	0.26683	1.00000	-0.03956	0.02255	-0.01791	0.08576	-0.05733	-0.09604
IIA41	0.07412	0.02748	0.00123	-0.03956	1.00000	0.11755	0.17176	0.12934	-0.09696	-0.20041
IIB11	0.06103	0.04225	0.05418	0.02255	0.11755	1.00000	0.18096	0.25238	0.06264	0.03120
IIB21	-0.08682	-0.01587	0.03367	-0.01791	0.17176	0.18096	1.00000	0.10901	0.06219	0.09249
IIB31	-0.02391	0.00626	0.06405	0.08576	0.12934	0.25238	0.10901	1.00000	-0.16972	-0.08616
IIIA11	0.13836	-0.16016	-0.12134	-0.05733	-0.09696	0.06264	0.06219	-0.16972	1.00000	0.44105
IIIA21	0.01661	-0.13780	-0.22663	-0.09604	-0.20041	0.03120	0.09249	-0.08616	0.44105	1.00000
IIIA51	-0.18882	0.06663	-0.06413	0.02502	-0.08790	-0.05136	-0.01357	-0.18207	0.23658	0.07290
IIIA61	-0.11766	0.06057	-0.07755	-0.09245	-0.01985	-0.03880	-0.01681	-0.08481	0.21567	0.08788
IIIB11	-0.01511	-0.04494	0.12954	0.10067	0.13561	0.21857	0.26321	0.16966	0.20121	0.09691
IVA11	-0.09952	0.29604	-0.01271	-0.08954	-0.06081	-0.00590	-0.11040	-0.07753	-0.09368	-0.01256
IVA214	0.03413	-0.14801	-0.24670	-0.09556	-0.11442	0.11219	0.08842	-0.04462	0.15435	0.18838
IVA31	-0.04592	0.21600	-0.10004	-0.10044	0.26092	-0.05480	0.15182	-0.12679	-0.22053	-0.16162
IVA41	0.03094	0.10308	0.03129	-0.06244	-0.09540	-0.02054	-0.10263	-0.05997	0.10445	0.13887
IVA51	-0.06809	0.33630	-0.03171	-0.17645	-0.03653	-0.11982	-0.16405	-0.04451	-0.21343	-0.12469
VA41	0.06454	0.01794	-0.08361	-0.19910	0.09775	0.03622	-0.07473	-0.11926	0.20246	0.24893
VB11	-0.04900	0.06674	0.04543	0.02719	0.15972	0.23122	-0.03750	0.15178	0.02816	-0.03654
VB21	-0.00230	-0.21175	0.04782	0.05564	-0.10583	-0.04517	-0.05850	-0.09418	0.08442	0.06670
VB31	-0.06954	-0.11846	-0.07139	0.06475	-0.09967	0.08995	-0.02215	0.03658	0.05288	0.08614
VIA111	0.10743	-0.31950	0.03404	-0.00272	-0.10696	0.08615	-0.02974	-0.05269	0.27108	0.24351
VIA21	0.10124	-0.15070	-0.04667	0.00691	-0.01100	-0.08303	-0.12543	0.07814	-0.10179	0.04770
VIA31	0.01016	0.07994	0.12266	-0.01892	0.18609	-0.13772	-0.02866	0.04389	-0.31138	-0.32998
VIA41	0.16238	-0.18440	0.09987	0.08788	-0.06813	-0.05478	-0.16424	-0.08415	0.05102	0.07179
VIA61	-0.24367	0.07366	0.09358	0.05866	-0.13914	-0.20848	-0.12063	0.01842	-0.10545	-0.09374
VIIA21	-0.01073	-0.15097	-0.10265	0.07281	-0.04117	0.07482	-0.12606	-0.02664	0.07618	0.11521
VIIA61	-0.05904	-0.08456	-0.05538	0.03223	0.02572	-0.16047	-0.07242	-0.07508	-0.05800	-0.12185
VIIB21	-0.15942	-0.02236	0.10994	0.05079	0.04389	-0.15019	0.07022	0.01913	-0.08742	-0.02197
VIIB31	0.09572	-0.17111	0.11770	0.33631	-0.10106	0.14842	0.11213	0.21643	0.06025	-0.08133
VIIIA31	-0.00332	0.23481	0.19076	0.05367	0.37468	-0.11605	0.08136	-0.05457	-0.17569	-0.26033
VIIIB11	-0.09684	-0.06989	0.20807	0.27256	-0.05147	0.06586	-0.02904	0.28888	-0.15379	-0.17792
VIIIB21	-0.16888	-0.11169	-0.13472	-0.10706	-0.08812	-0.17063	-0.06190	-0.15174	-0.05125	0.12840
VIIIB31	0.00218	-0.09449	-0.05281	0.10455	-0.11781	-0.10341	-0.01525	-0.07764	-0.03011	-0.10998

	IIIA51	IIIA61	IIIB11	IVA11	IVA214	IVA31	IVA41	IVA51	VA41	VB11
IA11	-0.30782	-0.07370	-0.03509	-0.00612	0.03080	-0.14134	0.08985	-0.02551	0.08269	0.05804
IA31	-0.02744	-0.16339	-0.21180	-0.02687	-0.15681	0.31721	-0.14978	0.11536	-0.20983	-0.15209
IA41	0.08335	0.01334	-0.20588	0.17218	-0.02552	-0.02829	0.04019	0.29857	0.17072	0.05500
IA51	-0.07218	-0.06310	-0.04738	0.18003	0.00270	0.13107	-0.02243	0.40964	-0.04348	-0.09265
IA61	-0.18347	0.02846	-0.10372	-0.00960	-0.05100	-0.08018	0.11632	-0.08032	-0.10957	-0.11017
IA223	0.02221	-0.03408	0.01139	-0.06725	0.13585	-0.14994	-0.11710	-0.06594	-0.03186	-0.04400
IA32	-0.05449	-0.08641	-0.12438	0.08955	-0.09521	0.47624	-0.05401	0.12649	-0.08208	-0.23310
IA52	0.15722	-0.10795	-0.09449	0.24327	-0.00231	0.09711	-0.08338	0.35736	-0.04517	-0.10065
IA62	-0.00717	0.11665	-0.18134	0.02735	-0.01480	-0.04763	0.06948	-0.01937	-0.01249	-0.05653
IB12	0.14620	0.17448	0.07138	0.07142	0.03641	0.04060	0.06582	0.04610	0.10544	-0.14123
IA13	-0.18882	-0.11766	-0.01511	-0.09952	0.03413	-0.04592	0.03094	-0.06809	0.06454	-0.04900
IA53	0.06663	0.06057	-0.04494	0.29604	-0.14801	0.21600	0.10308	0.33630	0.01794	0.08674
IB231	-0.06413	-0.02755	0.12954	-0.01271	-0.24670	-0.10004	0.03139	-0.03191	-0.08361	0.04543
IB33	0.02502	-0.09245	0.10067	-0.08854	-0.09556	-0.10044	-0.06244	-0.17645	-0.19910	0.02719
IIA41	-0.08790	-0.01985	0.13561	-0.06081	-0.11442	0.26092	-0.09540	-0.03653	-0.09775	-0.15972
IIB11	-0.05136	-0.03880	0.21857	-0.00590	0.11219	-0.05480	-0.02054	-0.11982	0.03622	0.23122
IIB21	-0.01357	-0.01681	0.26321	-0.11040	0.08842	0.15182	-0.10263	-0.16405	-0.07473	-0.03750
IIB31	-0.18707	-0.08481	0.16966	-0.07753	-0.04462	-0.12679	-0.05997	-0.04451	-0.11926	0.15178
IIIA11	0.23658	0.21567	0.20421	-0.09368	0.15435	-0.22053	0.10445	-0.21343	0.20246	0.02816
IIIA21	0.07290	0.08788	0.09691	-0.01256	0.18838	-0.16162	0.13887	-0.12469	0.24893	-0.03654
IIIA51	1.00000	0.18066	0.07900	0.00375	0.09530	-0.00255	-0.06196	0.09646	-0.01103	-0.01324
IIIA61	0.18066	1.00000	0.19405	0.09599	0.02686	-0.05921	0.07291	0.07323	0.00681	-0.08150
IIIB11	0.07900	0.19405	1.00000	-0.10859	0.10683	-0.02463	-0.04121	-0.09314	0.05878	0.08990
IVA11	0.00375	0.09599	-0.10859	1.00000	-0.08195	0.25689	0.15920	0.41252	-0.03578	-0.10286
IVA214	0.09530	0.02686	0.10683	-0.08195	1.00000	-0.13842	-0.04342	-0.09139	0.05911	0.09303
IVA31	-0.00255	-0.05921	-0.02463	0.25689	-0.13842	1.00000	-0.07084	0.25425	-0.15173	-0.19238
IVA41	-0.06196	0.07291	-0.04121	0.15920	-0.04342	-0.07084	1.00000	0.04965	0.13126	0.07379
IVA51	0.09646	0.07323	-0.09314	0.41252	-0.09139	0.25425	0.04965	1.00000	-0.01828	-0.04641
VA41	-0.01103	0.00681	0.05878	-0.03578	0.05911	-0.15173	0.13126	-0.01828	1.00000	0.14139
VB11	-0.01324	-0.08150	0.08990	-0.10286	0.09303	-0.19238	0.07379	-0.04641	0.14139	1.00000
VB21	-0.07191	-0.11336	-0.07471	-0.30134	0.09710	-0.09465	-0.06379	-0.13231	0.00604	0.19880
VB31	0.03367	-0.02426	-0.03518	-0.17299	0.08696	-0.25379	-0.02102	-0.14704	0.10706	0.09919
VIA111	0.01132	-0.04410	0.04830	-0.10236	0.07147	-0.26638	0.27558	-0.24235	0.18809	-0.00702
VIA21	-0.15324	0.02911	-0.07609	0.09525	0.03004	-0.12313	0.01160	-0.01645	0.01333	-0.20118
VIA31	-0.07955	0.00947	-0.05335	-0.09764	-0.13230	0.26919	-0.08173	0.05297	-0.29728	-0.14399
VIA41	-0.10754	-0.13231	-0.19193	0.07345	-0.02673	-0.17026	0.19025	-0.05157	0.15905	-0.04932
VIA61	0.15701	0.03718	-0.23417	0.09241	-0.13534	-0.01193	0.01150	0.06779	-0.10009	0.00859
VIIA21	-0.01391	-0.07647	-0.00279	0.03433	0.03351	-0.06886	0.01010	-0.15465	-0.10610	-0.09545
VIIA61	0.01415	0.09309	-0.01924	-0.13132	-0.01043	0.01074	-0.20325	-0.17925	0.02217	-0.17895
VIIB21	-0.11765	0.02599	-0.00574	-0.09111	-0.03396	-0.09203	-0.07186	-0.13622	-0.06018	0.02963
VIIB31	-0.03745	-0.13505	0.11907	-0.20826	-0.02855	-0.04989	-0.12520	-0.22101	0.07360	0.15737
VIIIA31	0.00063	0.17593	-0.04483	0.08273	-0.16132	0.19948	-0.04240	0.08354	-0.26231	-0.08178
VIIIB11	-0.09149	-0.13414	-0.05732	-0.20798	-0.03173	-0.11819	-0.07377	-0.14859	-0.18513	0.09379
VIIIB21	-0.02789	-0.09108	-0.06695	-0.19191	0.03186	-0.05379	-0.06537	-0.10803	0.05764	0.07589
VIIIB31	0.13050	-0.21096	-0.22672	-0.16099	-0.10189	0.03667	-0.16854	-0.04649	-0.23912	0.03844

	VB21	VB31	VIA111	VIA21	VIA31	VIA41	VIA61	VIIA21	VIIA61	VIIB21
IA11	0.01888	-0.04561	-0.07152	0.02265	0.09710	0.12847	-0.08671	-0.15936	-0.15835	-0.03880
IA31	0.00823	-0.12910	-0.12504	-0.11048	0.26673	-0.02939	-0.00367	-0.11044	0.00795	-0.17771
IA41	-0.06065	0.09374	-0.06266	0.04217	-0.11348	0.03923	-0.00176	-0.08930	0.03529	0.00552
IA51	-0.02692	-0.08230	-0.18513	-0.02999	0.23686	0.01645	-0.06340	-0.13169	0.00541	-0.16697
IA61	-0.10740	-0.04133	0.09116	0.14157	-0.01484	0.14649	0.12471	0.07120	0.17485	0.04933
IA223	-0.07224	0.02672	0.02430	0.16451	-0.01474	0.00078	-0.13236	-0.02858	-0.11716	-0.11733
IA32	-0.11287	-0.18076	-0.20356	-0.02690	0.19942	-0.09655	-0.07872	-0.06093	0.03622	-0.01314
IA52	-0.09920	-0.07359	-0.26379	-0.11528	0.05704	-0.10656	0.06702	0.13502	-0.07925	0.01836
IA62	-0.04684	-0.09153	-0.06655	-0.06772	-0.01711	-0.02220	0.15067	0.03544	0.07202	-0.02410
IB12	-0.14570	-0.06596	0.14081	-0.02476	-0.05617	-0.14085	-0.08896	0.02250	0.04886	-0.12483
IA13	-0.00230	-0.06954	0.10743	0.10124	0.01016	0.16238	-0.24367	-0.01073	-0.05904	-0.15942
IA53	-0.21175	-0.11846	-0.31950	-0.15070	0.07994	-0.18440	0.07366	-0.15097	-0.08456	-0.02236
IB231	0.04782	-0.07139	0.03404	-0.04667	0.12266	0.09987	0.09358	-0.10265	-0.05538	0.10994
IB33	0.05564	0.06475	-0.00272	0.00691	-0.01892	0.08788	0.05666	0.07281	0.03223	0.05079
IIA41	-0.10583	-0.09967	-0.10696	-0.01100	0.18609	-0.06813	-0.13914	-0.04117	0.02572	0.04389
IIB11	-0.04517	0.08995	0.08615	-0.08303	-0.13772	-0.05478	-0.20848	0.07482	-0.16047	-0.15019
IIB21	-0.05850	-0.02215	-0.02474	-0.12543	-0.02866	-0.16424	-0.12063	-0.12606	-0.07242	0.07022
IIB31	-0.09418	0.03658	-0.05269	0.07814	0.04389	-0.08415	0.01842	-0.02664	-0.07508	0.01913
IIIA11	0.08442	0.05288	0.27108	-0.10179	-0.31138	0.05102	-0.10545	0.07618	-0.05800	-0.08742
IIIA21	0.06670	0.08414	0.24351	0.04770	-0.32998	0.07179	-0.09374	0.11521	-0.12185	-0.02197
IIIA51	-0.07191	0.03367	0.01132	-0.15324	-0.07955	-0.10754	0.15701	-0.01391	0.01415	-0.11765
IIIA61	-0.11336	-0.02426	-0.04410	0.02911	0.00947	-0.13231	0.03718	-0.07647	0.09309	0.02599
IIIB11	-0.07471	-0.03518	0.04830	-0.07609	-0.05335	-0.19193	-0.23417	-0.00279	-0.01924	-0.00574
IVA11	-0.30134	-0.17299	-0.10236	0.09525	-0.09764	0.07345	0.09241	0.03433	-0.13132	-0.09111
IVA214	0.09710	0.08696	0.07147	0.03004	-0.13230	-0.02673	-0.13534	0.03351	-0.01043	-0.03396
IVA31	-0.09465	-0.25379	-0.26638	-0.12313	0.26919	-0.17026	-0.01193	-0.06886	0.01074	-0.09203
IVA41	-0.06379	-0.02102	0.27568	0.01160	-0.08173	0.19025	0.01150	0.01010	-0.20325	-0.07186
IVA51	-0.13231	-0.14704	-0.24235	-0.01645	0.05297	-0.05157	0.06779	-0.15465	-0.17925	-0.13622
VA41	0.00604	0.10706	0.18809	0.01333	-0.29728	0.15905	-0.10009	-0.10610	0.02217	-0.06018
VB11	0.19880	0.09919	-0.00702	-0.20118	-0.14399	-0.04932	0.00859	-0.09545	-0.17895	0.02963
VB21	1.00000	0.20178	-0.03281	-0.18430	-0.04974	-0.04632	-0.13889	0.06480	-0.03543	0.10920
VB31	0.20178	1.00000	0.08467	-0.04979	-0.09614	0.08218	-0.00057	0.00900	0.02284	0.05581
VIA111	-0.03281	0.08467	1.00000	0.24830	-0.25576	0.31413	-0.03125	0.06851	-0.06061	-0.05291
VIA21	-0.18430	-0.04979	0.24830	1.00000	-0.08328	0.30218	0.11503	0.17243	-0.04385	-0.01207
VIA31	-0.04974	-0.09614	-0.25576	-0.08328	1.00000	-0.09092	-0.07364	-0.19162	0.12257	-0.01662
VIA41	-0.04632	0.08218	0.31413	0.30218	-0.09092	1.00000	0.12038	0.05330	-0.09186	-0.10581
VIA61	-0.13889	-0.00057	-0.03125	0.11503	-0.07364	0.12038	1.00000	-0.01962	0.17862	0.09384
VIIA21	0.06480	0.00900	0.06851	0.17243	-0.19162	0.05330	-0.01962	1.00000	-0.00319	-0.00900
VIIA61	-0.03543	0.02284	-0.06061	-0.04385	0.12257	-0.09186	0.17862	-0.00319	1.00000	0.10155
VIIB21	0.10920	0.05581	-0.05291	-0.01207	-0.01662	-0.10581	0.09384	-0.00900	0.10155	1.00000
VIIB31	0.06918	0.07758	0.00710	-0.01593	-0.03967	-0.02401	0.01728	0.11191	0.17517	-0.13755
VIIIA31	0.08225	-0.16407	-0.27654	-0.17285	0.23037	-0.10432	-0.00698	0.00826	-0.10118	0.12208
VIIIB11	0.14658	0.01121	-0.01575	-0.00963	0.08696	0.06332	-0.04771	0.04767	-0.08354	0.06672
VIIIB21	0.28762	0.07335	0.04693	-0.01229	-0.01505	-0.03856	0.00353	0.05067	0.05161	0.09360
VIIIB31	-0.01418	-0.02352	-0.04797	-0.09576	-0.01137	-0.05503	0.11615	0.00907	0.16782	0.02738

	VIIB31	VIIIA31	VIIIB11	VIIIB21	VIIIB31
IA11	0.01845	-0.06896	0.00814	-0.10685	-0.20398
IA31	-0.08322	0.15060	-0.09489	-0.01165	0.01511
IA41	-0.12786	-0.04298	-0.15524	-0.06638	0.03208
IA51	-0.20290	0.02022	-0.16630	-0.03008	-0.08141
IA61	-0.15775	-0.01113	-0.03165	-0.04311	-0.16823
IA223	-0.17462	0.02530	0.09218	-0.06692	-0.05215
IA32	-0.08892	0.14775	-0.11188	-0.09699	0.04751
IA52	-0.15380	0.05875	-0.08737	-0.10053	0.00005
IA62	-0.11582	-0.02430	0.00743	-0.05604	-0.06903
IB12	0.00924	-0.12692	-0.14691	0.09252	0.04408
IA13	0.09572	-0.00332	-0.09684	-0.16888	0.00218
IA53	-0.17111	0.23481	-0.06989	-0.11169	-0.09449
IB231	0.11770	0.19076	0.20807	-0.13472	-0.05281
IB33	0.33631	0.05367	0.27256	-0.10706	0.10455
IIA41	-0.10106	0.37468	-0.05147	-0.08812	-0.11781
IIB11	0.14842	-0.11605	0.06586	-0.17063	-0.10341
IIB21	0.11213	0.08136	-0.02904	-0.06190	-0.01525
IIB31	0.21643	-0.05457	0.28888	-0.15174	-0.07764
IIIA11	0.06025	-0.17569	-0.15379	-0.05125	-0.03011
IIIA21	-0.08133	-0.26033	-0.17792	0.12840	-0.10998
IIIA51	-0.03745	0.00063	-0.09149	-0.02789	0.13050
IIIA61	-0.13505	0.17593	-0.13414	-0.09108	-0.21096
IIIB11	0.11907	-0.04483	-0.05732	-0.06695	-0.22672
IVA11	-0.20826	0.08273	-0.20798	-0.19191	-0.16099
IVA214	-0.02855	-0.16132	-0.03173	0.03186	-0.10189
IVA31	-0.04989	0.19948	-0.11819	-0.05379	0.03667
IVA41	-0.12520	-0.04240	-0.07377	-0.06537	-0.16854
IVA51	-0.22101	0.08354	-0.14859	-0.10803	-0.04649
VA41	0.07360	-0.26231	-0.18513	0.05764	-0.23912
VB11	0.15737	-0.08178	0.09379	0.07589	0.03844
VB21	0.06918	-0.08225	0.14658	0.28762	-0.01418
VB31	0.07758	-0.16407	0.01121	0.07335	-0.02352
VIA111	0.00710	-0.27654	-0.01575	0.04693	-0.04797
VIA21	-0.01593	-0.17285	-0.00963	-0.01229	-0.09576
VIA31	-0.03967	0.23037	0.08696	-0.01505	-0.01137
VIA41	-0.02401	-0.10432	0.06332	-0.03856	-0.05503
VIA61	0.01728	-0.00698	-0.04771	0.00353	0.11615
VIIA21	0.11191	0.00836	0.04767	0.05067	0.00907
VIIA61	0.17517	-0.10118	-0.08354	0.05161	0.16782
VIIB21	-0.13755	-0.12208	0.06672	0.09360	0.02738
VIIB31	1.00000	-0.23400	0.22399	-0.12935	0.16470
VIIIA31	-0.23400	1.00000	0.09930	-0.17670	-0.02701
VIIIB11	0.22399	0.09930	1.00000	-0.09841	0.13641
VIIIB21	-0.12935	-0.17670	-0.09841	1.00000	0.02806
VIIIB31	0.16470	-0.02701	0.13641	0.02806	1.00000

Appendix H

Factor Analysis Results

Estimated and Final Communalities for OVERALL

VARIABLE	EST COMMUNALITY	COMMUNALITY
IA11	0.51223	0.45010
IA31	0.51016	0.42974
IA41	0.40036	0.14967
IA51	0.47634	0.37626
IA61	0.45292	0.38028
IA223	0.33496	0.08083
IA32	0.42484	0.31135
IA52	0.50878	0.21064
IA62	0.35968	0.11823
IB12	0.36985	0.23661
IA13	0.39082	0.31654
IA53	0.40280	0.40647
IE231	0.36628	0.21838
IB33	0.37464	0.28680
IIA41	0.43197	0.32924
IIB11	0.38944	0.27267
IIB21	0.40093	0.27592
IIB31	0.39281	0.25627
IIIA11	0.48668	0.39008
IIIA21	0.42860	0.37278
IIIA51	0.37370	0.23166
IIIA61	0.40668	0.16375
IIIB11	0.44548	0.33576
IVA11	0.46048	0.46122
IVA214	0.25364	0.14376
IVA31	0.55570	0.49100
IVA41	0.30455	0.16722
IVA51	0.52917	0.55172
VA41	0.44831	0.24691
VB11	0.35363	0.32245
VB21	0.38578	0.33508
VB31	0.20926	0.14345
VIA111	0.45734	0.41336
VIA21	0.41208	0.26010
VIA31	0.42550	0.31572
VIA41	0.35839	0.36378
VIA61	0.41827	0.30552
VIIA21	0.31779	0.07377
VIIA61	0.41183	0.16485
VIIB21	0.30507	0.17093
VIIB31	0.48506	0.41324
VIIIA31	0.51176	0.30690
VIIIB11	0.39874	0.31401
VIIIB21	0.38329	0.23641
VIIIB31	0.40801	0.32321

Eigenvalues and Percent of Variance for OVERALL Factors

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT
1	4.08695	9.1	9.1
2	3.05554	6.8	15.9
3	2.54074	5.6	21.5
4	2.32493	5.2	26.7
5	2.10102	4.7	31.4
6	2.01208	4.5	35.8
7	1.76184	3.9	39.7
8	1.65762	3.7	43.4
9	1.54934	3.4	46.9
10	1.45696	3.2	50.1
11	1.40532	3.1	53.2
12	1.26504	2.8	56.0
13	1.18486	2.6	58.7
14	1.10847	2.5	61.1
15	1.06862	2.4	63.5
16	0.98426	2.2	65.7
17	0.94829	2.1	67.8
18	0.91331	2.0	69.8
19	0.87816	2.0	71.8
20	0.86280	1.9	73.7
21	0.83760	1.9	75.6
22	0.76447	1.7	77.3
23	0.72771	1.6	78.9
24	0.70750	1.6	80.5
25	0.66959	1.5	81.9
26	0.63146	1.4	83.3
27	0.63012	1.4	84.7
28	0.59381	1.3	86.1
29	0.56387	1.3	87.3
30	0.52571	1.2	88.5
31	0.50491	1.1	89.6
32	0.48823	1.1	90.7
33	0.47680	1.1	91.8
34	0.44210	1.0	92.7
35	0.43599	1.0	93.7
36	0.38232	0.8	94.6
37	0.35145	0.8	95.3
38	0.33264	0.7	96.1
39	0.31341	0.7	96.8
40	0.28976	0.6	97.4
41	0.26551	0.6	98.0
42	0.25367	0.6	98.6
43	0.22600	0.5	99.1
44	0.22062	0.5	99.6
45	0.19762	0.4	100.0

Seven Factor Rotated Matrix for OVERALL

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6	FACTOR 7
IA11	0.07419	0.06181	0.02783	-0.07563	0.10850	0.63392	0.14372
IA31	0.00055	-0.03338	-0.13141	0.39316	-0.13446	0.48208	-0.07932
IA41	0.31489	-0.13149	-0.08842	-0.13476	0.01550	-0.03446	-0.07624
IA51	0.40022	-0.09298	-0.11549	0.10596	-0.12323	0.40901	0.01973
IA61	-0.12362	0.01631	-0.34075	0.14262	0.18774	0.08596	0.43086
IA223	-0.06911	-0.00939	0.08252	-0.02757	0.03893	0.01542	0.25815
IA32	0.06546	-0.09512	-0.15479	0.50490	-0.12706	0.05464	-0.00077
IA52	0.30440	-0.07393	-0.25551	0.15667	-0.15042	-0.00496	0.00567
IA62	0.00493	-0.02576	-0.28619	0.07330	0.05983	-0.07913	0.14289
IB12	0.00403	-0.29110	0.05634	0.12140	0.05990	-0.33979	-0.12203
IA13	-0.12074	-0.06410	0.22087	0.09330	0.26979	0.39899	-0.10191
IA53	0.55971	0.11822	0.02342	0.08851	-0.21612	-0.11608	0.10319
IB231	0.00297	0.43923	0.11343	-0.02219	0.06516	0.04023	-0.07885
IB33	-0.19009	0.39223	0.07480	-0.06111	0.08976	0.03749	-0.27933
IIA41	-0.12160	0.12957	0.19401	0.44500	-0.10929	-0.02420	0.22242
IIB11	-0.01230	0.11378	0.48528	-0.13151	0.04044	-0.02277	0.06799
IIB21	-0.15841	-0.01784	0.41348	0.15914	-0.16544	-0.16345	0.01108
IIB31	-0.06419	0.40301	0.25955	-0.06843	0.00741	0.00511	0.13268
IIIA11	-0.13740	-0.41931	0.26651	-0.21708	0.19303	-0.18866	-0.06619
IIIA21	-0.11122	-0.46985	0.14010	-0.23626	0.18926	-0.14416	0.08720
IIIA51	0.11503	-0.17980	-0.01462	-0.03106	-0.09489	-0.35511	-0.22220
IIIA61	0.10466	-0.10739	0.06244	0.03805	0.01931	-0.31018	0.19833
IIIB11	-0.08709	-0.01043	0.53200	-0.00728	-0.05587	-0.17006	0.11377
IVA11	0.60077	-0.01825	-0.05803	0.18265	0.22195	-0.11348	0.03204
IVA214	-0.09814	-0.26140	0.13382	-0.19369	-0.03328	-0.00600	0.09607
IVA31	0.19975	-0.06675	0.02961	0.60341	-0.23243	0.02583	-0.16426
IVA41	0.18617	-0.07077	0.01315	-0.11805	0.30497	-0.00864	0.14270
IVA51	0.70954	-0.05574	-0.10858	0.13240	-0.08492	0.05933	-0.07159
VA41	0.09615	-0.32493	0.12643	-0.29240	0.17283	0.01862	0.01962
VB11	0.08427	0.14078	0.17727	-0.48107	-0.17125	0.04858	-0.03142
VB21	-0.26443	-0.07633	-0.05455	-0.34349	-0.30599	0.20181	-0.06329
VB31	-0.13744	-0.03112	-0.01358	-0.34817	-0.04644	-0.00152	-0.00548
VIA111	-0.25262	-0.18097	0.07305	-0.19880	0.51780	-0.05842	0.02014
VIA21	-0.06304	0.04315	-0.13007	0.03205	0.46947	0.01253	0.12553
VIA31	-0.00556	0.20859	-0.07663	0.37080	-0.27263	0.23239	0.02190
VIA41	-0.02334	0.04489	-0.15478	-0.12368	0.53032	0.20180	0.00064
VIA61	0.09637	0.21007	-0.42075	-0.05072	0.11221	-0.22202	-0.10084
VIIA21	-0.15906	-0.01505	-0.07942	-0.02660	0.15595	-0.12838	-0.02055
VIIA61	-0.23093	-0.01460	-0.24617	0.11207	-0.07493	-0.12675	-0.12833
VIIB21	-0.14686	0.16292	-0.16535	-0.10026	-0.18041	-0.15405	0.17072
VIIB31	-0.26254	0.24328	0.23236	-0.11940	0.07817	0.01320	-0.45891
VIIIA31	0.11830	0.28852	0.01350	0.35659	-0.22234	-0.06031	0.17676
VIIIB11	-0.20402	0.49586	0.01801	-0.14404	-0.04469	0.02812	-0.05140
VIIIB21	-0.20645	-0.24062	-0.21988	-0.19939	-0.21849	0.00394	0.00595
VIIIB31	-0.15214	0.08710	-0.20157	0.02303	-0.12051	-0.09698	-0.47685

Estimated and Final Communalities for SCIENCE

VARIABLE	EST COMMUNALITY	COMMUNALITY
IA11	0.61064	0.46724
IA31	0.70446	0.62730
IA41	0.54362	0.16552
IA51	0.65250	0.38295
IA61	0.59387	0.19282
IA223	0.54733	0.20143
IA32	0.61677	0.30511
IA52	0.63975	0.26039
IA62	0.56448	0.19517
IB12	0.50703	0.27533
IA13	0.56934	0.40190
IA53	0.60784	0.45341
IB231	0.56276	0.44651
IB33	0.61722	0.30741
IIA41	0.44510	0.30380
IIB11	0.59008	0.27338
IIB21	0.57358	0.38685
IIB31	0.57331	0.26627
IIIA11	0.65749	0.46532
IIIA21	0.61300	0.42388
IIIA51	0.52881	0.18765
IIIA61	0.56509	0.33440
IIIB11	0.67115	0.54042
IVA11	0.56206	0.32982
IVA214	0.48754	0.20743
IVA31	0.73082	0.50402
IVA41	0.44712	0.17784
IVA51	0.71007	0.47577
VA41	0.60308	0.32351
VB11	0.58848	0.55242
VB21	0.57754	0.31297
VB31	0.38417	0.10466
VIA111	0.66687	0.47986
VIA21	0.60033	0.39633
VIA31	0.64380	0.54992
VIA41	0.56368	0.36087
VIA61	0.63724	0.37209
VIIA21	0.53062	0.08488
VIIA61	0.66615	0.26137
VIIB21	0.51659	0.11141
VIIB31	0.68264	0.48525
VIIIA31	0.68517	0.42039
VIIIB11	0.51374	0.19599
VIIIB21	0.59343	0.54861
VIIIB31	0.49703	0.24906

Eigenvalues and Percent of Variance for SCIENCE Factors

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT
1	4.66553	10.4	10.4
2	3.37490	7.5	17.9
3	2.80984	6.2	24.1
4	2.58297	5.7	29.9
5	2.42319	5.4	35.2
6	1.99619	4.4	39.7
7	1.85146	4.1	43.8
8	1.80500	4.0	47.8
9	1.74896	3.9	51.7
10	1.55010	3.4	55.1
11	1.53641	3.4	58.5
12	1.29284	2.9	61.4
13	1.26241	2.8	64.2
14	1.13051	2.5	66.7
15	1.09620	2.4	69.2
16	1.03168	2.3	71.5
17	0.93483	2.1	73.5
18	0.89184	2.0	75.5
19	0.88327	2.0	77.5
20	0.81705	1.8	79.3
21	0.79904	1.8	81.1
22	0.73494	1.6	82.7
23	0.71858	1.6	84.3
24	0.68228	1.5	85.8
25	0.62753	1.4	87.2
26	0.58826	1.3	88.5
27	0.53375	1.2	89.7
28	0.50252	1.1	90.8
29	0.42570	0.9	91.8
30	0.39476	0.9	92.7
31	0.38389	0.9	93.5
32	0.34381	0.8	94.3
33	0.33436	0.7	95.0
34	0.30390	0.7	95.7
35	0.27930	0.6	96.3
36	0.26472	0.6	96.9
37	0.23408	0.5	97.4
38	0.19832	0.4	97.9
39	0.18282	0.4	98.3
40	0.16205	0.4	98.6
41	0.14740	0.3	99.0
42	0.13009	0.3	99.2
43	0.12342	0.3	99.5
44	0.11568	0.3	99.8
45	0.10242	0.2	100.0

Seven Factor Rotated Matrix for SCIENCE

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6	FACTOR 7
IA11	0.08593	0.12924	0.50887	0.42230	-0.06939	-0.02884	-0.01469
IA31	-0.36706	0.12498	0.65643	0.06768	-0.07402	0.08501	-0.16957
IA41	0.19214	0.30232	-0.13844	0.04701	-0.09070	-0.05010	-0.07132
IA51	-0.20244	0.48514	0.25510	0.06112	-0.16863	0.04799	-0.08399
IA61	0.03470	0.11509	0.05255	0.03531	-0.10860	0.40243	-0.02476
IA223	0.02995	-0.05342	-0.13451	-0.03818	0.08206	0.41389	-0.00937
IA32	-0.37117	0.20690	0.28600	-0.19823	-0.04375	-0.03306	-0.02076
IA52	-0.16334	0.44309	0.07723	-0.04400	-0.16913	-0.01238	0.02694
IA62	0.06177	0.08519	0.01566	-0.22689	-0.29723	-0.08040	0.19382
IB12	0.10270	-0.01584	-0.00336	-0.47216	0.18872	0.01355	-0.07611
IA13	0.07390	-0.25854	0.55281	0.10994	-0.01049	-0.07523	0.07830
IA53	-0.20605	0.43264	-0.21058	0.02166	-0.00429	-0.40339	0.12737
IB231	-0.27859	-0.13622	-0.16536	0.44364	0.19759	-0.09043	0.28099
IB33	-0.08727	-0.26926	-0.07218	0.06336	-0.07543	-0.08406	0.45311
IIA41	-0.29234	-0.07157	0.20973	-0.05056	0.40415	-0.05185	0.02542
IIB11	0.23306	-0.22491	-0.09529	0.11145	0.28526	-0.23107	0.11048
IIB21	-0.06148	-0.31667	0.04665	-0.01023	0.52505	-0.02866	0.06336
IIB31	-0.27778	-0.34009	-0.18720	0.17943	0.04177	-0.02566	-0.06166
IIIA11	0.53234	-0.26349	0.13360	-0.11252	0.21378	0.07420	0.17544
IIIA21	0.53319	-0.05878	0.01872	-0.08340	0.09925	0.27079	-0.21364
IIIA51	0.08180	0.11893	-0.18944	-0.27832	-0.03458	0.02170	0.22758
IIIA61	0.12333	0.22479	-0.16288	-0.32889	0.27508	-0.03611	0.23802
IIIB11	0.04300	-0.14735	-0.19369	-0.13035	0.67441	-0.05091	0.07023
IVA11	-0.01995	0.53982	-0.06786	0.06399	-0.02699	0.05466	0.16000
IVA214	0.43708	-0.02889	0.03773	-0.10790	-0.03970	0.01880	-0.02368
IVA31	-0.44710	0.19823	0.34067	-0.27734	0.17892	-0.19035	-0.05999
IVA41	0.25660	0.12886	0.06867	0.28730	0.08386	-0.01814	0.02785
IVA51	-0.17959	0.65344	-0.06504	-0.00425	-0.04455	-0.08851	-0.04845
VA41	0.53573	0.03543	0.08605	0.05200	0.03905	-0.09014	-0.12836
VB11	0.21540	-0.07833	-0.27959	0.45937	-0.02750	-0.42889	-0.16124
VB21	0.17103	-0.10204	0.12906	0.10091	-0.02841	-0.26869	-0.41649
VB31	0.24746	-0.16807	-0.04509	0.06674	-0.04596	-0.03627	-0.07244
VIA111	0.44530	-0.28961	0.04144	0.10874	0.11731	0.41271	-0.00824
VIA21	0.11713	0.06078	-0.15799	-0.05109	-0.08057	0.58639	-0.03155
VIA31	-0.68190	-0.10086	0.21481	-0.06669	0.01783	-0.13955	-0.06614
VIA41	0.19875	-0.09897	0.09879	0.39459	-0.15023	0.33288	0.11283
VIA61	-0.20410	-0.01163	-0.31750	0.10167	-0.31115	0.22774	0.26547
VIIA21	0.07454	-0.08468	-0.22290	-0.06637	-0.09355	0.09366	0.02319
VIIA61	-0.12498	-0.14691	-0.04799	-0.43115	-0.18157	0.03959	0.03797
VIIB21	-0.08029	0.04729	-0.31233	0.06331	0.01642	0.00187	-0.03001
VIIB31	0.08492	-0.55017	0.04654	-0.00593	-0.04571	-0.34240	0.23181
VIIIA31	-0.42621	0.30087	-0.05469	0.04688	0.24349	-0.16023	0.24094
VIIIB11	-0.15165	-0.25869	-0.17977	0.20301	-0.09382	-0.08096	0.13109
VIIIB21	0.02680	-0.02900	-0.19502	-0.06497	-0.10343	0.11761	-0.69301
VIIIB31	-0.15242	-0.25724	-0.10520	-0.08352	-0.37275	-0.02497	0.04518

Estimated and Final Communalities for NONSCIENCE

VARIABLE	EST COMMUNALITY	COMMUNALITY
IA11	0.70412	0.50330
IA31	0.69081	0.25541
IA41	0.53590	0.[illegible]7357
IA51	0.63976	0.36191
IA61	0.61059	0.37221
IA223	0.53907	0.15048
IA32	0.59817	0.29081
IA52	0.63468	0.35903
IA62	0.55784	0.43916
IB12	0.66348	0.21190
IA13	0.62637	0.25652
IA53	0.58887	0.35489
IB231	0.54310	0.24012
IB33	0.58859	0.39470
IIA41	0.73656	0.46618
IIB11	0.62126	0.30777
IIB21	0.67976	0.31179
IIB31	0.61445	0.39097
IIIA11	0.68977	0.56429
IIIA21	0.59225	0.40688
IIIA51	0.65251	0.27381
IIIA61	0.65576	0.15534
IIIB11	0.62168	0.25494
IVA11	0.64229	0.47108
IVA214	0.57264	0.20505
IVA31	0.65537	0.47962
IVA41	0.59713	0.29920
IVA51	0.70479	0.65307
VA41	0.72918	0.25324
VB11	0.44904	0.18577
VB21	0.56639	0.42667
VB31	0.30903	0.16411
VIA111	0.67889	0.52428
VIA21	0.68085	0.36961
VIA31	0.56753	0.26263
VIA41	0.55556	0.36134
VIA61	0.57209	0.30277
VIIA21	0.61250	0.24405
VIIA61	0.52841	0.19161
VIIB21	0.56192	0.26703
VIIB31	0.66537	0.53850
VIIIA31	0.74343	0.42680
VIIIB11	0.70958	0.39092
VIIIB21	0.60483	0.22593
VIIIB31	0.63931	0.37285

Eigenvalues and Percent of Variance for NONSCIENCE Factors

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT
1	3.90239	8.7	8.7
2	3.52583	7.8	16.5
3	3.01657	6.7	23.2
4	2.80541	6.2	29.4
5	2.31537	5.1	34.6
6	2.08237	4.6	39.2
7	1.97349	4.4	43.6
8	1.74358	3.9	47.5
9	1.64465	3.7	51.1
10	1.55346	3.5	54.6
11	1.47921	3.3	57.9
12	1.43278	3.2	61.1
13	1.27046	2.8	63.9
14	1.20350	2.7	66.6
15	1.15287	2.6	69.1
16	1.05271	2.3	71.5
17	1.00976	2.2	73.7
18	0.90996	2.0	75.7
19	0.83160	1.8	77.6
20	0.82015	1.8	79.4
21	0.80054	1.8	81.2
22	0.75418	1.7	82.8
23	0.72644	1.6	84.5
24	0.66091	1.5	85.9
25	0.62187	1.4	87.3
26	0.59781	1.3	88.6
27	0.49766	1.1	89.7
28	0.48523	1.1	90.8
29	0.47207	1.0	91.9
30	0.44763	1.0	92.9
31	0.40638	0.9	93.8
32	0.34884	0.8	94.5
33	0.34005	0.8	95.3
34	0.30030	0.7	96.0
35	0.25808	0.6	96.5
36	0.24342	0.5	97.1
37	0.22885	0.5	97.6
38	0.20151	0.4	98.0
39	0.18886	0.4	98.5
40	0.16880	0.4	98.8
41	0.13833	0.3	99.1
42	0.11560	0.3	99.4
43	0.10543	0.2	99.6
44	0.09519	0.2	99.8
45	0.06864	0.2	100.0

Seven Factor Rotated Matrix for NONSCIENCE

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6	FACTOR 7
IA11	0.23554	0.27597	-0.17544	-0.03074	0.05906	-0.46362	0.34858
IA31	-0.15951	-0.07162	0.08187	0.05536	0.24889	-0.27109	0.27928
IA41	0.10714	0.01286	0.19164	0.30861	-0.07446	-0.13488	-0.32592
IA51	0.16612	0.00814	-0.02795	0.31683	-0.01237	-0.40760	-0.00499
IA61	-0.18314	0.11095	0.01582	0.01841	0.00585	-0.11042	0.55994
IA223	-0.07708	-0.03110	-0.35268	0.01734	-0.04079	0.12885	-0.02481
IA32	-0.35158	-0.15504	0.15761	0.26238	-0.02707	0.10148	0.19696
IA52	0.01260	-0.39397	0.17939	0.29857	0.00493	0.04671	0.28306
IA62	-0.02738	0.00732	0.17264	0.05533	-0.15450	0.08867	0.61135
IB12	0.15964	-0.12270	0.19547	0.15053	-0.15644	0.27903	-0.09034
IA13	0.00202	0.45862	-0.19974	0.07516	-0.01496	-0.00860	-0.01850
IA53	-0.16709	-0.19132	-0.07645	0.39088	-0.31064	-0.18504	0.03142
IB231	0.03057	0.29183	0.08241	-0.17618	0.17041	-0.25477	-0.14915
IB33	0.08544	0.20729	-0.05816	-0.21133	0.54049	0.02028	-0.06198
IIA41	-0.62327	-0.02285	-0.21184	0.02171	0.05252	0.06510	0.15764
IIB11	0.04243	0.00696	-0.53303	0.09404	0.09113	0.05502	0.04037
IIB21	-0.21986	-0.35710	-0.26410	-0.01245	-0.04437	0.06534	-0.24437
IIB31	0.00519	0.07453	-0.56613	0.09652	0.20701	0.06179	0.08141
IIIA11	0.34642	-0.03252	-0.07054	-0.15551	-0.57044	0.28778	-0.07641
IIIA21	0.13098	-0.03974	-0.17879	-0.07085	-0.42240	0.41400	-0.03659
IIIA51	0.12145	-0.32434	0.21366	-0.01286	-0.16272	0.19338	-0.21019
IIIA61	0.06128	0.02215	0.05411	-0.03611	-0.38122	-0.02954	0.02564
IIIB11	0.18325	-0.07256	-0.44952	-0.02683	-0.02719	0.10144	-0.04768
IVA11	-0.08088	0.04744	0.04635	0.65525	-0.17157	0.03639	0.00477
IVA214	0.04194	-0.23023	-0.30512	-0.13737	-0.17438	0.01224	-0.09250
IVA31	-0.44276	-0.25996	0.19068	0.39242	0.10909	0.02585	-0.11437
IVA41	-0.00765	0.33097	0.18281	0.17023	-0.29181	0.19614	-0.05985
IVA51	0.06275	-0.07703	0.19144	0.70288	-0.01330	-0.28802	-0.17139
VA41	0.33063	0.14430	0.00342	0.13306	-0.27292	0.14200	-0.10359
VB11	0.29870	-0.15870	-0.22678	-0.08698	0.07769	-0.00313	-0.07947
VB21	0.17280	-0.09999	0.12811	-0.55933	0.12073	-0.12565	-0.16487
VB31	0.25337	-0.02647	0.13254	-0.24020	0.03927	0.01412	-0.14902
VIA111	0.11246	0.51454	0.14823	-0.07058	-0.06816	0.41742	-0.20257
VIA21	-0.08657	0.55666	-0.06535	0.09187	0.12939	0.09736	0.11537
VIA31	-0.23003	-0.01018	0.11114	0.01789	0.01935	-0.44280	0.07213
VIA41	0.05976	0.55344	0.21248	0.02138	-0.05694	-0.01787	0.04802
VIA61	0.08741	-0.08938	0.46861	0.03178	-0.04925	0.03629	0.25058
VIIA21	-0.00978	0.12347	0.02991	0.03888	0.14231	0.43843	0.11759
VIIA61	0.08773	-0.13080	0.22362	-0.24082	0.11038	-0.04966	0.21013
VIIB21	-0.24717	-0.07860	0.08970	-0.43160	-0.05852	-0.04068	-0.01890
VIIB31	0.38711	-0.02742	-0.07267	-0.06488	0.57860	0.20444	0.04266
VIIIA31	-0.62962	0.04913	0.01633	-0.06267	0.03429	-0.14381	-0.04374
VIIIB11	0.01911	0.04502	-0.16533	-0.25643	0.53658	-0.07844	-0.03702
VIIIB21	0.06231	-0.12374	0.22923	-0.38213	-0.04343	0.06640	-0.04325
VIIIB31	-0.08005	-0.27279	0.31264	-0.12037	0.36934	0.14660	-0.14800