

A SURVEY OF STUDENT ATTITUDES
TOWARD SCIENCE AND SOCIETY

by

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CHAPTER I

INTRODUCTION

"The newly developing countries are eager for science and technology. They have seen that they bring to its possessors power over nature, life, death, sickness, and people. Only religion, it seems, has affected the lives of men as profoundly as has technology."¹ Some would perhaps argue with the last statement. However few could argue that science has profoundly affected modern man. For better or for worse, science and technology have become a principal foundation of modern American society. With the development of science and technology has come accelerated change, a phenomenon to which contemporary man is struggling to adapt. Additionally modern science has provided man power over many aspects of nature, but not always wisdom in applying this power. These two difficulties are presently considered of chief importance in educating future generations. Can we educate young people in science and technology such that they can cope with accelerating change? Can we help them evolve an ethic that will enable them to use wisely the technological powers they will inherit? What is the present attitudinal structure which guides student interactions with science and technology? Before considering these questions, it is necessary to view science education within the framework of American education.

Education in the United States has been patterned predominantly on the educational strategies and institutions of Western Europe. However, two important evolutions have occurred that resulted in the American system possessing individual characteristics quite apart from European systems. The first of these was the evolution from an education for the elite to an education for everyone. The early 1600's saw the establishment of

educational institutions for male students from predominantly well-to-do families. By the twentieth century the states had assumed financial responsibility for providing education to all students. The past twenty years has witnessed an exponential increase in the need for a high school diploma and subsequent college training. Many suggest that education has widened its responsibility from the elite to the masses because of the need for an educated electorate to maintain a successful democracy. Others argue that the philosophy of democracy recognized education of the elite as an inconsistency and thus broadened and democratized the role of education. Whatever the case may be, American education has distinguished itself in its attempt to provide as much education to as many people who desire it.

As education expanded to include individuals of various intellectual abilities and desires, so did the curriculum expand to provide a variety of educational experiences. Indeed American education is characteristic in its attempt to provide an education that has become functional and closely related to the daily concerns of its citizenry. As American education evolved from education for the elite to education for the masses, science education has assumed an increasingly functional role in providing a citizenry cognizant of the technology surrounding it.

The evolution of science education in these directions is more apparent in the changes that have occurred during the past twenty years. The first group of science curricular projects was undertaken in the 1950's and focused upon an attempt to upgrade elementary and secondary preparation in the sciences. These projects attempted to upgrade the content of science courses as well as promote student inquiry and involvement. However, in these attempts, they satisfied the needs of only a very few students of exceptional intelligence who were interested in specializing in science.

American schools were full of many less exceptional students, who were being inadequately served by these curricula. Thus the early 1960's saw another wave of science curricular projects that attempted to provide a variety of experiences and resources. The emphasis was placed upon meeting the needs of as many students of diverse abilities and interests as possible. The latest curricular projects are attempting to fashion curricula which prepare students to understand and deal effectively with the scientific society in which they live. Such outcomes may or may not be assumed to be related to either the process or content of science, depending upon the particular individuals involved in the project. Thus science education has within the past twenty years evolved from education for the elite to education for the majority; from consideration of the content of science toward consideration of the ethics of science.

In the midst of this evolution scientists and science educators have attempted to set down explicitly the aims of science education. Of most recent importance has been the discussion of 'scientific literacy'. A large number of individuals have attempted to identify the components of 'scientific literacy' necessary for a citizen in today's society. Pella et al.,² attempted to define scientific literacy in terms of the most frequently mentioned components present in papers presented by scientists and science educators. These components were:

- (1) understanding the interrelationship between science and society
- (2) understanding the ethics of science
- (3) understanding the nature of science
- (4) knowledge of the concepts of science
- (5) understanding the difference between science and technology
- (6) understanding the interrelationship between the sciences and the humanities.

The first three components were mentioned nearly twice as often as the last

four, and thus are the most universally accepted components. In considering this list, essentially four aspects of science become apparent. Scientific literacy apparently consists of an understanding and knowledge of: (a) the content of science, (b) the processes and methods of science, (c) the ethics underlying science, and (d) the interrelationship of science and other aspects of society.

Understanding the interrelationship of science and society has of late received the most attention in discussions concerning scientific literacy. The justification for inclusion of this as a component of scientific literacy has been argued primarily on the need for continued financial support of science. Many funding decisions concerning science are made by individuals not trained in science. Thus there arises considerable need for the individuals in these positions to recognize the degree to which modern American society is dependent upon science, as well as science's dependence upon the society. Parsons has noted: "Science is intimately integrated with the whole social structure and cultural tradition. They mutually support one another - only in certain types of society can science flourish, and conversely without a continuous and healthy development and application of science such a society cannot function properly."³ In order to insure continued societal support of science, layman understanding of the interrelationship between science and society is indeed crucial.

The second justification of this component of scientific literacy deals with the individuals who make up the society. Considerable concern has been expressed with the human being's ability to respond to the accelerated change and increasing complexities resulting from science. Such response is dependent not only upon the psychological adaptation by

the individual but also upon the institutional adaptation by the society.

Winthrop has suggested:

"What is even more important in this connection is the fact that both scientific and technical progress are creating a continually increasing burden of social complexity in our lives - a burden to which the populations of advanced countries are adapting very slowly and very poorly psychologically. To make matters even worse, the best of our institutional efforts to deal socially with that complexity is not very efficient, and the cultural gap or lag between the socially complex conditions produced by advancing science and technology and our efforts to adapt them institutionally is increasing all the time."

The difficulties in adjusting to accelerated social change is in part dependent upon the individual's ability to perceive his identity in a maze of technology. More importantly, he must have some concept of the impact of science; and the resulting change it will have upon his identity. Thus understanding of the interrelationship between science and society contributes to the psychological well-being of a society.

Once the validity of understanding the interrelationship between science and society as a respectable objective in science teaching has been accepted by science educators, the problem confronting them is the implementation and evaluation of that objective. A number of papers have been directed toward the inclusion of this objective in classroom teaching situations, and several curricula have included reference to the impact science has had upon modern society. Additionally, several attempts have been made to evaluate individual perceptions of science and society. It is worthwhile to scan briefly the research and information available in student attitudes toward science in general and toward the relationship between science and society in particular.

Numerous articles exist reporting various types of attitude inventories developed, tested, and utilized in exploratory research. The only common

thread joining these studies is the phrase 'attitude toward science'. The source of this diversity can be appreciated by recalling the definition of an attitude. Edwards suggests that an attitude is " . . . the degree of positive or negative affect associated with some psychological object."⁵ Remmers offers a slightly different interpretation by defining an attitude as an " . . . affectively toned idea or group of ideas predisposing the organism to action with reference to specific attitude objects."⁶ The words psychological or attitudinal object are then responsible for the diversity of studies in attitudes toward science. The number of identifiable attitudes is the same as the number of attitude objects, or the number of things to which an individual may respond. Thus the various attitudes toward science are differentiated by what part or facet of science is designated as the attitude object.

One approach to unifying work done in attitudes toward science is to utilize the components of scientific literacy discussed earlier. The first of these, the content of science, has been firmly developed on cognitive grounds and by tradition has not been treated affectively. However, interest studies toward science often treat a component of this aspect. The second of these, the methods and processes of science, also bridges the cognitive and affective domains. One important distinction must be made with regard to these types of attitude studies. An individual may be taught that certain values govern the behavior of scientists in their work. Thus many attitude inventories may measure his recognition of the existence of those values in science, and are essentially cognitive in nature. Other inventories may attempt to measure the degree to which an individual has accepted such values. At this point the inventory has surpassed understanding and is indeed

concerned with the affects which shape an individual's behavior toward science.

The remaining two aspects are related to the ethics of science and the interrelationship between science and society. These two aspects are distinguished from the content and process of science in that they deal with the values and responsibilities of science as a human endeavor rather than science as a way of knowing and learning. Attitude studies in these areas include desirability of science as a career and student images of a scientist. These deal exclusively with the affective domain but often do not probe into the desirability of the value system underlying such images. Recent attempts have sought to identify the ethics of science and the elements of the interrelationship of science and society. Most of these inventories have concerned themselves with the public's feelings toward science, the public financing of science, and the impact science has had upon society.

These four aspects seem to summarize the major views of science as a subject for attitudinal studies. By no means can they be considered categories mutually exclusive of one another. Certainly in many respects they represent a deepening of commitment from learning about science, to doing science, to becoming a scientist, to basing a society upon science. In another sense, this deepening of commitment may also represent different levels of students to whom we teach science. Understanding their attitudes in each of these four aspects seems useful information.

In dealing with the interrelationship between science and society, two types of attitudinal studies appear relevant. The first of these involves the image of the scientist, insofar as the image relates to the social

actions and position of the scientist. A large proportion of the work in attitudes toward science has been devoted to this topic. The motivation for studies dealing with the image of the scientist arose from the paradox that while students seemed to have favorable attitudes toward science, few were actually choosing scientific careers. In a study of high school students Allen noted that the overall image of the scientist seemed favorable, but that a substantial portion of the students felt that scientists were too narrow in their views, too emotional, essentially magicians, and willing to sacrifice the welfare of others to further their own interests.⁷ Additional studies by Barker, et al.,⁸ Gallagher,⁹ Mead and Metraux,¹⁰ O'Dowd and Beardslee,¹¹ and Remmers¹² substantiate these dimensions of the image as well as many others. The generally accepted dimensions include:¹³

- (1) scientist is more likely to be mentally ill (19%)
- (2) scientist cannot have normal family life (34%)
- (3) scientist is a genius (38%)
- (4) scientists have no thought about the consequence of their work (53%)
- (5) scientists are impractical in manner of solving everyday problems (30%)
- (6) scientists are more than a little bit odd (28%)
- (7) scientists have little regard for humanity (20%)
- (8) scientists are likely to be radical about matters outside their field (54%)
- (9) scientists sacrifice the welfare of others to further their own interests (38%)

There are indeed many negative dimensions of the image of the scientist that appear to contradict the generally expressed favorable attitudes expressed by students.

The second type of attitudinal studies relevant to understanding student perceptions of the interrelationship of science and society have dealt with attitudes toward the societal consequences of science. All these studies have in common the attempt to judge how various groups of

individuals perceive the relationship and impact science has had upon their lives and society. Moore and Sutman included the dimensions of science as a technology versus science as knowledge generating activity, and the necessity of public support of science in their inventory.¹⁴ Earlier work conducted by Withey in 1959 probed the public's response to the accomplishments of science, the progress induced by science, and the ability of science to solve future problems.¹⁵ These studies indicated people felt the progress resulting from science was difficult to adjust to and that conceivably science would allow a relatively few to control the lives of many. Additionally they did not foresee science solving the social problems of the world. This opinion had been substantiated earlier in a study done by Heath, et al.¹⁶ Concern for the possibility of scientific control of the country was articulated in advocating greater governmental control of scientists. A more recent survey done by Science and Public Affairs suggests that students feel science cannot solve many of the social problems facing society today, but that it should direct its attention to the environmental problems that it can conceivably solve. All agreed, however, that science was essential for modern life.¹⁷

The research undertaken in this study is based upon the Science Support Scale developed by Schwirian.¹⁸ This survey instrument attempted to explore attitudes toward science in relation to society in a more fundamental manner. The majority of inventories have probed the individual's attitude toward continued support of science, the direction science should devote its resources and other attitudinal outcomes. The Science Support Scale is a more basic evaluative device in that it probes attitudes toward five cultural values theorized by Barber as being necessary for the growth of science within

society.¹⁹ By dealing directly with these values, the Science Support Scale considers the structure from which an individual, for example, decides what direction scientific research should proceed. In this sense it provides more fundamental information concerning an individual's perception of science and society and the resulting interrelationships.

The nature of this study is to investigate student attitudes toward the cultural values supportive of science as operationalized in the Science Support Scale. In the context of this study the term attitude specifically refers to the positive or negative affect associated with these cultural values. Such response is assumed to be based upon both cognitive and affective constructs within each individual. This investigation is intended to serve as a vehicle by which student perceptions and feelings toward societal values related to science may become more apparent. At this stage it serves primarily as a descriptive tool to educators. It serves such a purpose in that it attempts to describe differences among student populations commonly encountered in the classroom. More directive research into the effect of these attitudes upon achievement in science, the effect of these attitudes in the development of curricula, the variables affecting the degree of support of these values are beyond the scope of this study.

CHAPTER II

DESIGN OF THE STUDY

Survey Instrument

Schwirian clearly states the scope of the Science Support Scale: "The specific focus of the study is an attitude scale designed to assess the degree to which individuals respond supportively to science, its products, and its practitioners."²⁰ Insofar as the Science Support Scale measures support or nonsupport of societal values related to science, resulting information may provide insight into students' perception of science as a societal institution or endeavor. Information gained from any survey must be carefully interpreted in relation to the nature and format of the survey instrument, thus it is necessary to closely examine the construction and validation of the Science Support Scale.

The Science Support Scale was constructed around the theoretical work done by Barber on the sociology of science. In tracing the historical development of science through various societal structures, Barber identified five cultural values as being those particularly conducive to the growth and development of science. These were: (1) rationality; (2) utilitarianism; (3) universalism; (4) individualism; and (5) progress and meliorism.²¹ In no sense may these values be considered mutually exclusive or entirely definitive of a society which supports science. As Barber explains: "These values are not, of course, officially or even informally codified, so the particular list we give here can only be offered as the consensus of numerous scholars and moral leaders who have tried to discover them. Any similar listing would, however, probably have a very large overlap with this one, especially when merely verbal differences were eliminated by close analysis."²²

The motivation for identifying these values was to establish an ideal model for a society that is conducive to the growth of science. By measuring the extent to which an individual supports these values we may ascertain the relationship of individual to societal attitudes concerning values supportive of science.

Remmers has suggested that ". . . attitudes constitute the individual's own evaluation of his conduct and desires in relation to the system of social values as he understands them."²³ This evaluation is usually operationalized as being positive (favorable) or negative (unfavorable). At this point the term operationalization must be qualified. To operationalize a physical quantity, one describes precisely how that quantity is to be measured. In attitudinal survey research one views an attitude as taking on all possible positions, either continuously or discretely, on a linear scale between two extreme views (positive, negative). The operationalization of a specific attitude consists of devising a test or measure which will allow one to specify an attitude by some point on this linear continuum. As such, in attitudinal research one does not have the control over all factors affecting an individual that a physicist possesses over physical factors in a given measurement. In constructing items for the Science Support Scale Schwirian was concerned with operationalizing these cultural values such that an individual's response to the items would reflect his acceptance of the value.

The first and most fundamental value identified by Barber was rationality. In defining this value Barber identified the continuum by placing rationality on one end and traditionalism on the other end.²⁴ Schwirian chose a definition by Chinoy as exemplary of the value of rationality: "As a value rather than a way of thinking, rationality refers to the moral approval placed upon the

use of reason in understanding nature. Rationality may be contrasted with 'traditionalism', which accepts ideas simply because they have the sanctity associated with conventional usage."²⁵ By posing a situation in which one must support a rational response in contrast to a traditional response, the degree to which this value is accepted may be measured. The primary difficulty facing this type of operationalization is the identification of sources of traditionalism present within a given society. Schwirian chose to identify these sources within our present society as religion, common sense or common knowledge, age, approved moral behavior, societal stability.²⁶ The source of rationality was defined to be science.

The second value identified by Barber was utilitarianism. He defined the term a little more narrowly than it is commonly used. "By the value of utilitarianism, we mean that predominant interest modern man has in the affairs of this world, this natural world, rather than in other worldly affairs such as supernatural salvation."²⁷ Thus the value of utilitarianism restricts the application of rationality to the present world and environment of man. This definition places no judgment as to the use of that rationality within this world, only that its use in the present world be chiefly valued. The continuum established for this value places science as being utilitarian at one extreme and religion as dealing chiefly with life beyond that of the present at the other extreme.

The third value was universalism. In the scientific sense universalism is the value placed upon unbiased observation and interpretation of phenomena. Extended beyond its scientific application universalism refers to the use of universalistic or general norms in judging other individuals. Universalism implies that all people be accepted equally on the basis of their merit or

some such universalistic norm which applies equally to all individuals. The operationalism of universalism quite appropriately involves an investigation into prejudice. A continuum in this situation places prejudice at one extreme and universalism at the other extreme. As with traditionalism, the sources of prejudice must be selected for the particular society in question. Schwirian chose to omit religion and race as possible groups likely to experience prejudice because of the threatening nature of such items. Other groups chosen to most likely experience prejudice include those who hold unpopular political views, foreigners, the economically poor, women, and those whose behavior may deviate from the norm.²⁸ Items dealing with this continuum asked the individual to judge such groups working in science.

The fourth value, individualism, similarly seems to be deeply embedded in the American tradition. Barber suggests that "When individualism is an agreed-upon value, members of the society believe in the rightness of moral preference of individual conscience rather than those of organized authority."²⁹ The modern commitment toward the respect of the individual and the right of that individual to adhere to the truth he perceives is an example of individualism. Such a value is inherent in the support of science, insofar as science rejects the imposition of truth by any organized or nonscientific authority. Individualism was operationalized by probing the individual's commitment to an individual's right to make a decision as contrasted to the acceptance of authoritarian decisions. The resulting continuum placed authority at one extreme and the individuality of science or scientists at the other extreme. Authority was characterized in the form of government, tradition, and present beliefs of society or science.³⁰

The final value incorporated into the Science Support Scale was progress

and meliorism. By meliorism we are specifically referring to the commitment to improve man's lot. Barber suggested that science could not survive were it not for the acceptance of progress; and going a bit deeper, were it not for the belief that man can improve his condition. A continuum may be established with an attitude of resisting change opposing progress and meliorism. As Schwirian states: "The logical opposite of a commitment to progress and meliorism is that, 'What was good enough for Dad is good enough for me!'"³¹ Progress was characterized by computers, automation, space exploration, mechanization of tasks, etc.

These then are the five values identified by Barber and operationalized in the Science Support Scale. A summary of the values and representative continua is shown in Table I. One could quarrel with individual statements which compose Schwirian's Science Support Scale. However the instrument does treat Barber's cultural values, and it has been tested. Initial testing by Schwirian implied that the attitude inventory did distinguish between varying attitudes toward these values within a single population.

Scale items for the Science Support Scale were constructed according to the Likert Technique or Method of Summated Ratings.³² According to this technique the scale items are written in the form of statements to which the individual may respond in one of five ways; strongly agree, agree, undecided, disagree, and strongly disagree. The statement is assigned a favorable or unfavorable 'correct' response and the individual's response is scored by assigning numbers for his response in comparison to the 'correct' response. For a favorable item, for example, a response of strongly agree receives a score of five, agree a score of four, undecided a score of three, disagree

TABLE I. Continua used in the Science Support Scale to operationalize Barber's value dimensions.

TABLE I

<u>REJECTION</u>	<u>VALUE DIMENSION</u>	<u>ACCEPTANCE</u>
Religion Common Sense Common Knowledge Age Approved Moral Behavior Societal Stability	Rationality	Science
Religion	Utilitarianism	Science
Communists Foreigners Women Deviates	Universalism	No Prejudice
Government Society	Individualism	Individual
Tradition	Progress and Meliorism	Technology

a score of two, and strongly disagree a score of one. The total score is thus calculated by summing the item scores.³³

Validation of the instrument was obtained using a combination of logical validation and jury opinion. By logical validation, we are referring to the question of whether the statements are valid operationalizations of the five values theorized by Barber. Does the individual's response to each item actually measure his commitment to the value in question? The foregoing paragraphs attempted to outline the development of the Science Support Scale and was considered by Schwirian to be evidence of logical validation.³⁴ Additionally a panel of judges considered to be expert in either science education or attitude scale construction concurred that the instrument was logically valid. A list of these individuals is included in Schwirian's dissertation.³⁵

Reliability of the instrument was obtained using split-half reliability techniques. In measuring reliability we are attempting to measure the precision of the instrument. Essentially we are attempting to estimate how well the given attitude score represents the true score for a given individual. According to the technique of split-half scale reliability, the attitude inventory is split into two halves, usually into odd and even items and scored separately. The Pearson correlation coefficient for the two scores is then calculated. Since reliability is a function of the number of scale items, a correction formula, the Spearman-Brown correction factor, is applied. The corrected reliability of the sixty item scale was 0.77.³⁶

The scale used in this study was slightly altered from the Science Support Scale developed by Schwirian. The original copy of the Science Support Scale obtained by the author was a Xerox copy of Behavioral

Objectives in the Affective Domain by Eiss and Haubeck.³⁷ This copy included only 58 of the original 60-item scale. Additionally item 25 was not readable and a slightly different item was included in the original survey form. The 58 items from the Science Support Scale as used in this study is contained in Appendix I. Reliabilities for this form were calculated and are included in Appendix II.

Survey Application

In validating the scale Schwirian chose to administer the inventory to a total of 200 respondents. Of these respondents, 113 were University of Wisconsin students enrolled in a science education course required for elementary education majors and the remaining 87 were Ohio State University students enrolled in a sociology of education course. Both groups consisted predominantly of women who had no particular interest or disinterest in science.

This particular study is an extension of Schwirian's work in that the Science Support Scale was administered to several groups thought to constitute varying populations with respect to their support of science. As stated earlier, today's science educator is faced with the problem of communicating with students who oftentimes are antagonistic toward science. It was anticipated that the Science Support Scale could prove useful in describing the nature of some of these antagonisms. Because of the nature of the course offerings at Kansas State University, three groups were chosen for testing: Man's Physical World, General Physics, and Engineering Physics.

Man's Physical World is a physical science course developed for non-science students. The textbook presently used is Hewitt's Conceptual Physics.³⁸ Student enrollment is restricted to freshmen and sophomores,

the majority of whom have declared majors in nonscience areas. The distribution of majors and year of study for the semester during which the survey was conducted is shown in Table II. This course is typically one of three or four science courses taken for distribution requirements by nonscience students. Although this population is not as homogenous as that chosen by Schwirian, it was thought that their attitudes would be similar to those expressed by her sample.

General Physics is a two-semester non-calculus physics course for students predominantly in pre-professional fields. The textbook presently used is Adkins' Physics.³⁹ The majority of students enrolling in this course are sophomores majoring in fields such as pre-veterinary medicine, pre-medicine, biological science, physical science teaching, and other such fields. The distribution of majors and year of study for the semester during which the survey was conducted is shown in Table III. Because of the type of majors pursued by this group of students, it was thought they represented a group more committed to and acceptive of these value dimensions than the Man's Physical World sample.

Engineering Physics is a two-semester calculus based course predominantly for engineering and science students. The textbook presently used is Shortley and Williams' Elements of Physics.⁴⁰ Table IV shows the distribution of majors and year of study for the students participating in this survey. It was felt that this group of students would represent a population of undergraduate students most supportive and acceptive of science.

The fourth and last population chosen for study consisted of the faculty and graduate students in the Physics Department. Approximately eighty questionnaires were distributed of which fifty-two were completed and

TABLE II. Distribution of majors and year of study for the
Man's Physical World students included in the
survey are shown

TABLE II
MAN'S PHYSICAL WORLD

<u>Major</u>	<u>Number</u>	<u>Percent</u>	<u>Major</u>	<u>Number</u>	<u>Percent</u>
General	198	23.3	Social Science	7	0.8
Business	129	16.4	Applied Music	6	0.7
Education	117	13.8	Architecture	4	0.5
Home Economics	98	11.6	Biology	4	0.5
Physical Education	56	6.6	Mathematics	3	0.4
Journalism	43	5.1	Business	3	0.4
Psychology	26	3.1	Music	3	0.4
Pre-Law	22	2.6	Agriculture	2	0.2
Political Science	20	2.4	Geology	2	0.2
Sociology	19	2.2	Pre-Medicine	2	0.2
Speech	14	1.7	Engineering	1	0.1
Modern Languages	14	1.7	Anthropology	1	0.1
English	12	1.4	Pre-Vet Medicine	1	0.1
Computer Science	10	1.2	Economics	1	0.1
History	9	1.1	Pre-Forestry	1	0.1

<u>Year</u>	<u>Number</u>	<u>Percent</u>
Freshman	501	59.1
Sophomore	254	30.0
Junior	77	9.1
Senior	15	1.8
More than 4	1	0.1

TABLE III. Distribution of majors and year of study for the General Physics students included in the survey are shown.

TABLE III
GENERAL PHYSICS

<u>Major</u>	<u>Number</u>	<u>Percent</u>	<u>Major</u>	<u>Number</u>	<u>Percent</u>
Pre-Veterinary Medicine	72	17.5	Accounting	1	0.2
Agriculture	108	26.3	Physical Science	1	0.2
Architecture	69	16.8	Geochemistry	1	0.2
Pre-Medicine	29	7.1	Modern Languages	1	0.2
Biology	32	7.8	Philosophy	1	0.2
General	13	3.2	Physics	1	0.2
Medical Technology	5	1.2	Business	1	0.2
Fishery-Wildlife Biology	10	2.4	Statistics	1	0.2
Pre-Pharmacy	5	1.2	Political Science	1	0.2
Wildlife Conservation	7	1.7	Microbiology	2	0.5
Computer Science	4	1.0	Physical Therapy	1	0.2
Mathematics	5	1.2	Biochemistry	1	0.2
Geology	9	2.2	Psychology	1	0.2
History	1	0.2	Music Education	1	0.2
Pre-Dental	4	1.0			

<u>Year</u>	<u>Number</u>	<u>Percent</u>
Freshman	21	5.1
Sophomore	267	65.0
Junior	87	21.2
Senior	28	6.8
More than 4 Years	8	1.9

TABLE IV. Distribution of majors and year of study for the Engineering Physics students included in the survey are shown.

TABLE IV
ENGINEERING PHYSICS

<u>Major</u>	<u>Number</u>	<u>Percent</u>
Engineering	155	82.0
Architecture	13	6.9
Agriculture	6	3.2
Education	3	1.6
Physics	4	2.1
Chemistry	3	1.6
General	2	1.1
Mathematics	1	0.5
Pre-Medicine	1	0.5

<u>Year</u>	<u>Number</u>	<u>Percent</u>
Freshman	4	2.1
Sophomore	162	85.7
Junior	20	10.6
Senior	3	1.6

returned. Of the total sample of 52, 21 were faculty responses and 31 were graduate student responses. This population was included in the study for the purpose of contrasting student responses with those of academic scientists. Most classroom situations involve communication between this group and the three student groups described above. Knowledge of the attitude differences should be more useful than simple knowledge of the student attitudes toward Barber's value dimensions.

The Science Support Scale was administered to the three student populations during the first week of the Fall Semester, 1971. It was administered to five lecture classes of Man's Physical World I, yielding a total sample size of 768. 67 of the responses were discarded because they were incomplete, resulting in a sample of 701. The survey was administered to General Physics I and Engineering Physics I during the laboratory sessions, also during the first week of classes. The original sample size of the General Physics population was 338. Twenty-three responses were discarded because they were incomplete, yielding a final sample size of 315. The sample size of Engineering Physics was 191, nineteen of which were discarded, providing a final sample size of 172. The Science Support Scale was administered to the Physics faculty in February 1972. The time difference between administration to the faculty and students was not judged to introduce any difficulty because of the presumed relative stability of the scientist's attitudes. Of the 52 responses received from the faculty, two incomplete responses were discarded yielding a sample size of 50.

Scoring the Inventory

Students were asked to respond to the survey items on an IBM answer sheet, IBM Document Number 505. The IBM answer sheets were scored using an

IBM 1230 Optical Mark Scoring Reader, and item responses were punched into 80-column cards. These cards were then rescored according to Likert scale procedures. Schwirian did not include an assignment of positive or 'correct' response to the items as they were utilized in her study. Thus the items were judged in conjunction with her discussion of the operationalization of the values. The 'correct' responses utilized for this study are indicated in Appendix I. The Likert scores were utilized for the remainder of the study. In considering various statistics reported in the remainder of the study, the reader should recall that the scale from 1-5 represents a graded response from unfavorable to favorable rather than the actual response on the Science Support Scale.

Although not completely committed to these chosen 'correct' responses, the Academic Physicists represent the most committed population within the society. The correct responses were compared to the responses by the Academic Physicists. The items on which the Academic Physicists were undecided or nonsupportive of the societal values are listed below:

1. One important function of science is to demonstrate the wonder and orderliness of God's universe. (Utilitarianism)
2. It is likely that much of the scientific information we have today will be demonstrated to be inaccurate or inadequate in the future. (Rationality)
15. The United States should encourage more students from foreign countries to study science in American universities. (Universalism)
20. Teaching machines promote improved education. (Progress and Meliorism)
32. The scientist's activities must not violate the basic values of his society. (Individualism)
40. In times of national emergency a scientist's utmost concern should be for the contribution he can make to his country's needs rather than his own specific research interests. (Individualism)
51. It is a good policy to base an important decision purely on evidence even if it is the opposite of the decision based upon common sense. (Rationality)

- 52. The true meaning of any discovery should be judged by man's physical wants and needs rather than by his moral standards. (Utilitarianism)
- 55. It will be a good thing when machines free men of all manual labor. (Progress and Meliorism)

Items 51 and 55 show the Academic Physicists nonsupportive of the values in the context in which they appear. Items 20 and 52 show the majority undecided about the statement. Items 1, 2, 15, 32, and 40 show distributions split between support and nonsupport of the value in the context of the statements. Items 2 and 51 indicate an unwillingness by the Academic Physicists to support rationality as opposed to traditionalism within their own field of study. As would be expected, scientists are more tolerant of traditionalism within their own field of study than in other areas of society. Item 15 more than likely reflects the current financial straits American scientists are experiencing, causing many to abandon universalism in this situation. Items 32 and 40 indicate that scientists feel some responsibility toward the society in which they work, and hence act within some of the boundaries established by the society. Items 1 and 52 show the Academic Physicists split between utilitarianism and values inherent in morality or religion. These items seem to reiterate items 32 and 40 in expressing the attitude that scientists have some responsibility to act in their society. Items 20 and 55 showed the Academic Physicists undecided about the item, indicating some conservatism toward change.

These items indicate that the Academic Physicists as a population are not entirely supportive of Barber's societal values. It is useful to note these deviations from support of the various values by the Academic Physicists in subsequent discussions of results. In most cases the student populations were more nonsupportive of the particular value than the Academic Physicists.

Analysis of the Survey

An initial analysis of the total scores for each population was conducted. Essentially two assumptions are made in any attitude study: (1) that attitudes are measurable, and (2) that attitudes vary along a linear continuum.⁴¹ The total score, calculated from the Likert item scores, represents the position of an individual along this linear continuum. Because of the Likert scaling, however, the data is interval data and no true zero point is known within the continuum. Studies dealing with this type of data are restricted to comparison-type investigations. A first step in these comparisons is to ascertain population differences with respect to the position along the attitude continuum.

Total scores were calculated for all individuals in the populations studied, and frequency distributions were compared. These distributions are shown for all four populations in Plates 1 and 2. The total score distributions were compared using a one-tailed t-test for two independent samples.⁴² Table V contains a summary of those calculations. For comparative purposes, a t-score of 1.3 indicates a probability of 90% that the populations are different. All t-test scores yielded a level of significance of 0.0005 except that between General Physics and Engineering Physics, which was judged at a level much greater than 0.10. By level of significance we are referring specifically to the probability (0.10=10%) that two alike populations are judged to be different. Thus except for the General Physics and Engineering Physics populations, the remaining populations were different with respect to the attitude scores measured by the Science Support Scale. The large difference between the student populations and the Academic Physicists should be noted. Having established these differences with respect to attitudes toward

PLATE I. Total score distributions for Man's Physical World
and General Physics populations are shown.

PLATE I

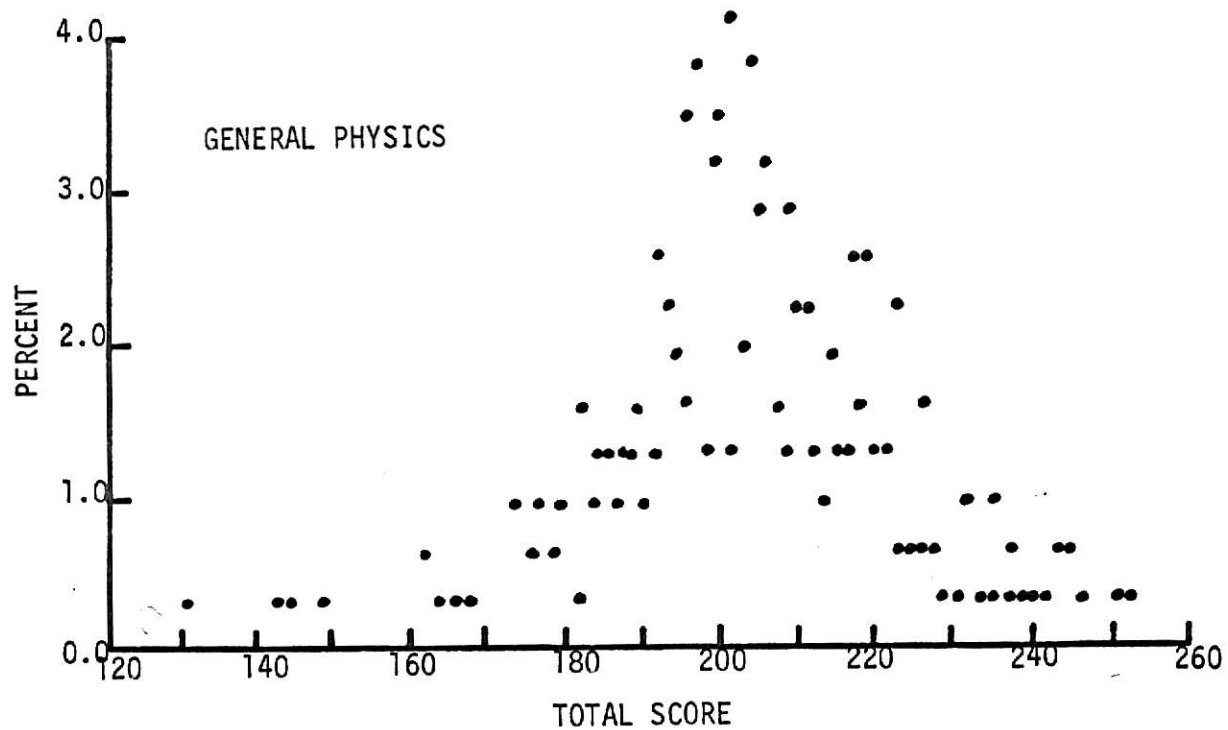
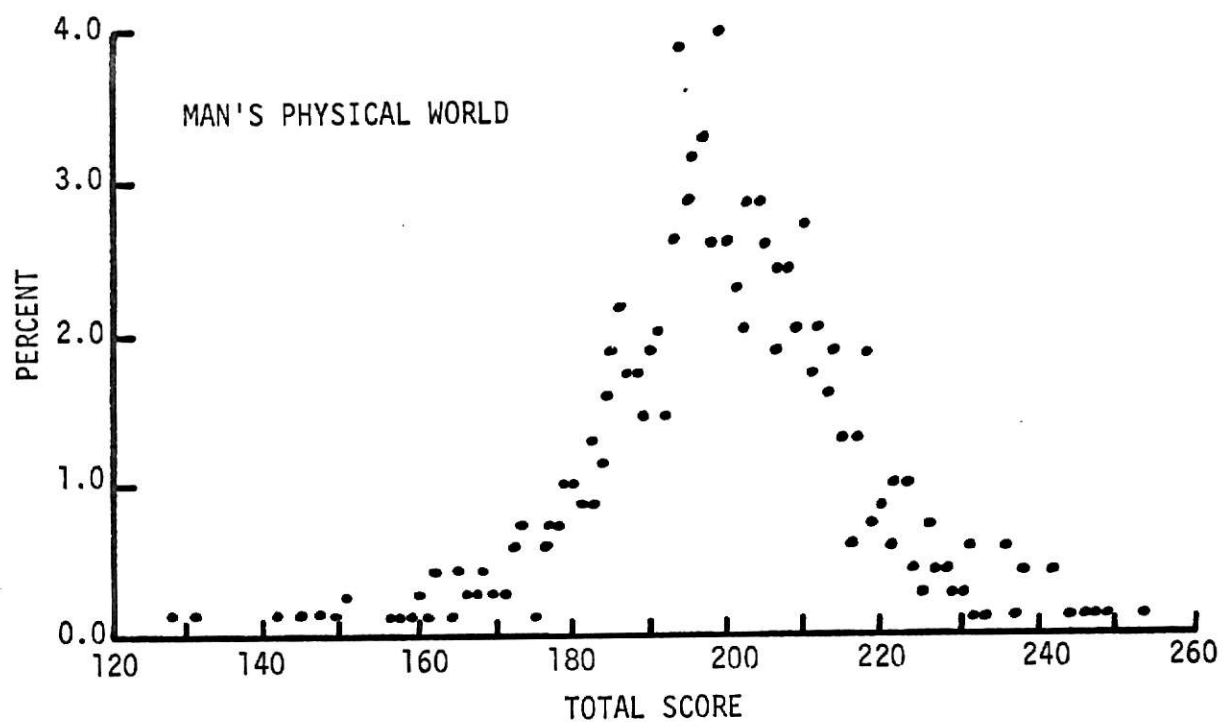


PLATE II. Total score distributions for Engineering Physics and Academic Physicists populations are shown.

PLATE II

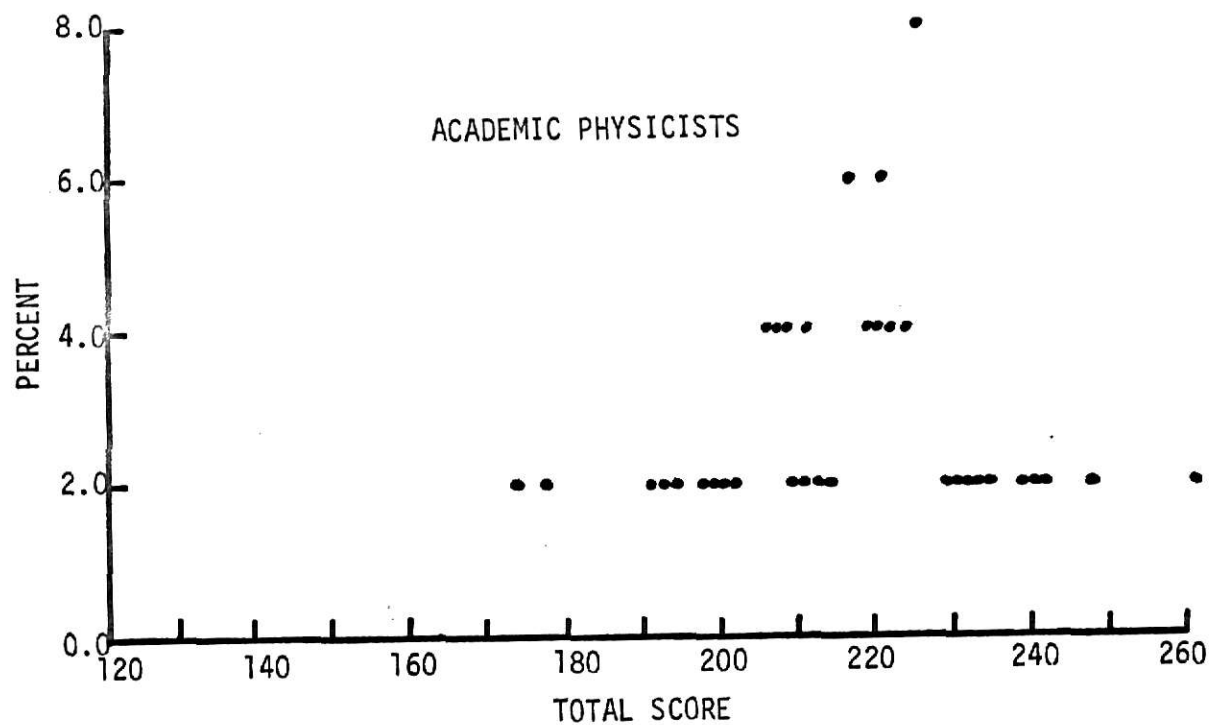
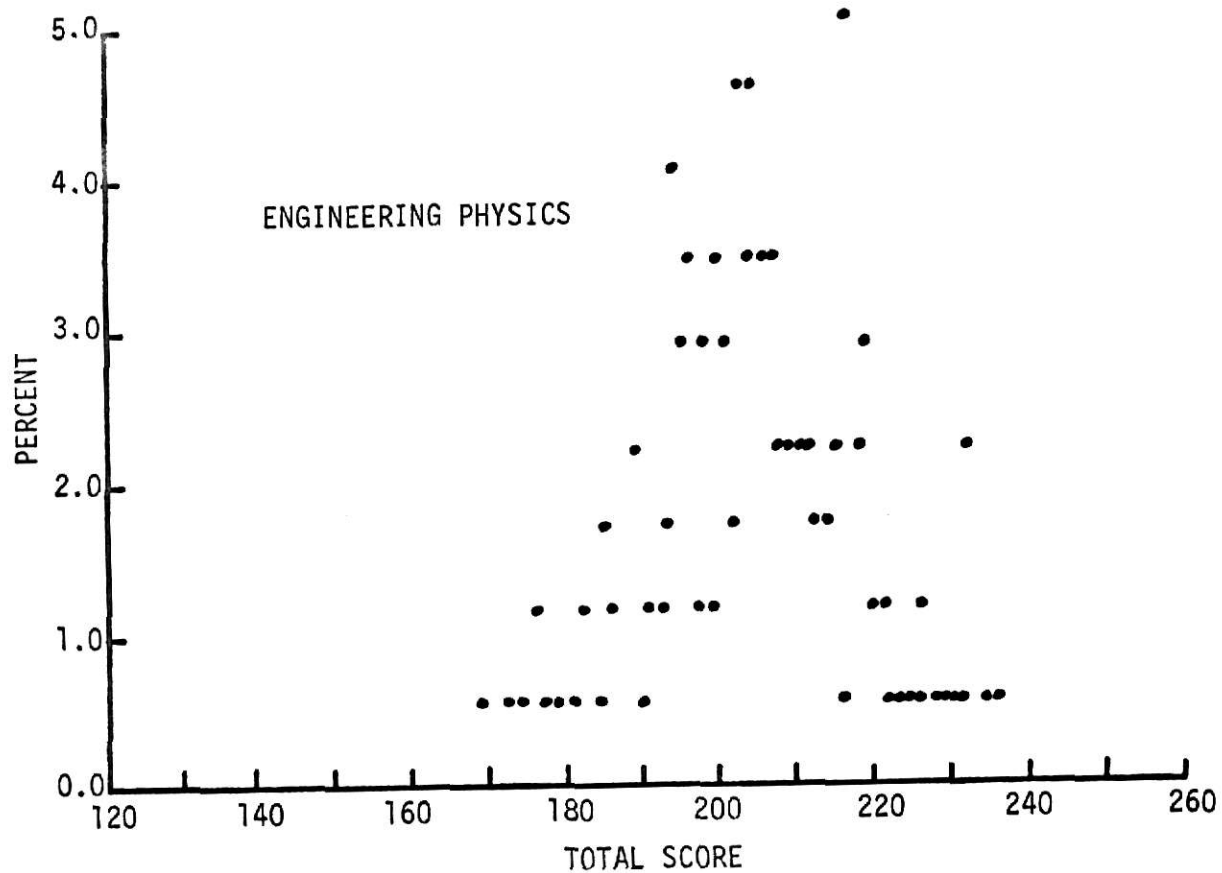


TABLE V. A summary of t-scores obtained from application of the t-test of independent samples to the four populations utilized in this study.

TABLE V
TOTAL SCORE COMPARISONS

Populations	Mean	t-test Scores		
		Man's Physical World	General Physics	Engineering Physics
Man's Physical World	199.4	0.00	3.67	3.97
General Physics	203.7	3.67	0.00	0.94
Engineering Physics	205.1	3.97	0.94	0.00
Academic Physicists	217.1	7.26	5.01	5.21

societal values supportive of science, the remainder of the study involved determining and describing the nature of the differences reflected in the total score distributions.

The first approach used to ascertain the differences of attitudes assumed the existence of the value dimensions as defined by Barber and operationalized by Schwirian. Total scores were computed for each of the five values; rationality, utilitarianism, universalism, individualism, and progress and meliorism. Population distributions for each value were compared to ascertain whether the populations differed. Once differences were found, the distributions of Likert scores for two populations were plotted for each item in the value subset. Chi-square tests of independence were applied to the items to determine if the populations differed with respect to their response to the item. Items with a level of significance greater than .05 were omitted from discussion. The remaining items were then compared as to the nature of the population differences. The original data utilized in this analysis are contained in Appendix II. Results from this approach are presented and discussed in Chapter III.

The second approach used to determine population differences on the Science Support Scale assumed no prior value dimensions. The fifty-eight items were treated as a series of items representative of values toward science and society. Factor analysis was performed on the items for each population to determine if the items clustered in a configuration different than that used in constructing the Science Support Scale. Results from this approach are presented and discussed in Chapter IV.

CHAPTER III

ANALYSIS OF RESULTS: BARBER'S VALUE DIMENSIONS

The graphs included in Plate I and Plate II indicate that Man's Physical World students, General Physics students, and Engineering Physics students differ significantly from Academic Physicists in their attitudes toward societal values supportive of science. One approach to analyzing these differences is to examine the item scores of these populations within the structure of the original value dimensions. The questions being pursued in this section are: (1) Are the differences as reflected by the total score distributions divided equally among the five value dimensions comprising the Science Support Scale? (2) What type of differences in attitude exist with respect to the original items? In all cases the student populations were initially compared to the Academic Physicists.

The first of these questions was considered by calculating value subset scores for each population. The items included in each value subset as operationalized by Schwirian are contained in Appendix I. The subset scores were computed using FREQ, KSU Program Library User Program 13.3.001.⁴³ The various population distributions were then compared graphically. Means and standard deviations were calculated for the various distributions in an effort to better describe population differences.

The second of these questions, dealing with item differences, was considered within the context of the value dimensions. The purpose of this analysis was to examine the population differences by means of the Likert distributions, considering in detail only those items with statistically significant differences. The categorization of responses used in Likert scaling suggests the use of the chi-square statistic in judging the significance of any

item score differences. The null hypothesis being tested was that the Likert scores were independent of the population chosen.

The chi-square distribution is essentially an approximation of the multinomial distribution, equivalent to the normal approximation of the binomial distribution. Membership in one of the populations was chosen to be the independent variable and the Likert score of the scale item was chosen to be the dependent variable. The data were arranged in a bivariante frequency table; expected frequencies for each cell determined by the equation:⁴⁴

$$E_{ij} = \frac{\sum_i (\text{Row Frequencies})_i \sum_j (\text{Column Frequencies})_j}{\text{Sum of Individuals in Both Populations}} .$$

The chi-square statistic was then calculated from the equation:⁴⁵

$$\chi^2 = \frac{(O_{ij} - E_{ij})^2}{E_{ij}} \quad \text{where } O_{ij} = \text{Observed Frequency}.$$

The larger the chi-square statistic, the greater the probability that the item score is a function of the populations being compared. Essentially a theoretical distribution based upon the observed distributions of the two populations is created, and the degree to which the two populations fit this theoretical distribution is calculated. The more alike the two populations are with respect to their item score, the better the fit to the theoretical distribution and hence the smaller the chi-square statistic. The resulting chi-square values and probabilities were computed using CHI SQUARE, KSU Program Library User Program 13.3.002.⁴⁶ The level of significance was chosen to be .05, and only items with this or smaller probabilities were considered in the discussion to follow.

Man's Physical World versus Academic Physicists

The total score distributions for the rationality value dimension are displayed in Plate III. The maximum possible score was sixty. As can be seen from the two graphs, both populations were generally supportive of rationality. The Academic Physicist (Physicists) distribution had a mean score of 45.3, while the Man's Physical World (MPW) distribution had a mean score of 41.5. The two distributions are difficult to compare, primarily because of the spread of the Physicist population scores. However the difference in mean scores and the large percentage of Physicists' scores greater than 45.0, indicate that the Physicists were more supportive of rationality. The items from this value dimension with chi-square values significant at the .05 level are listed below. The distributions for these items are contained in Plates IV and V.

RATIONALITY

- 2. It is likely that much of the scientific information we have today will be demonstrated to be inaccurate or inadequate in the future.
- 7. The skepticism of the scientist should be limited to his work.
- 22. The unbounded inquiry of the scientists has had a bad effect on society's moral standards.
- 29. When the findings or theories of science conflict with religious belief, it is better to accept the religious belief.
- 35. It is unlikely that a young scientist will make important discoveries.
- 45. Scientific findings should not be made public if they will create social unrest.
- 51. It is a good policy to base an important decision purely on evidence even if it is the opposite of the decision based on common sense.
- 53. All miracles have a scientific explanation.
- 54. Scientists go overboard on demanding evidence before drawing conclusions.

The deviation of the Physicists from support of rationality in items 2 and 51 was discussed previously. Man's Physical World (MPW) students similarly were unable to support rationality as opposed to present knowledge and common

PLATE III. Distributions of scores received for the rationality value dimension by Man's Physical World and Academic Physicist populations.

PLATE III

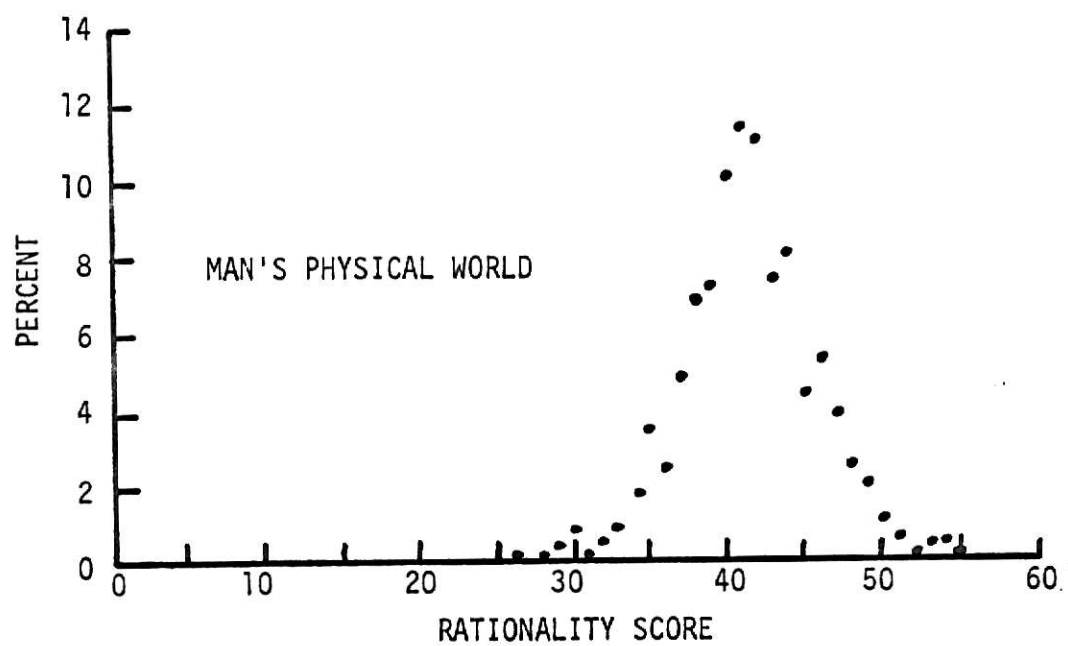
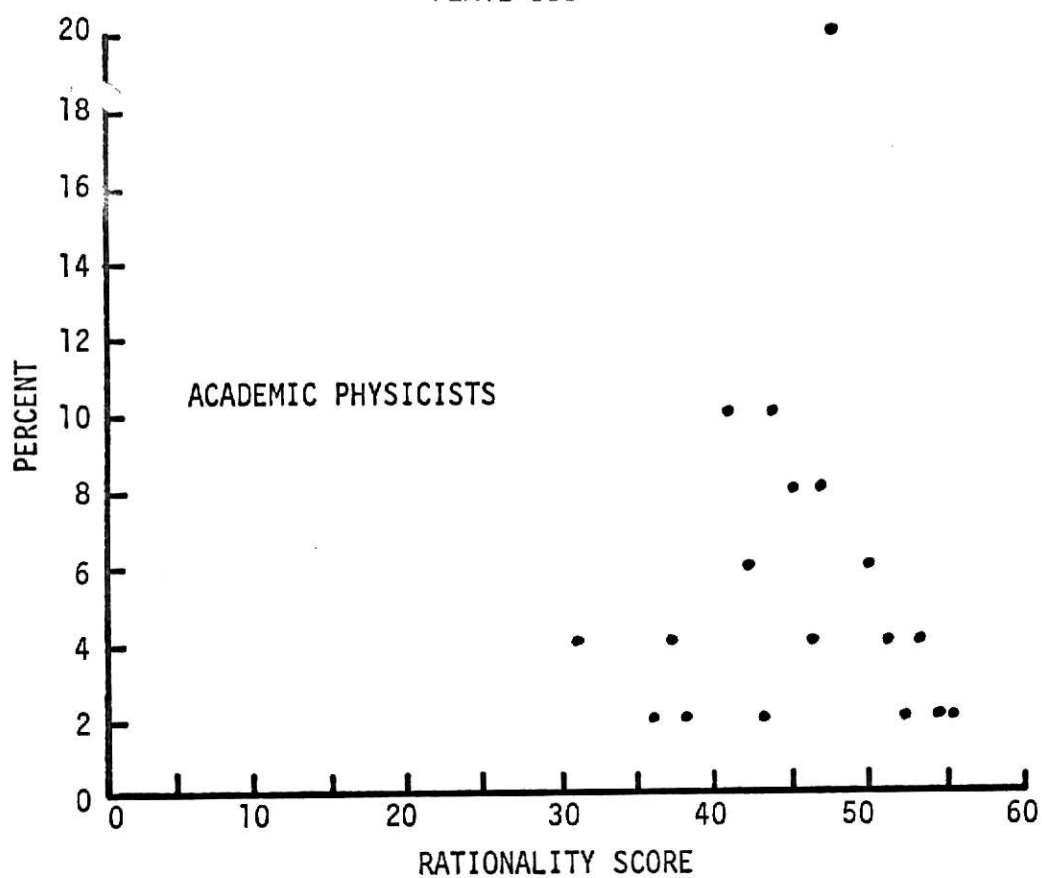
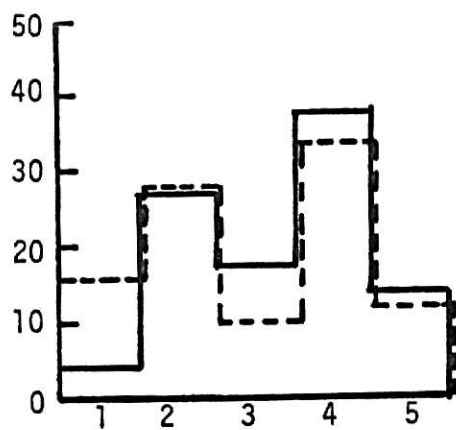
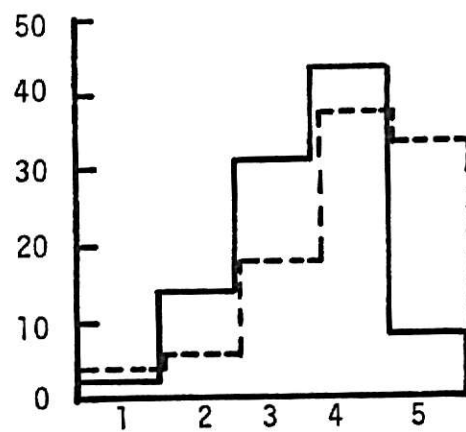


PLATE IV. Items from the rationality dimension with chi-square statistic significant at the .05 level. Likert scores are plotted along the abscissa, and percent receiving that score along the ordinate. The solid line represents the Man's Physical World population, and the broken line represents the Academic Physicist population.

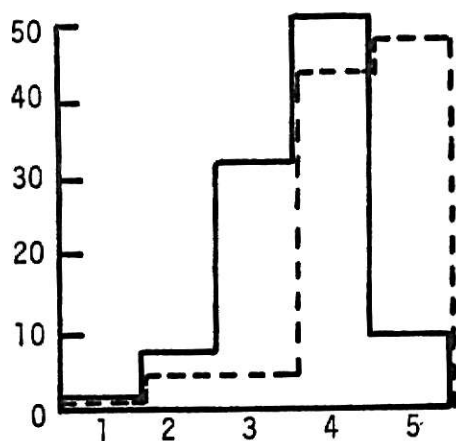
PLATE IV



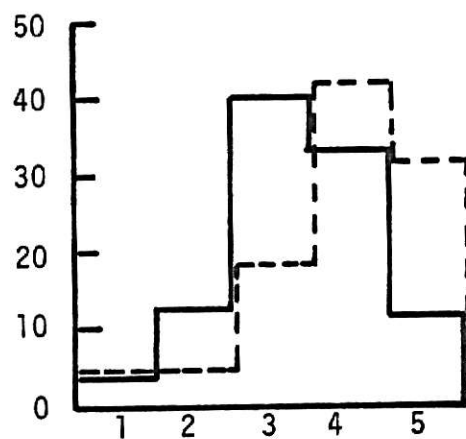
ITEM 2



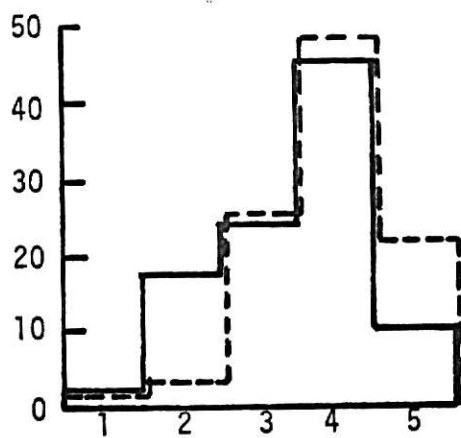
ITEM 7



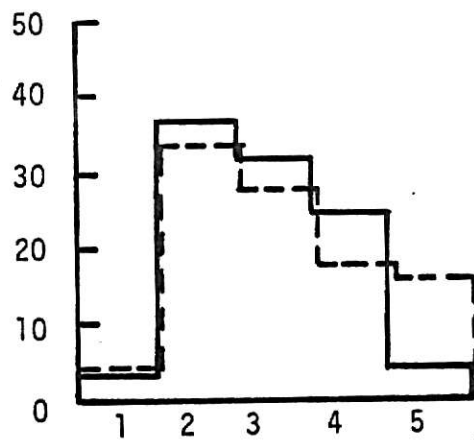
ITEM 22



ITEM 29



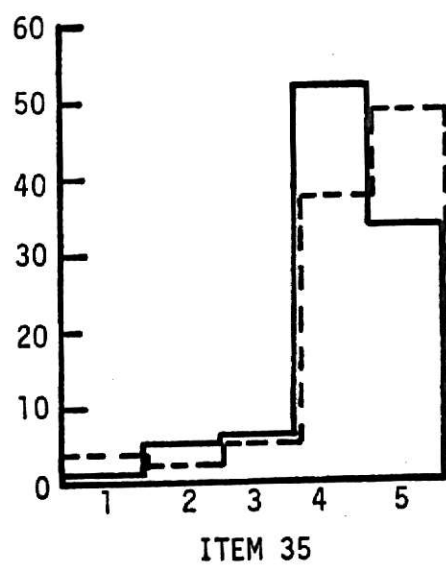
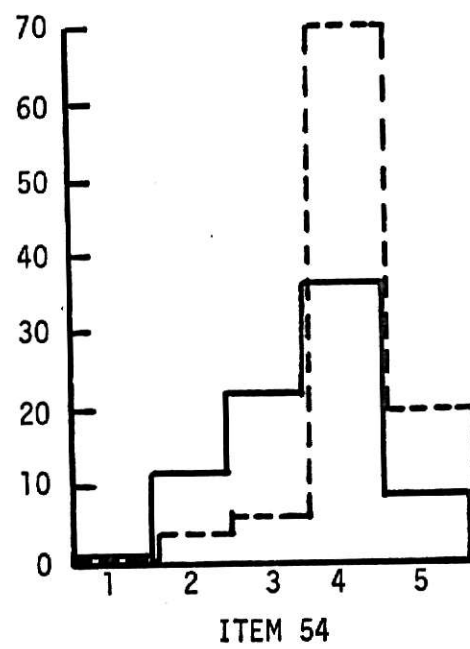
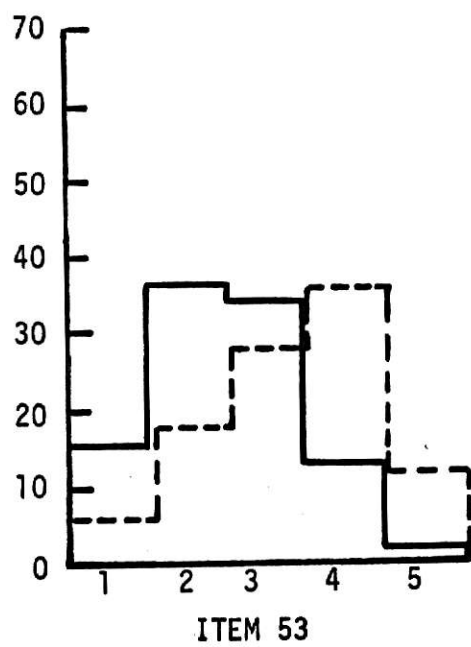
ITEM 45



ITEM 51

PLATE V. Items from the rationality dimension with chi-square statistic significant at the .05 level. Likert scores are plotted along the abscissa and percent receiving that score along the ordinate. The solid line represents the Man's Physical World population, and the broken line represents the Academic Physicist population.

PLATE V



sense. In both items the Physicists were more supportive of rationality than the MPW students; however, it is important to note that neither group was clearly supportive of rationality in these contexts. While the distributions differed, their differences were not in attitude but rather in degree of commitment.

Items 7, 22, 35, 45, and 54 showed support of rationality by both populations. Item 35 differentiated between the two populations only in the degree to which rationality was supported, i.e., more Physicists received a Likert score of five as contrasted to the number of MPW students who received a Likert score of four. Items 7, 22, and 54 showed some of these same differences; however, considerably more MPW students were undecided about the items. Items 7 and 54 dealt with the manner in which the scientist practices his commitment to rationality, while item 22 dealt with traditionalism vested in moral standards. Item 45 differentiated between the two populations with respect to the number of MPW students receiving a Likert score of two as opposed to the number of Physicists receiving a Likert score of five. While the MPW population was supportive of rationality, considerably more of them were willing to support traditionalism vested in societal stability.

The greatest disagreement between the two populations in the rationality dimension occurred in items 29 and 53. Item 29 indicated that a majority of MPW students were undecided about the item, while the majority of Physicists were supportive of rationality. This particular item dealt with rationality versus traditionalism as represented by religion. The majority of MPW students seemed unsure as to the relationship between religion and rationality. Item 53 was the only item in which the two populations differed entirely in

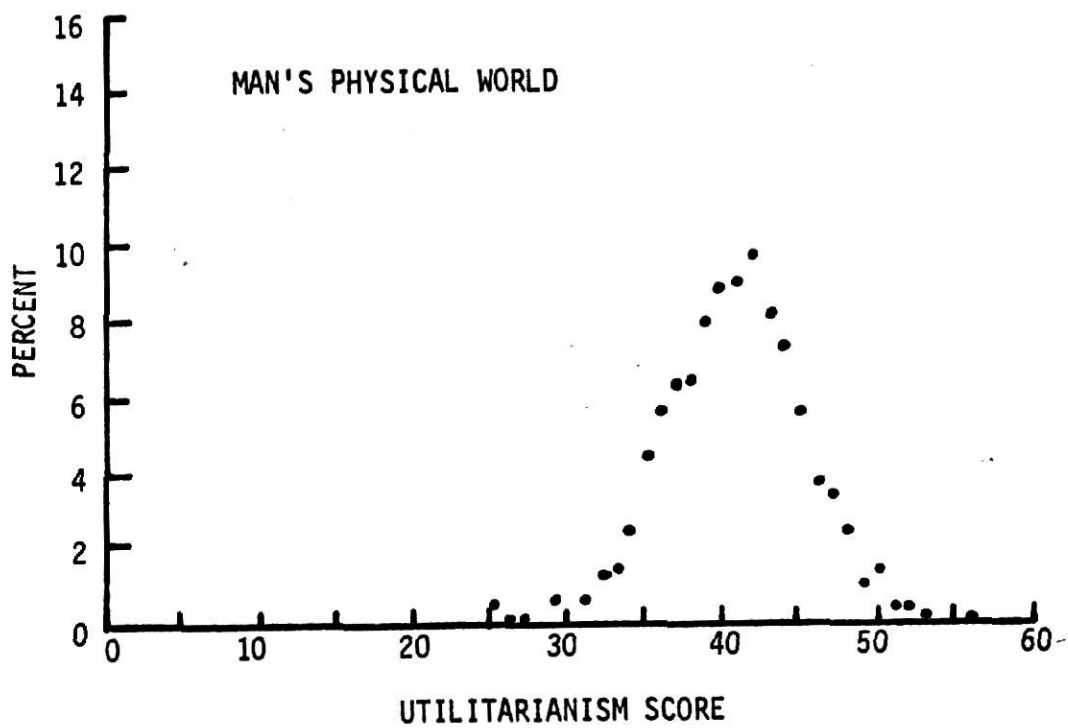
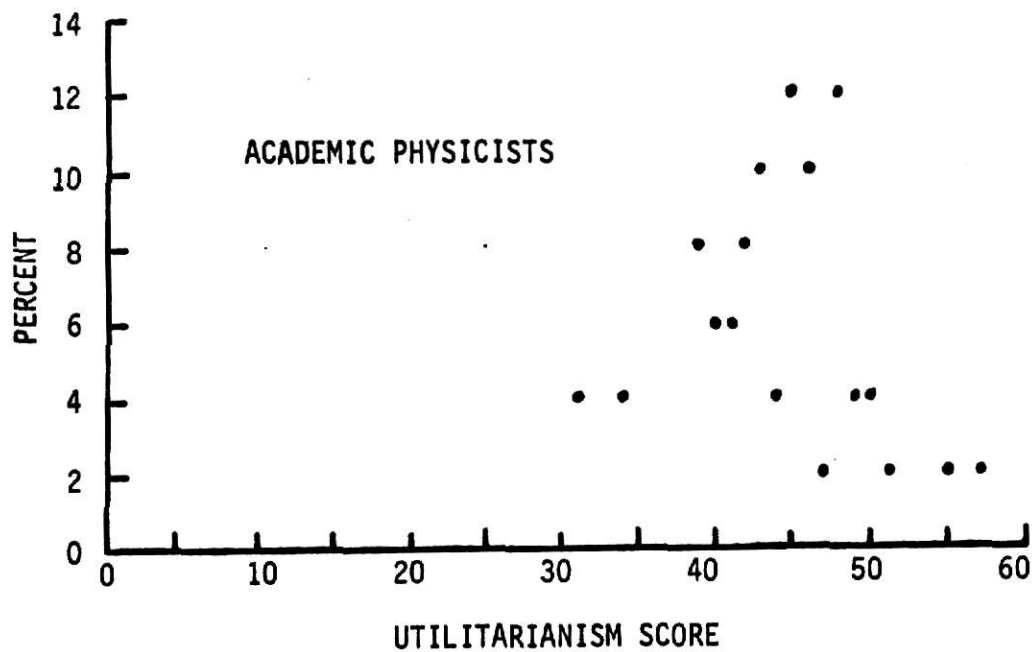
attitude toward the value. The MPW students were not willing to support rationality to the exclusion of other forms of explanations of miracles, while the Physicists generally supported the statement. Both these items dealt with rationality versus religion, where religion represented a form or source of traditionalism. It would appear that the MPW student differed significantly from the Physicists with respect to acceptance of this particular form of tradition.

In general, the MPW students were supportive of rationality, although not to the same degree as the Physicists. The results indicated considerable indecision on the part of the MPW student with respect to values placed on rational action as compared to societal stability or moral and religious standards. Smaller differences were encountered toward items dealing with the actions of scientists in applying rationality, such as in demanding evidence before making decisions. The remaining items that did not yield significant differences (items 16, 21, and 10) all dealt with the actions of the scientist. The MPW students seemed to agree that science should encourage people to question their beliefs; however, they did not agree as to whether those beliefs should be rejected in favor of scientific results and/or explanations. Thus differences between the two populations seemed to lie not so much in the validity and acceptability of the role of science as an activity, but in the acceptance of science as a complete and perhaps exclusive explanation of the universe. Item 53 indeed indicated that the MPW student feels certain that rationality should not be accepted at the exclusion of nonrational explanations of miracles, for example.

The total score distributions of the utilitarianism dimension are displayed in Plate VI. The maximum possible score was sixty. The mean score for the Physicists was 43.9, and the mean score for the MPW students was 40.7.

PLATE VI. Distributions of scores received for the utilitarianism value dimension by Man's Physical World and Academic Physicist populations.

PLATE VI



The Physicists more strongly supported utilitarianism, although the differences between the two populations were not as pronounced as was the case for the rationality dimension. The items yielding chi-square statistics significant at the .05 level are listed below. The distributions are displayed in Plates VII and VIII.

UTILITARIANISM

1. One important function of science is to demonstrate the wonder and orderliness of God's universe.
5. Religious leaders should be constantly on guard against the ideas and theories that scientists produce and explore.
6. Science is bound to lead our society into Godliness.
18. In order to be more effective, religious leaders should know about recent major advances and developments in science.
26. The meaning of any discovery should be judged by man's moral standards rather than by his intellectual need for truth.
27. It is possible for a man to be a dedicated scientist and to be highly committed to his religious convictions.
31. While man has become physically richer from the fruits of science, he has become spiritually poorer.
37. The material progress of science has made men care less than they should about the prospect of eternal life.
50. Men are worthy of enjoying the fruits of scientific discovery.
52. The true meaning of any discovery should be judged by man's physical wants and needs rather than by his moral standards.

The vast majority of Physicists were undecided on item 52. Almost as many MPW students supported as well as opposed the statement. The MPW population was considerably more diverse with respect to accepting provision for man's physical wants and needs as a justifiable reason for doing science. The relative affluence of the post-World-War-II decades has made young people more secure toward physical necessities. As a result there has been a growth of groups condemning the establishment for its materialistic concerns. It would seem that these groups are represented in the percentage that expressed nonsupport of item 52. The more conservative or 'establishment' portion of MPW students probably recognized the contribution scientific discovery has made toward satisfaction of physical wants and needs, supporting the statement.

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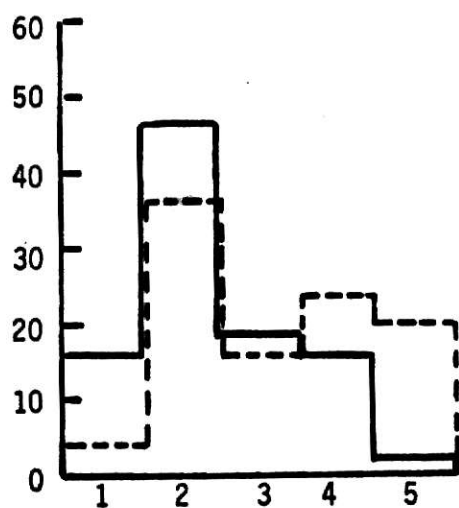
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5. Religious leaders should be constantly on guard against the ideas and theories that scientists produce and explore.
6. Science is bound to lead our society into Godliness.
18. In order to be more effective, religious leaders should know about recent major advances and developments in science.
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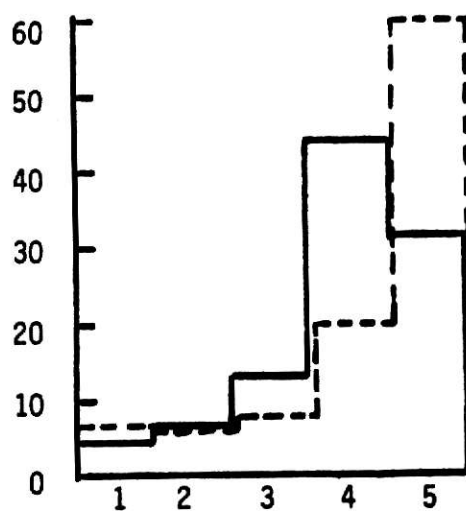
The majority of items (items 5, 6, 26, and 50) indicated only a difference between the two populations in degree of support of utilitarianism. Items 5

PLATE VII. Items from the utilitarianism dimension with chi-square statistic significant at the .05 level. Likert scores are plotted along the abscissa and percent receiving that score along the ordinate. The solid line represents the Man's Physical World population, and the broken line represents the Academic Physicist population.

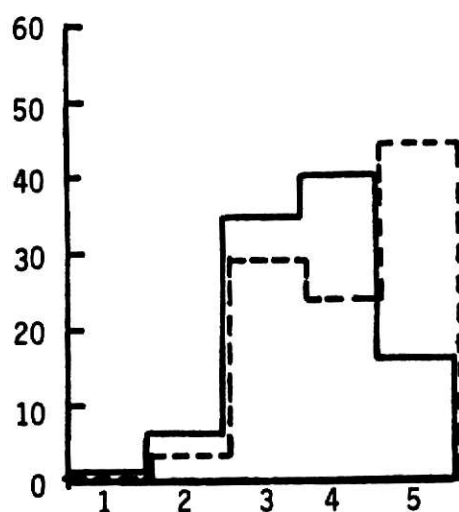
PLATE VII



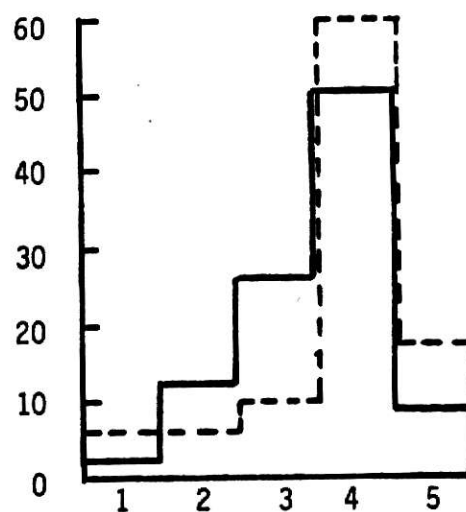
ITEM 1



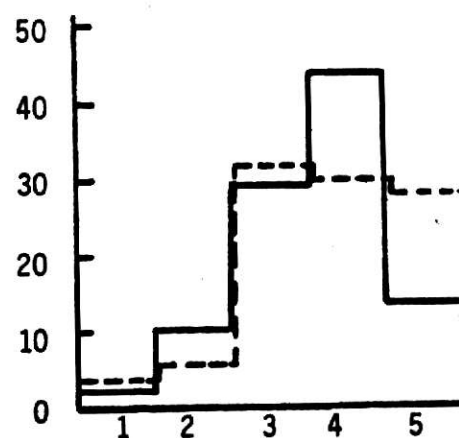
ITEM 5



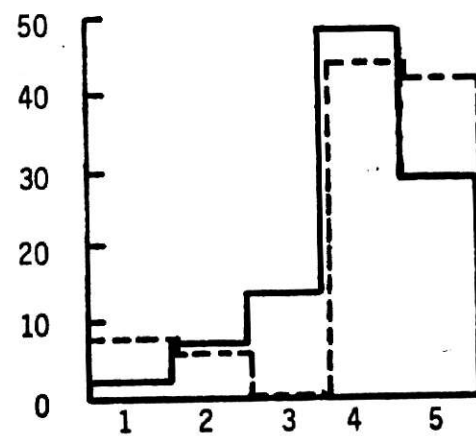
ITEM 6



ITEM 10



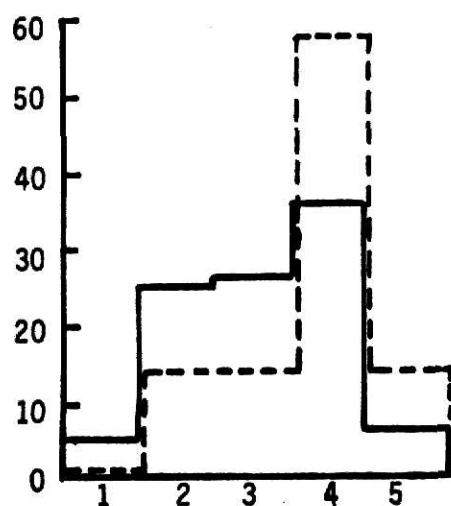
ITEM 26



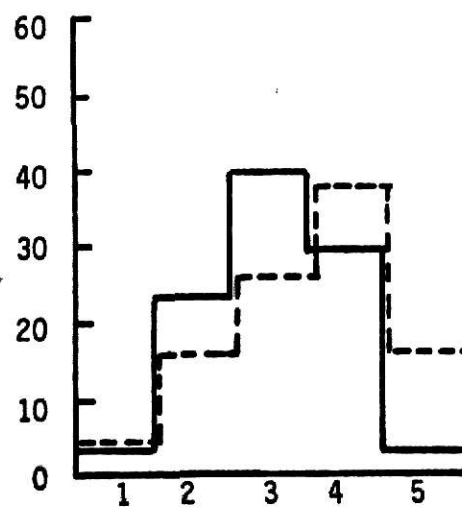
ITEM 27

PLATE VIII. Items from the utilitarianism dimension with chi-square statistic significant at the .05 level. Likert scores are plotted along the abscissa and percent receiving that score along the ordinate. The solid line represents the Man's Physical World population, and the broken line represents the Academic Physicist population.

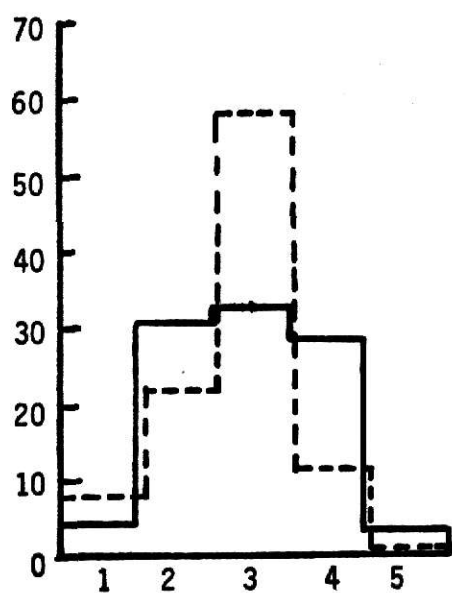
PLATE VIII



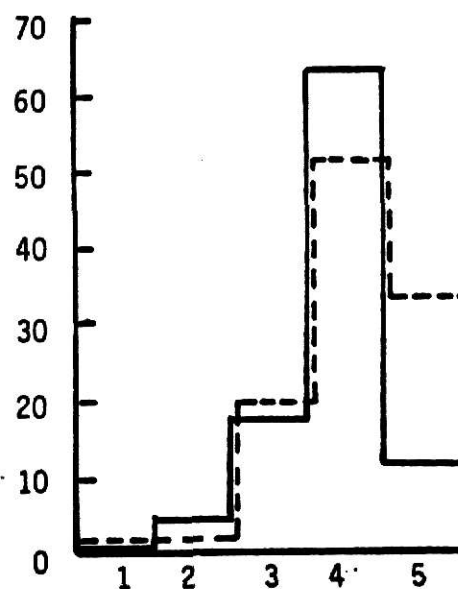
ITEM 31



ITEM 37



ITEM 52



ITEM 50

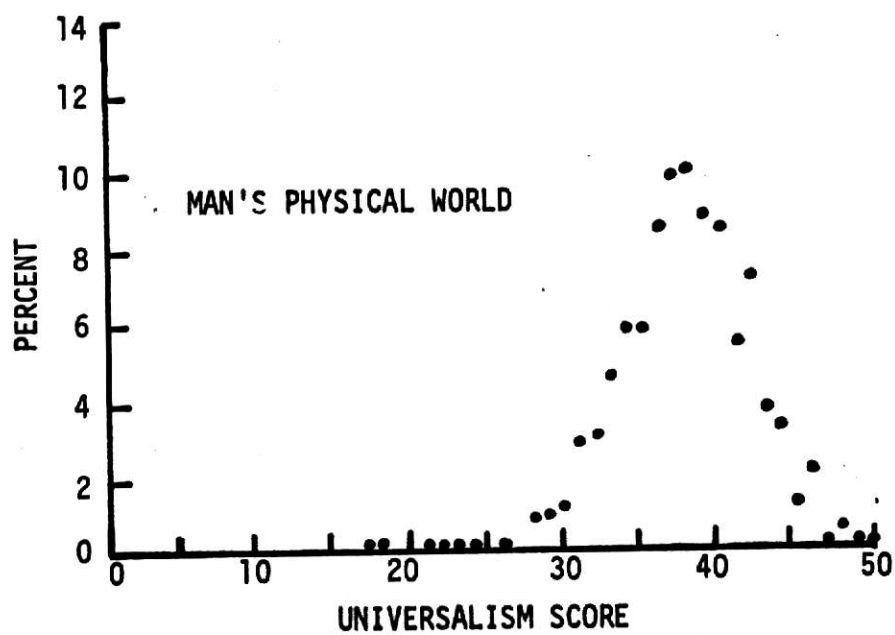
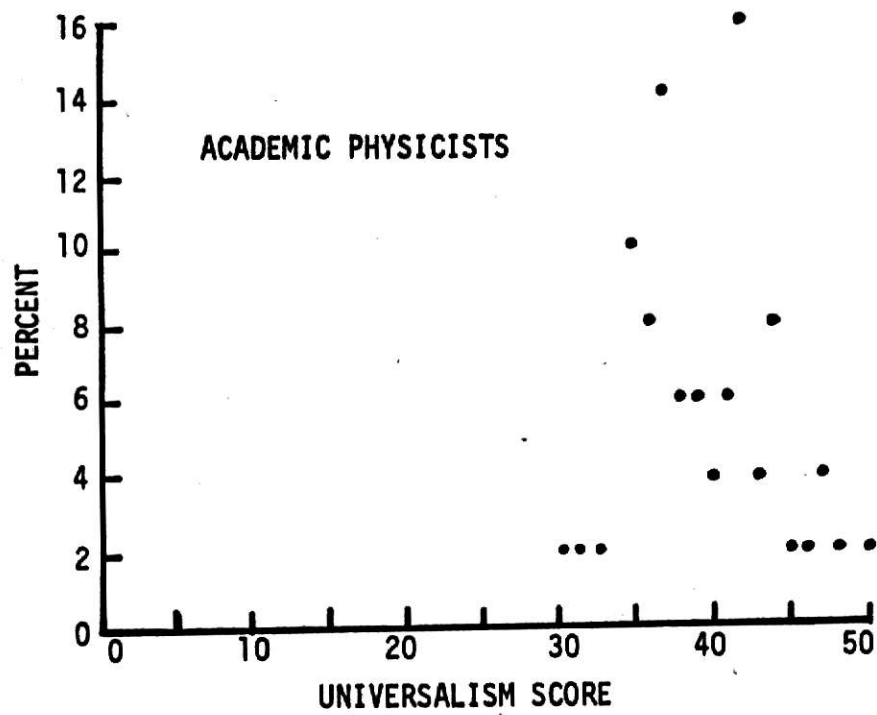
and 6 dealt with the relationship between utilitarianism and religion, while item 26 dealt with utilitarianism versus moral standards. Item 50 concerned itself with the acceptance of man's right and worth to discover. Items 6 and 26 showed a considerable percentage of both populations undecided although utilitarianism was still supported. Approximately the same percentage of MPW students were undecided in supporting utilitarianism as opposed to moral standards; where utilitarianism was represented by man's physical wants and needs and by man's intellectual need for truth. However, man's intellectual need for truth generally found more support than his physical wants and needs. Items 18 and 27 showed both populations supportive of utilitarianism, with the primary differences resulting from the percentage of MPW students undecided about the item. Both items dealt with the coexistence of religion and science.

Primary differences between the two populations appeared in items 1, 31, and 37. The first of these resulted in a bimodal distribution for the Physicist population. Neither population was supportive of utilitarianism in this context. Items 31 and 37 both dealt with the impact science has had upon man and his commitment to religion. Considerably more MPW students were either undecided or in agreement with both statements than was the case for the Physicists. MPW students expressed a degree of concern toward the impact science has had upon religion, and whether such an impact is acceptable. However, MPW students in general did not consider science and religion as being threatening to one another (items 5, 18, and 27).

The third value included in the Science Support Scale was universalism. The distribution of population scores in this value subset are displayed in Plate IX. The maximum possible score was fifty. It is worth noting that for

**PLATE IX. Distributions of scores received for the universalism
value dimension by Man's Physical World and Academic
Physicist populations.**

PLATE IX



both populations there were individuals who attained a maximum score. The two populations appeared to be very similar with respect to this value. The mean score for the Physicists was 39.7, while the mean score for the MPW students was 37.6. The items that yielded chi-square values significant at the .05 level are listed below. Their respective distributions are included in Plate X.

UNIVERSALISM

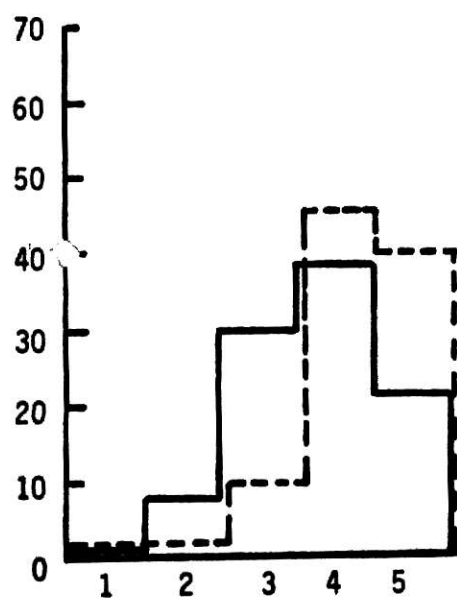
- 11. There is no place in science for sexual deviants such as homosexuals.
- 13. The work of any scientist should be judged without regard for his political views.
- 46. A scientist's reputation should be as important in judging his findings as the techniques he uses in his research.

These few items that were dependent upon the population is an indication that universalism was well accepted by MPW students as well as by Physicists. As Schwirian suggests: "This approval (placed on universalism) is clearly manifest in the American commitment to assuring a man his just position in society based on his abilities and performances."⁴⁷

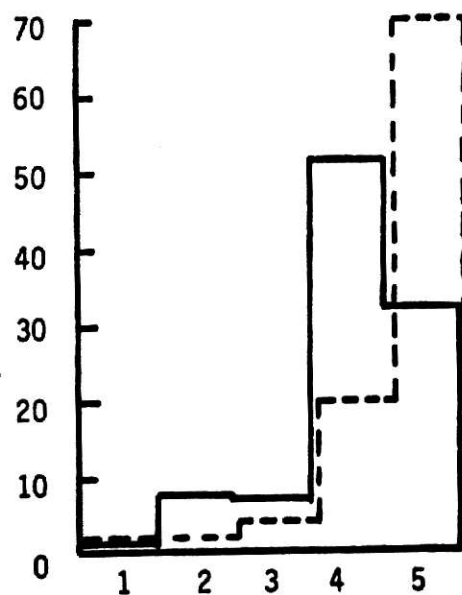
Items 11 and 13 differentiated between the two populations only with respect to the degree of support of universalism. These statements and the MPW responses may have reflected Midwestern conservatism. A considerable number of MPW students were undecided on item 11, indicating the sensitivity toward sexual deviants present in today's society. Item 46 indicated a significant difference between the two populations and a major departure from support of universalism by the MPW population. Thirty percent of MPW students were willing to judge a scientist's research as much by his reputation as by his experimental techniques. Perhaps this is a reflection of the difficulties laymen encounter in judging experimental procedures and results in

PLATE X. Items from the universalism dimension with chi-square statistic significant at the .05 level. Likert scores are plotted along the abscissa and percent receiving that score along the ordinate. The solid line represents the Man's Physical World population, and the broken line represents the Academic Physicist population.

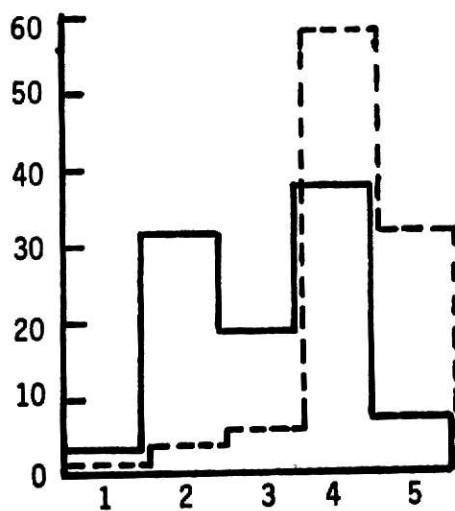
PLATE X



ITEM 11



ITEM 13



ITEM 46

ce. Being unable to do so, they rely upon the scientist's reputation as de. Additionally modern society seems to have become so complex, that is a very great tendency to accept an expert's opinion or decision in of attempting to understand the complex language or procedures within field. This was the only item that yielded any significant differences en the two populations in the value dimension involving universalism. The fourth value dimension included in the Science Support Scale was idualism. The distributions of population scores for this dimension are in Plate XI. There seems to be considerable difference between the two ations. The mean score of the Physicist population was 44.9, and the score of the MPW population was 40.4. The items yielding a chi-square stic significant at the .05 level are listed below. Their respective iutions are contained in Plates XII and XIII.

INDIVIDUALISM

9. The administration of colleges or universities should not discharge scientists whose political views are unpopular.
19. The individual scientist is the best judge of what research he should do.
23. The primary function of a college education in science is to teach an appreciation for the findings of the past great scientists.
43. It is not always appropriate for the Federal government to demand that the scientific research it sponsors serve the national policy ends.
44. Scientists could work more effectively if they were organized and guided in their work by a man who has proved himself to be an outstanding scientist.
48. Scientific work should be judged primarily by the political and social necessities of the nation and the world.
49. Scientists could work more effectively if they were organized and guided in their work by a Congressional committee which was aware of national needs.
57. More federal support to science should be in the form of grants for general scholarship and exploratory research rather than contracts for specified product research.

PLATE XI. Distributions of scores received for the individualism value dimension by Man's Physical World and Academic Physicist populations.

PLATE XI

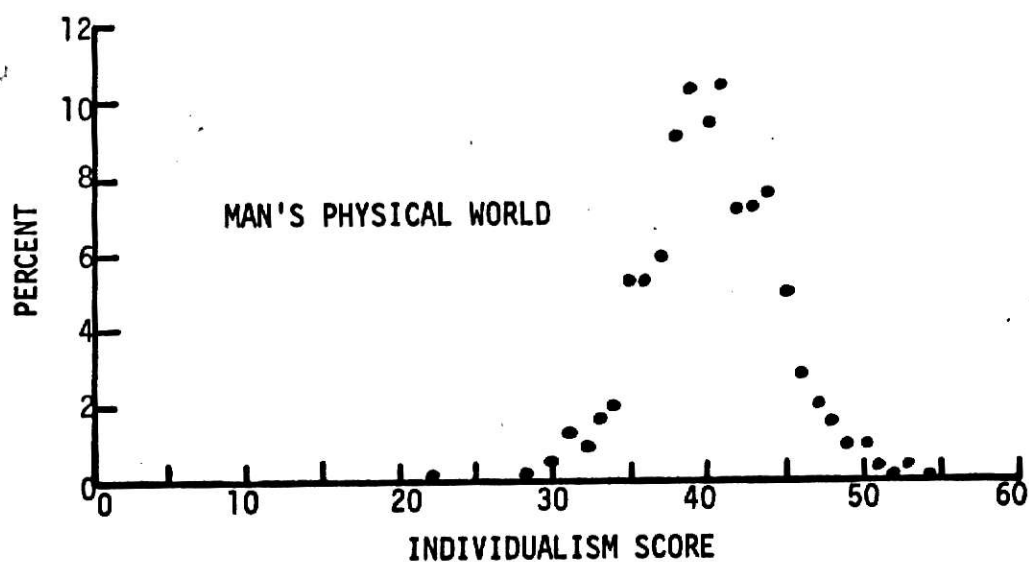
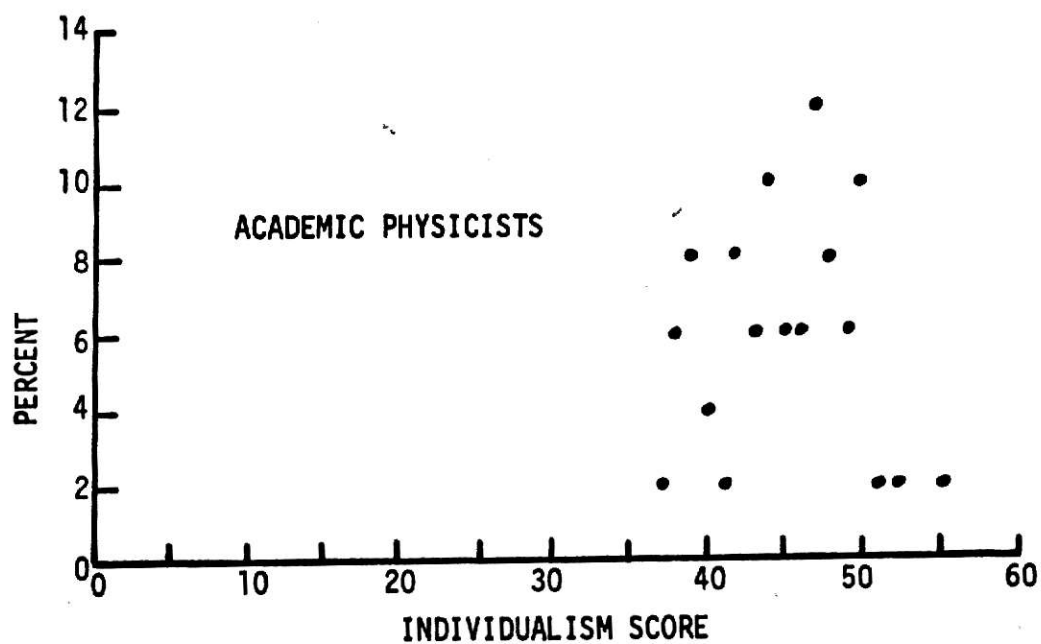


PLATE XII. Items from the individualism dimension with chi-square statistic significant at the .05 level. Likert scores are plotted along the abscissa and percent receiving that score along the ordinate. The solid line represents the Man's Physical World population, and the broken line represents the Academic Physicist population.

PLATE XII

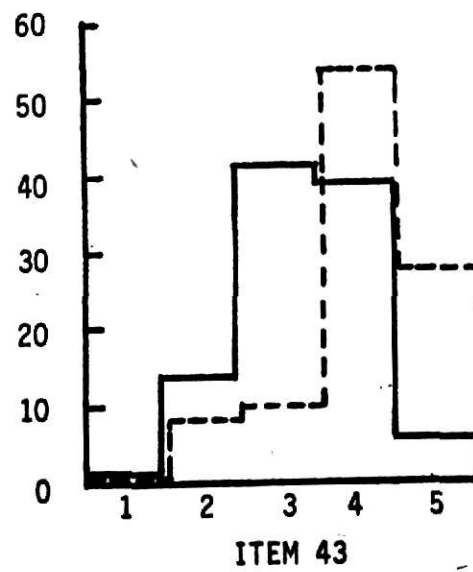
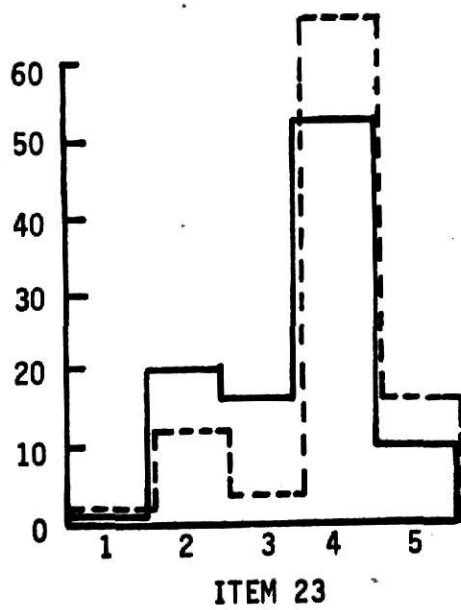
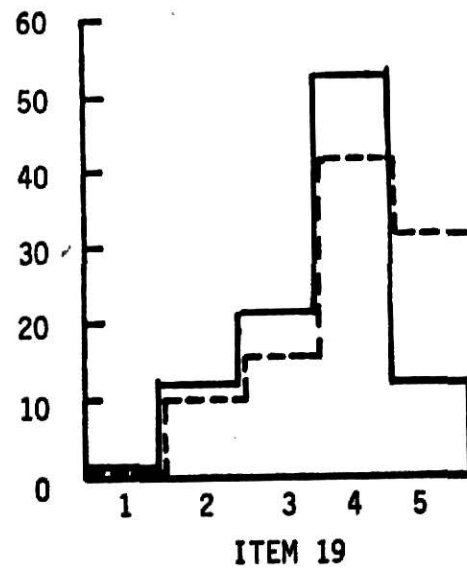
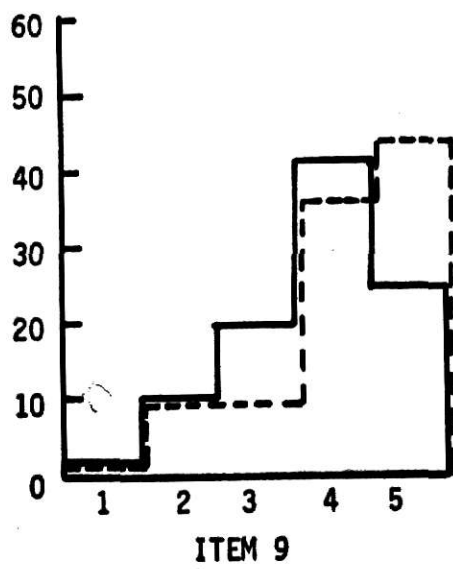
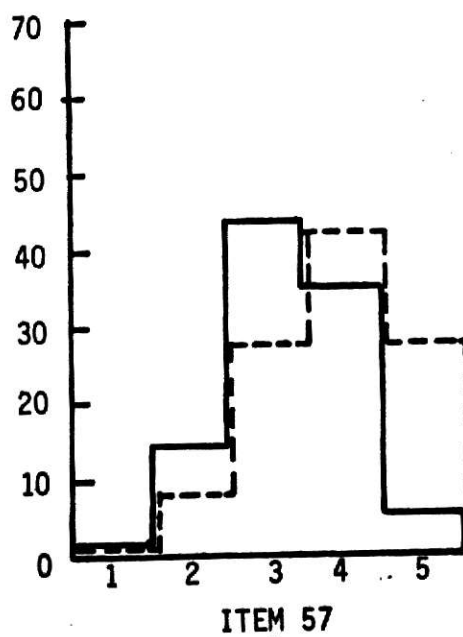
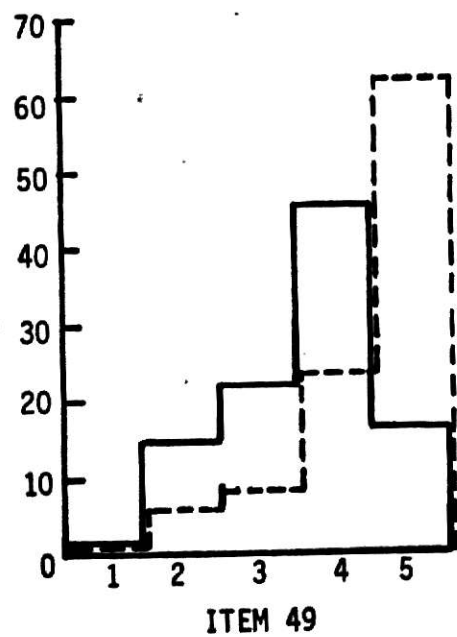
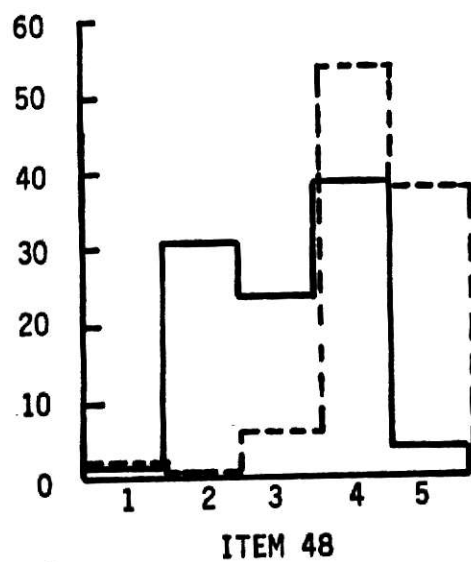
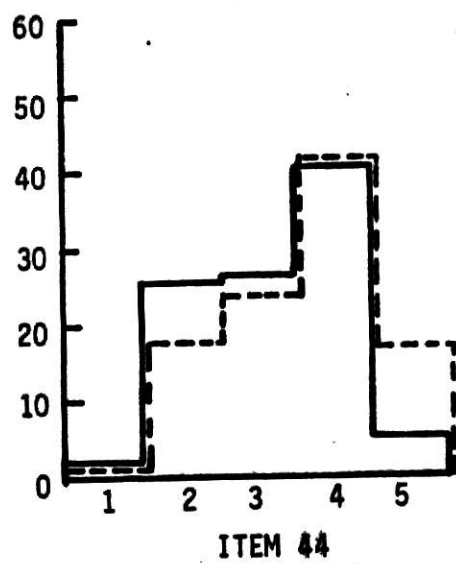


PLATE XIII. Items from the individualism dimension with chi-square statistic significant at the .05 level. Likert scores are plotted along the abscissa and percent receiving that score along the ordinate. The solid line represents the Man's Physical World population, and the broken line represents the Academic Physicist population.

PLATE XIII



Items 9, 19, 23, 44, and 49 showed both populations supportive of the value individualism, the Physicists stronger in their support. Items 44 and 49 dealt specifically with the organization of scientific research, first by scientists themselves and secondly by a Congressional committee. Both populations showed mild acceptance of the first alternative, but less acceptance of the second. The Physicist population was particularly united in its disagreement with statement 49. The other items indicated strong support of individualism by both populations. It should be noted, however, that a significant percentage of MPW students were undecided or nonsupportive of the value dimension. This reflects a lesser degree of commitment to the value.

Items 43, 48, and 57 showed the most significant differences between the two populations. All three items dealt with societal control and direction of scientific research. The Physicists felt very strongly that scientific research should continue independently of national needs. The majority of MPW students were either undecided or weakly supportive of research directed toward national needs. It would seem that item 49 would fit with these three items, in that it dealt with governmental control of science. While MPW students were somewhat undecided about the place of scientific research within society, they were certain that it should not be directed by a Congressional committee. This response seems to indicate an uncomfortable feeling toward governmental control, rather than support of non-directed scientific work.

With respect to the value dimension of individualism, it seems that the MPW student was most concerned with the role scientific research should play in society. In general he supported the right of the individual scientist to direct his own research on the basis of his own standards. However, a

significant number of MPW students were unsure as to whether science should be directed toward solving societal problems. Such concern appears understandable in light of the environmental problems being presently encountered.

The last value dimension included in the Science Support Scale was progress and meliorism. The distributions of population scores for this dimension are displayed in Plate XIV. The total possible score was sixty. The mean score of the Physicist population was 43.7, while the mean score of the MPW distribution was 39.3. The items in this dimension that yielded chi-square values significant at the .05 level are listed below. Their distributions are contained in Plate XV.

PROGRESS AND MELIORISM

- 14. It is not appropriate for man to tamper with the order and intentions of Nature.
- 36. The scientific information which has been gathered as a result of manned and unmanned space shots is well worth the large sums of money which have been spent on the projects.
- 42. A return to a simpler, less mechanized life would result in happier, more contented people.
- 47. The increased efficiency of computers does not justify their use because of all the unemployment produced when computers replace men.
- 55. It will be a good thing when machines free men of all manual labor.
- 56. When doing medical research, scientists should be able to collect information of a highly personal nature.

Both populations scored particularly low on item 55. The MPW students felt more strongly opposed to this statement than the Physicists; however neither group could, to any degree, support the statement. This result seems to contradict the popular image of a scientist as one who has no interest or concern for the social consequences of his work.⁴⁸ Both populations seemed to express concern with man's ability to adapt to the changes technology can accomplish, such as the prospect of no manual labor. Perhaps this is

**PLATE XIV. Distributions of scores received for the progress
and meliorism value dimension by Man's Physical
World and Academic Physicist populations.**

PLATE XIV

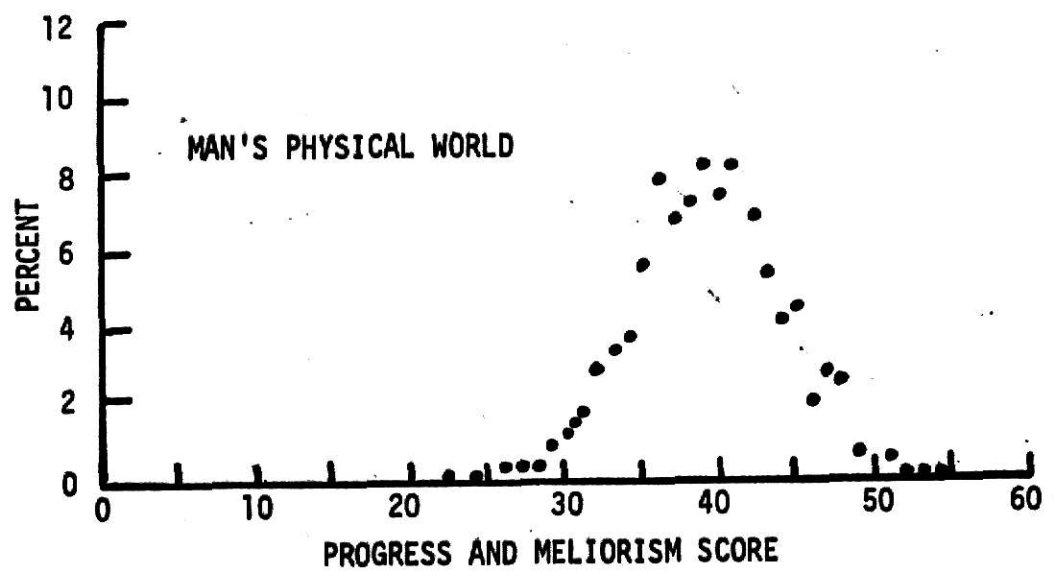
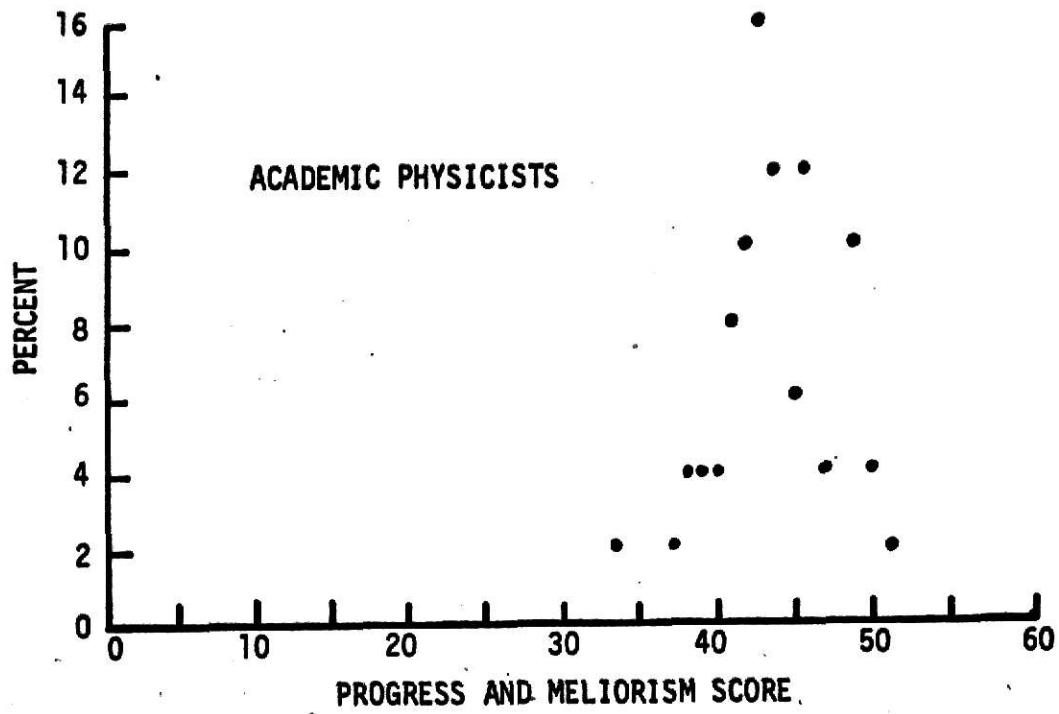
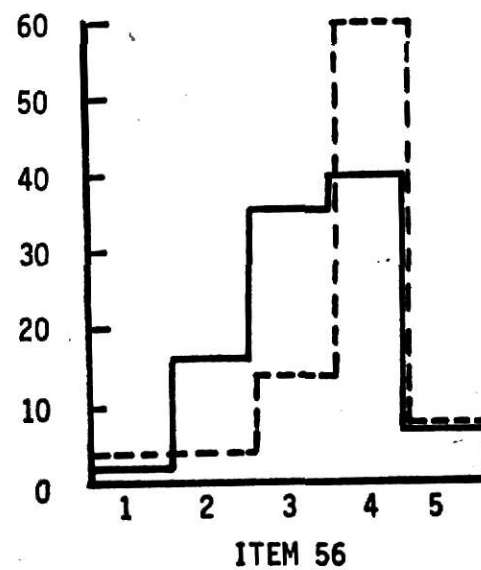
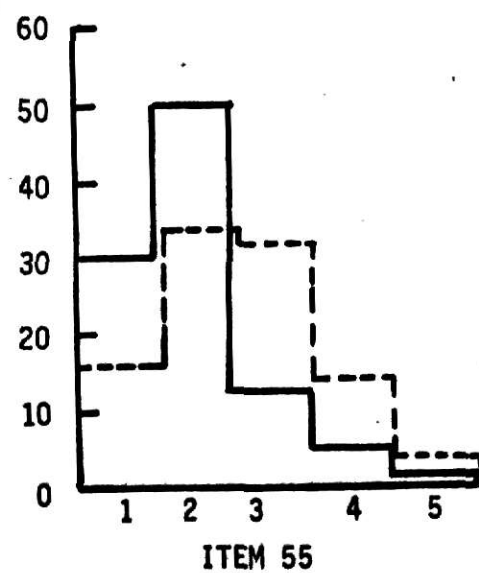
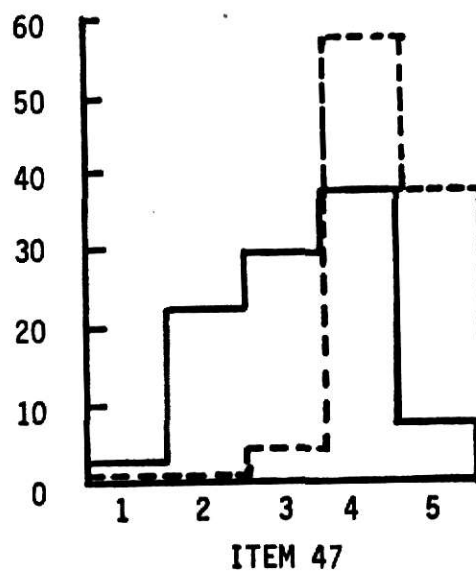
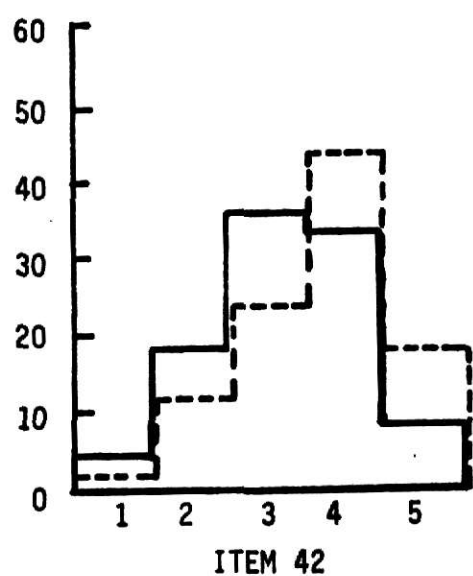
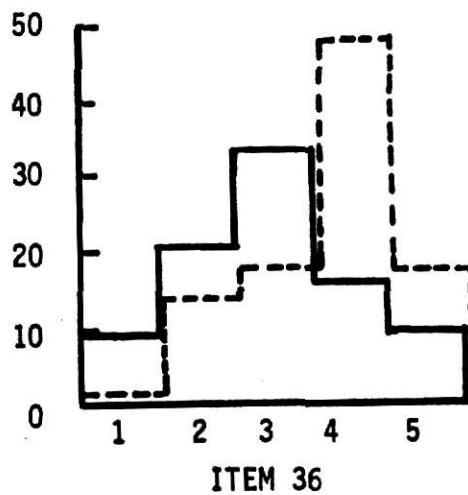
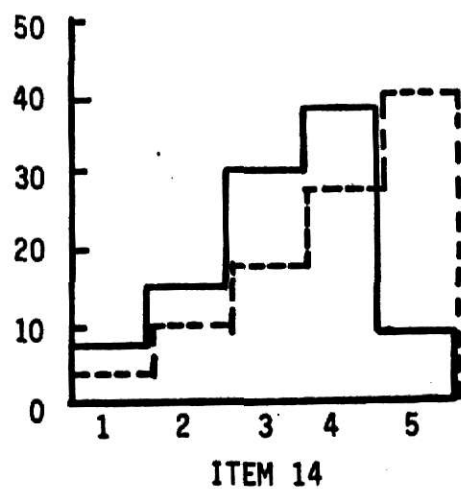


PLATE XV. Items from the progress and meliorism dimension with chi-square statistic significant at the .05 level. Likert scores are plotted along the abscissa and percent receiving that score along the ordinate. The solid line represents the Man's Physical World population, and the broken line represents the Academic Physicist population.

PLATE XV



a result of the Puritan work ethic, which saw manual labor as the most beneficial activity for man.

Items 14, 47, and 56 indicated support of progress and meliorism by both populations, however the Physicists were much stronger in their support. In all three items there was a considerable percentage of MPW students clearly undecided about the item. Additionally in item 36 a majority of MPW students was undecided about the issue, while a majority of Physicists was supportive. Item 42 dealt specifically with man's ability to cope with a more mechanized life and was thus similar to item 55. Both populations were concerned with man's ability to adapt to the changes brought about by science and technology; but neither group felt that returning to an earlier stage of development would help. There was concern about the pace of progress, but indeed still a commitment to progress. Item 36 reflected the concern previously shown toward research conducted without regard for societal needs. In this respect, the results of item 36 bear a similarity to the results from items 43, 48, and 57 from the individualism dimension.

In summary, MPW students and Physicists differed as to their support of the values of rationality, utilitarianism, individualism, and progress and meliorism; but differed little in support of universalism. The difference in support was primarily one of degree rather than one of nature. The MPW student was remarkably supportive of these values, perhaps indicative of the degree to which the present society has accepted science. However, there were a reasonable number of items in which the MPW students were primarily undecided or split between support and nonsupport of the statement. In the case of each of these items, the Physicist population was in decided support of the value in question. The items and their respective value dimensions are

listed below.

- 29. When the findings or theories of science conflict with religious belief, it is better to accept the religious belief. (Rationality)
- 36. The scientific information which has been gathered as a result of manned and unmanned space shots is well worth the large sums of money which have been spent on the projects. (Progress and Meliorism)
- 37. The material progress and science has made men care less than they should about the prospect of eternal life.
- 42. A return to a simpler, less mechanized life would result in happier, more contented people. (Progress and Meliorism)
- 43. It is not always appropriate for the Federal government to demand that the scientific research it sponsors serve the national policy ends. (Individualism)
- 46. A scientist's reputation should be as important in judging his findings as the techniques he uses in his research. (Universalism)
- 53. All miracles have a scientific explanation. (Rationality)
- 57. More federal support to science should be in the form of grants for general scholarship and exploratory research rather than contracts for specified product research. (Individualism)

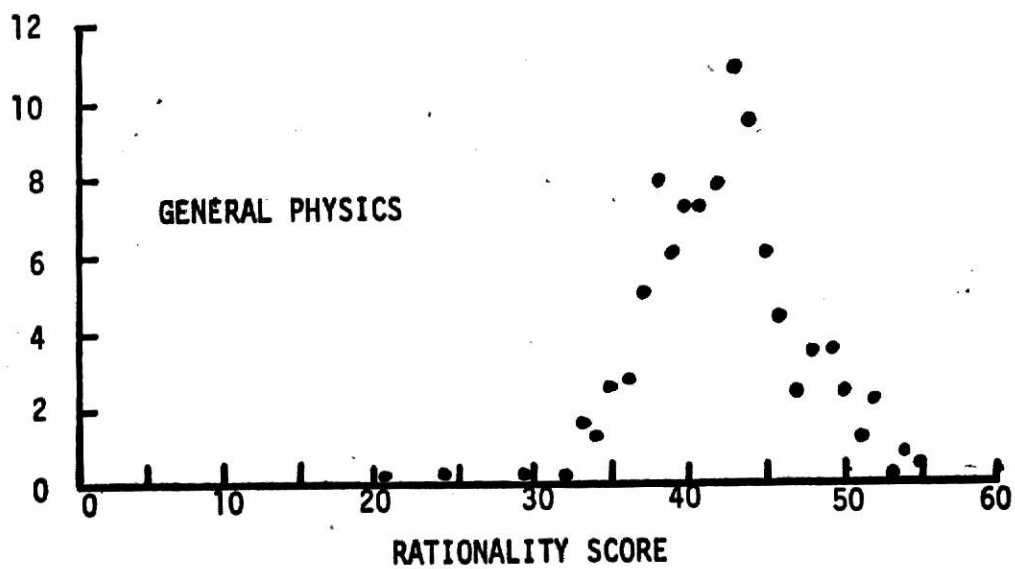
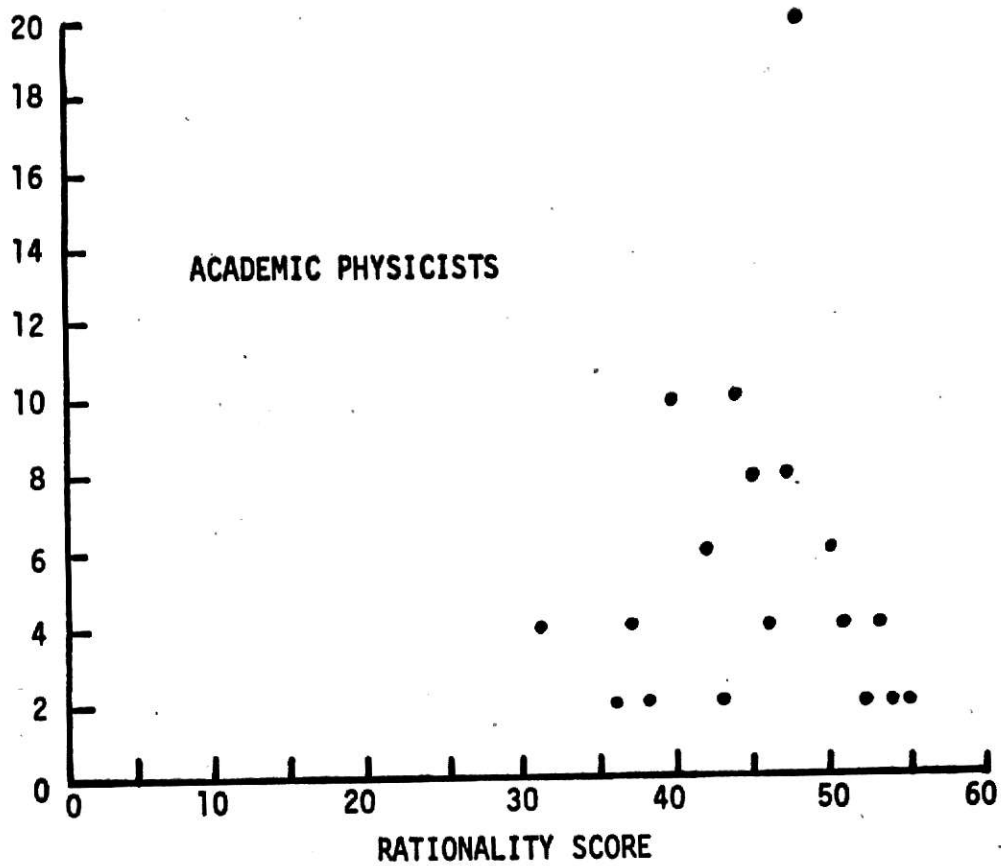
Several themes seem to reside in these items: (1) Should scientific research be directed toward national needs? (Items 36, 43, and 57) (2) What impact has science had upon religion? (Items 29, 37, and 53) (3) What impact has science and its resulting progress had upon people and their well-being? (Items 37 and 42). Item 46 seems unrelated to these themes. However, this single theme, the appeal to a scientific authority, and its general acceptance by students should be most distressing to the scientist-educator. The Man's Physical World student seemed concerned with the interaction of science with other priorities of the society and with his capability to deal with the changes brought about by science.

General Physics versus Academic Physicists

The total score distributions for General Physics (GenP) students as opposed to Academic Physicists for the rationality dimension are displayed in Plate XVI. The mean score for the Physicists was 45.3, while the mean score

**PLATE XVI. Distributions of scores received for the rationality
value dimension by General Physics and Academic
Physicist populations.**

PLATE XVI



for the GenP students was 42.2. The items in this dimension that yielded chi-square values significant at the .05 level are listed below, and their respective distributions are displayed in Plates XVII and XVIII.

RATIONALITY

- 7. The skepticism of the scientist should be limited to his work.
- 22. The unbounded inquiry of the scientists has had a bad effect on society's moral standards.
- 29. When the findings or theories of science conflict with religious belief, it is better to accept the religious belief.
- 35. It is unlikely that a young scientist will make important discoveries.
- 45. Scientific findings should not be made public if they will create social unrest.
- 51. It is a good policy to base an important decision purely on evidence even if it is the opposite of the decision based on common sense.
- 53. All miracles have a scientific explanation.
- 54. Scientists go overboard on demanding evidence before drawing conclusions.

The majority of items showed only a difference of degree of support of rationality by the two populations. Items 7, 22, 35, 45, and 54 showed a majority of individuals in both populations supporting rationality. Item 51, discussed in Chapter II, showed the GenP students as well as the Physicists supporting common sense rather than rationality. It should be noted, however, that the 'common sense' of a Physicist is rather flexible and does not necessarily bear relationship to the base of common sense associated with a general population. To many physicists quantum mechanics has become 'common sense'.

Items 29 and 53 were the only two items that showed differences in the actual support of the value dimension. Item 29 showed forty-five percent of GenP students undecided, although those receiving Likert scores of four or five was over fifty percent. In contrast to the Physicists, however, the

PLATE XVII. Items from the rationality dimension with chi-square statistic significant at the .05 level. Likert scores are plotted along the abscissa and percent receiving that score along the ordinate. The solid line represents the General Physics population, and the broken line represents the Academic Physicist population.

PLATE XVII

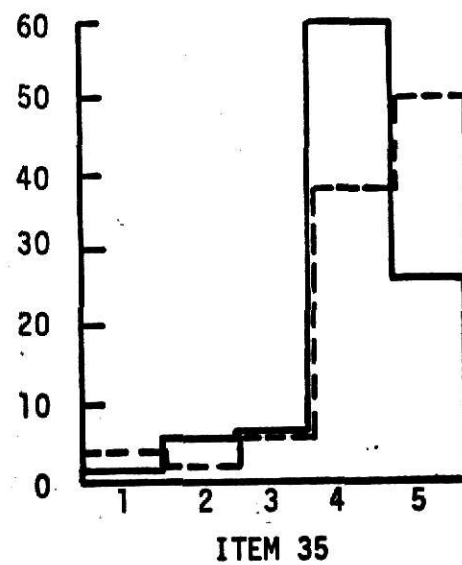
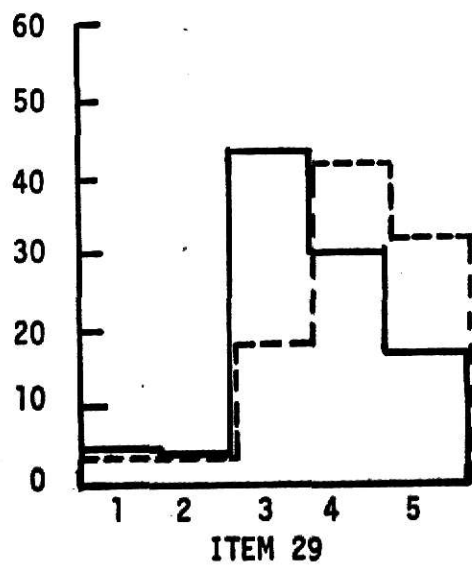
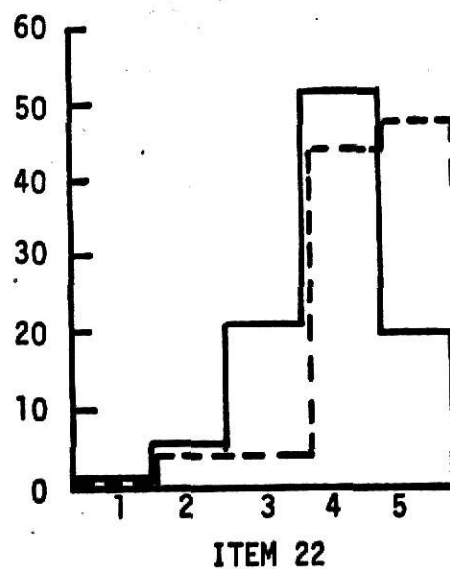
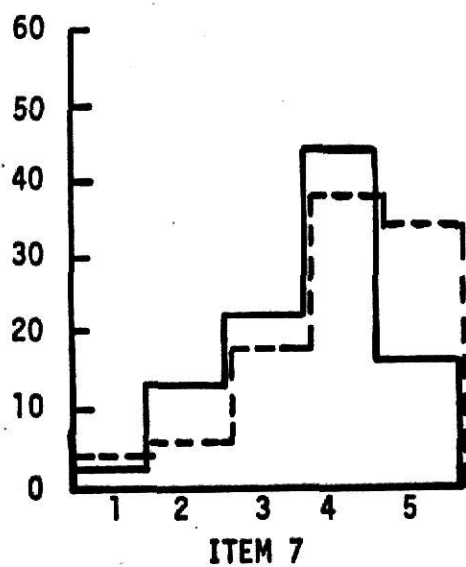
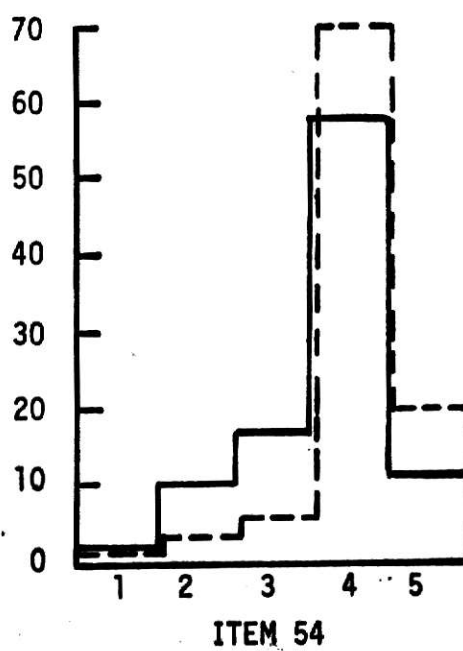
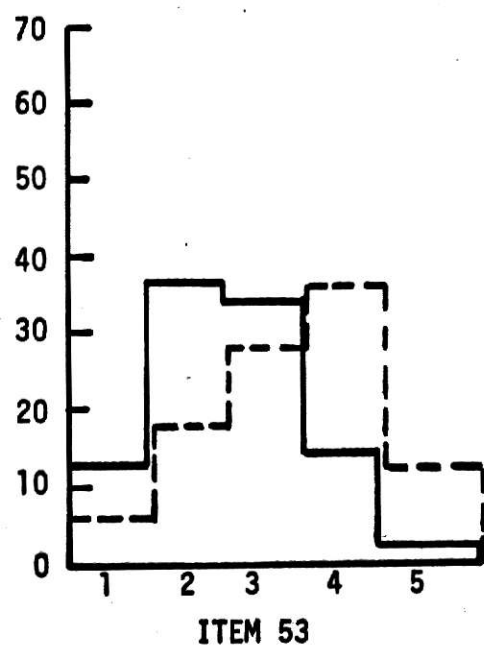
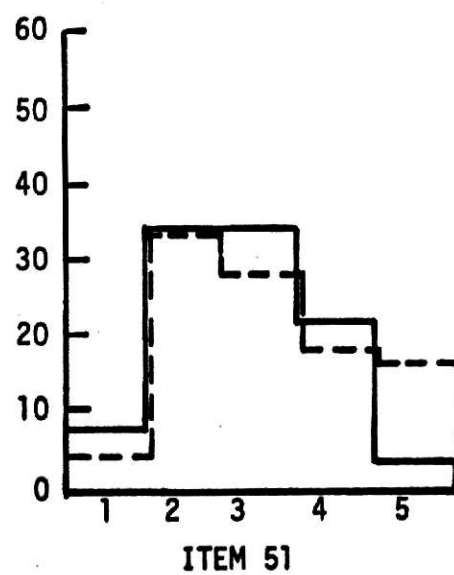
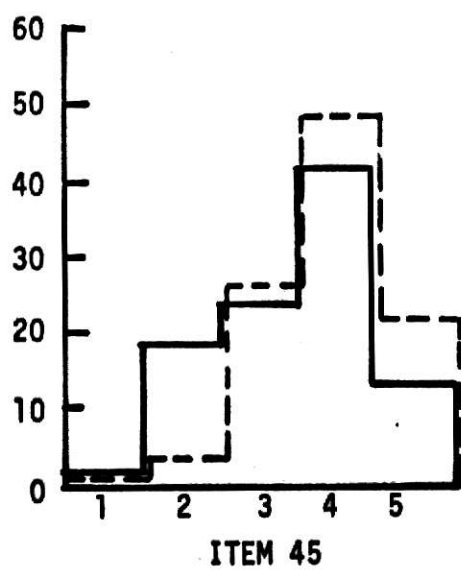


PLATE XVIII. Items from the rationality dimension with chi-square statistic significant at the .05 level. Likert scores are plotted along the abscissa and percent receiving that score along the ordinate. The solid line represents the General Physics population, and the broken line represents the Academic Physicist population.

PLATE XVIII



GenP students seemed unsure in supporting rationality as opposed to religious beliefs. Item 53 indicated this difference in attitude even more strongly as the GenP students were completely unwilling to support rationality to the exclusion of other explanations of miracles.

It would thus seem that the only phase of rationality with which the GenP students and Physicists differ is the support of rationality as opposed to religion. Neither population entirely supported rationality as opposed to present knowledge and common sense, as operationalized in items 2 and 51. Both populations supported rationality, the Physicists more strongly than the GenP students, on the remaining items dealing with rationality as opposed to societal stability, moral values, and youth. The GenP students were supportive of rationality except in situations where rationality was accepted at the exclusion of religious belief or truth.

The total score distributions for both populations for the value dimension of utilitarianism are shown in Plate XIX. The mean score received by the GenP population was 41.9, while the mean score received by the Physicist population was 43.9. The utilitarianism items that yielded chi-square values significant at the .05 level are listed below. The accompanying distributions are displayed in Plates XX and XXI.

UTILITARIANISM

1. One important function of science is to demonstrate the wonder and orderliness of God's universe.
5. Religious leaders should be constantly on guard against the ideas and theories that scientists produce and explore.
6. Science is bound to lead our society into Godliness.
18. In order to be more effective, religious leaders should know about recent major advances and developments in science.
26. The meaning of any discovery should be judged by man's moral standards rather than by his intellectual need for truth.
31. While man has become physically richer from the fruits of science, he has become spiritually poorer.
52. The true meaning of any discovery should be judged by man's physical wants and needs rather than by his moral standards.

**PLATE XIX. Distribution of scores received for the utilitarianism
value dimension by General Physics and Academic
Physicist populations.**

PLATE XIX

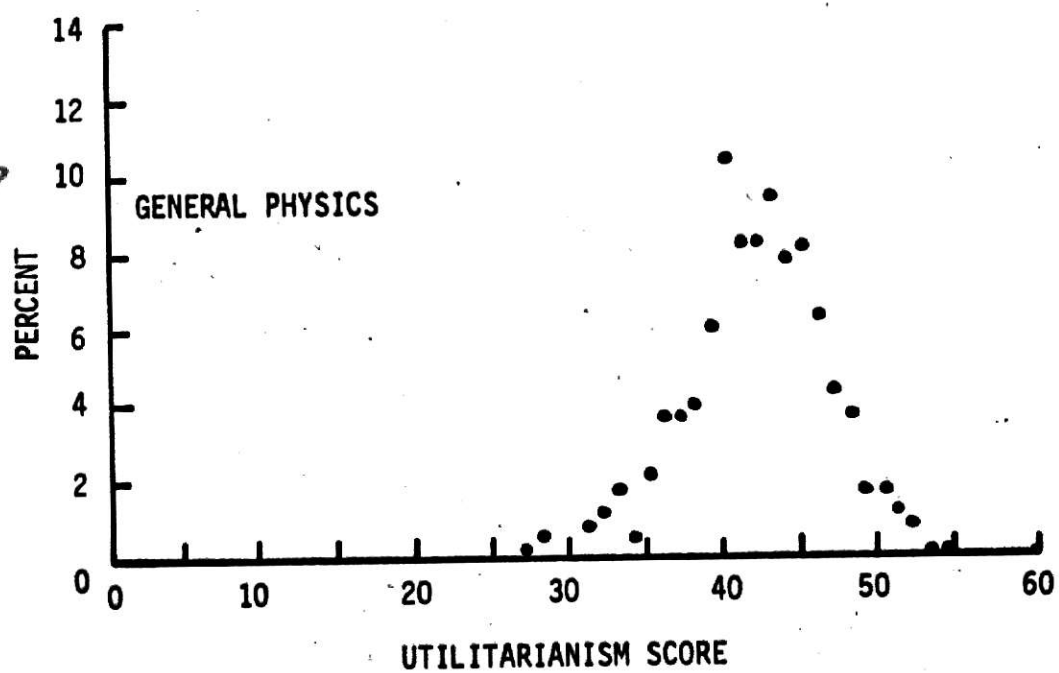
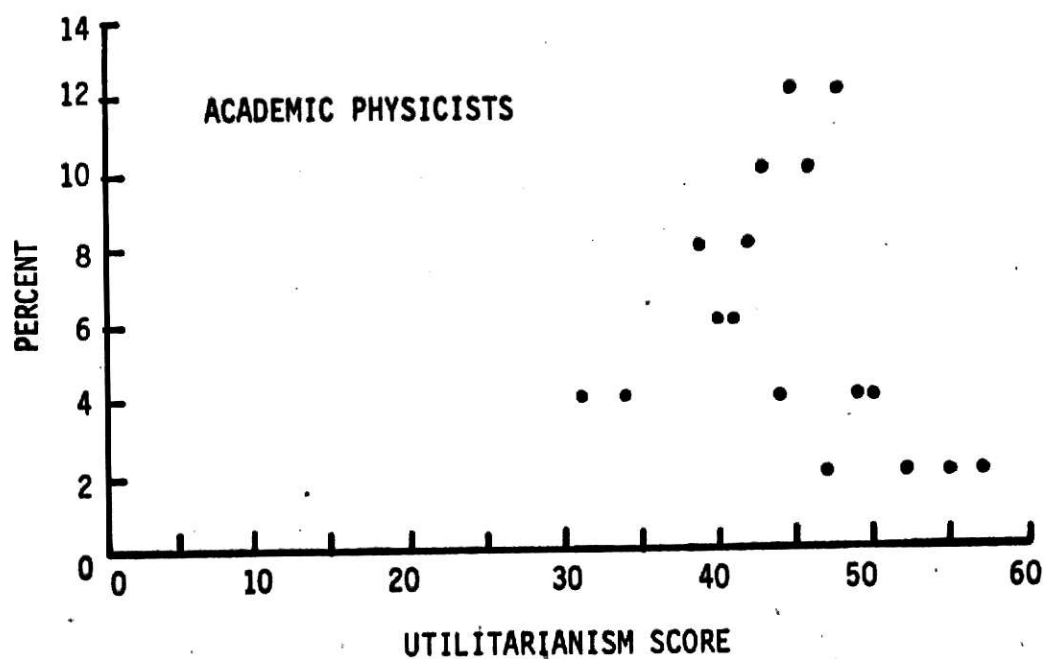


PLATE XX. Items from the utilitarianism dimension with chi-square statistic significant at the .05 level. Likert scores are plotted along the abscissa and percent receiving that score along the ordinate. The solid line represents the General Physics population, and the broken line represents the Academic Physicist population

PLATE XX

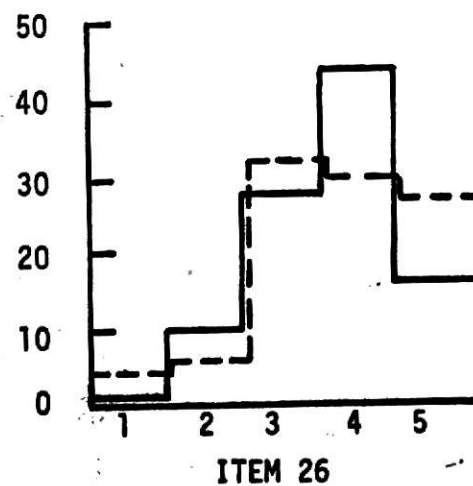
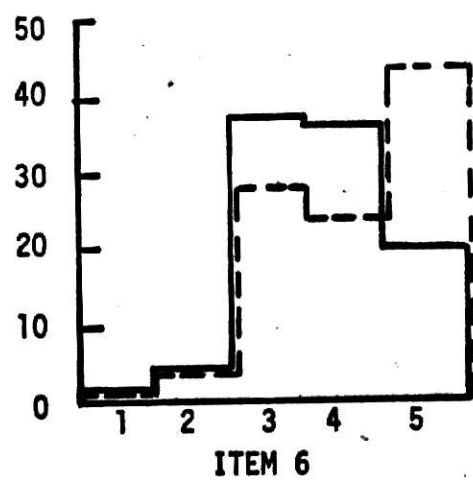
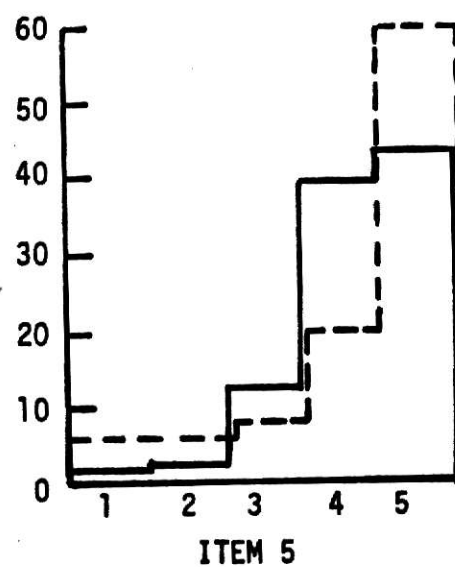
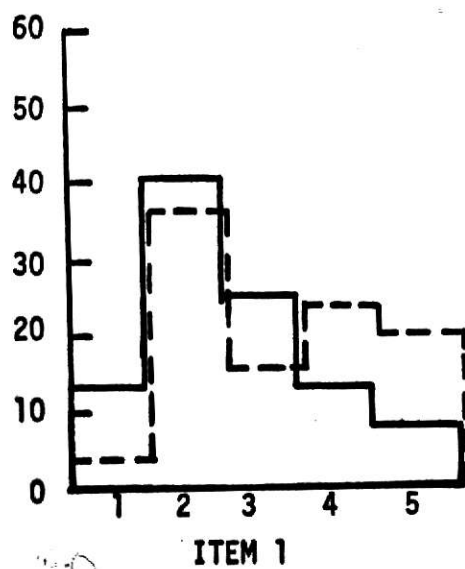
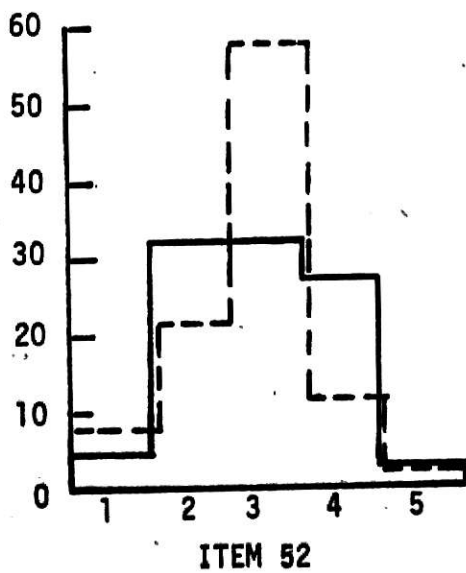
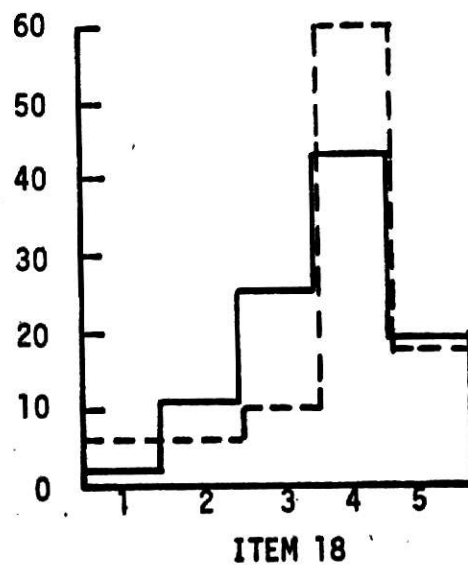
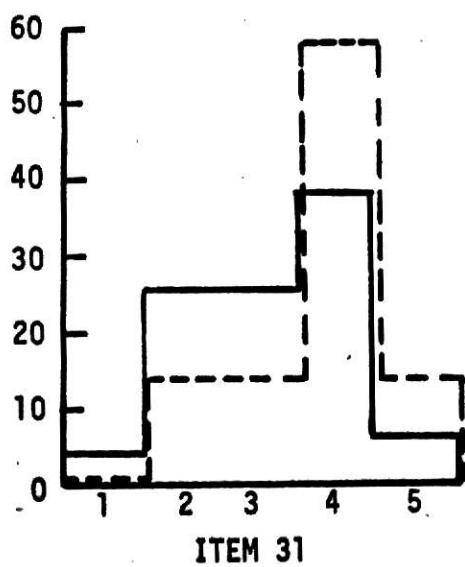


PLATE XXI. Items from the utilitarianism dimension with chi-square statistic significant at the .05 level. Likert scores are plotted along the abscissa and percent receiving that score along the ordinate. The solid line represents the General Physics population, and the broken line represents the Academic Physicist population.

PLATE XXI



Items 5, 6, 18, 26, and 31 showed a majority of both populations supporting utilitarianism, the Physicists more strongly than the GenP students. Support of utilitarianism in item 5 was particularly strong, indicating that neither population felt that religion should fear the developments of science. Although items 6, 18, 26, and 31 also showed general support of utilitarianism, well over twenty percent of the GenP students were either undecided or nonsupportive of the value. These items dealt with utilitarianism as opposed to religion and moral values.

Items 1 and 52 both indicated nonsupport of utilitarianism by both populations with GenP students more nonsupportive than the Physicists. The GenP student seemed to feel that science has a role in religion as a vehicle for understanding a world created by some universal power. This is indeed consistent with their response to item 27 in which they felt that a scientist could also be committed to his religion. The Physicist, although not so much in agreement with item 1, also indicated compatibility between science and religion in item 27. Item 52 asked for a commitment to utilitarianism as opposed to morality. The majority of GenP students were either undecided or committed to morality in this item, while the vast majority of Physicists were undecided about the issue.

The GenP students seemed committed to utilitarianism, although not as strongly as the Physicists. Their concern with the relationship between science and religion expressed in the rationality dimension seems to occur in the utilitarianism dimension, particularly in items 1, 31, and 18. Items 26 and 52 showed considerably more concern for the relationship between science and morality than was the case in the rationality dimension. These same concerns seemed to be expressed by the Physicists. There appears to be only

differences in degree of attitude between the two populations rather than actual differences in the nature of the attitude.

The distributions of population scores on the universalism dimension are displayed in Plate XXII. The mean response of the Physicists was 39.7, and the mean response of the GenP population was 37.4. The differences between the two populations with respect to universalism was not as great as was the case with rationality. The items included in this value subset that yielded chi-square statistics significant at the .05 level are listed below. Their respective distributions are included in Plate XXIII.

UNIVERSALISM

- 11. There is no place in science for sexual deviants such as homosexuals.
- 13. The work of any scientist should be judged without regard for his political views.
- 41. Those who have a history of mental illness cannot be trusted to do important scientific work.
- 46. A scientist's reputation should be as important in judging his findings as the techniques he uses in his work.

All four items showed general support of universalism by both populations. Item 13 differentiated between GenP students and Physicists only in the number of individuals receiving a Likert score of five as opposed to a Likert score of four. Items 11 and 41 showed a more significant percentage of GenP students undecided. Both of these items dealt with groups who experience some prejudice within the religious and moral norms of society. In this respect the GenP students do not seem as committed to universalism as the Physicists. Item 46 showed a significant percentage of GenP students nonsupportive of universalism. This item dealt with judging a scientist's work by his reputation as much as by his experimental procedures. As was the case with the Man's Physical World population, this result seems to indicate that the student is willing

PLATE XXII

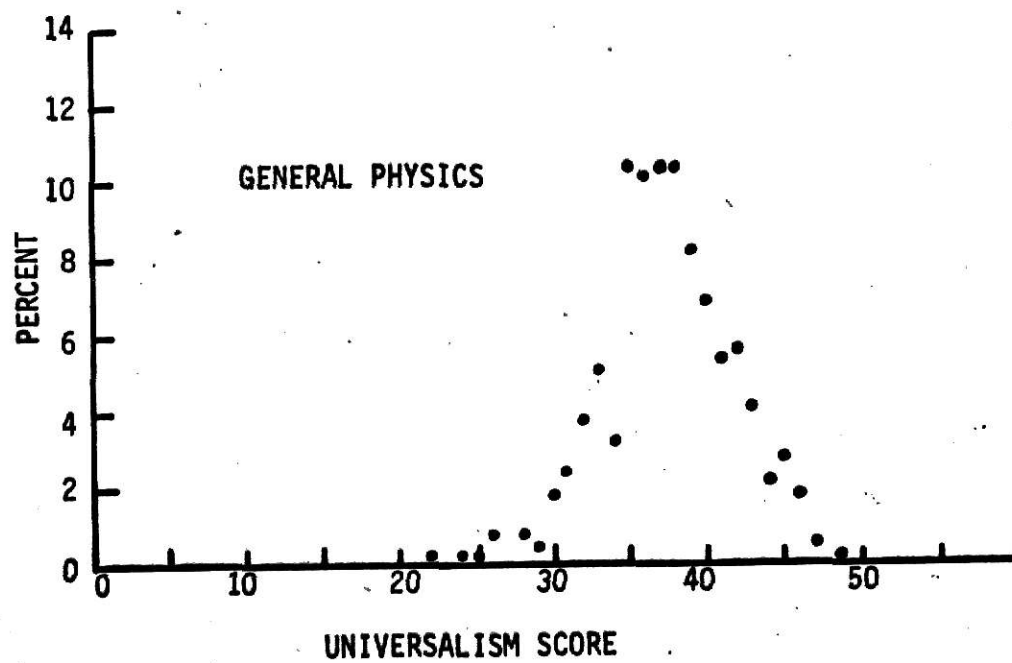
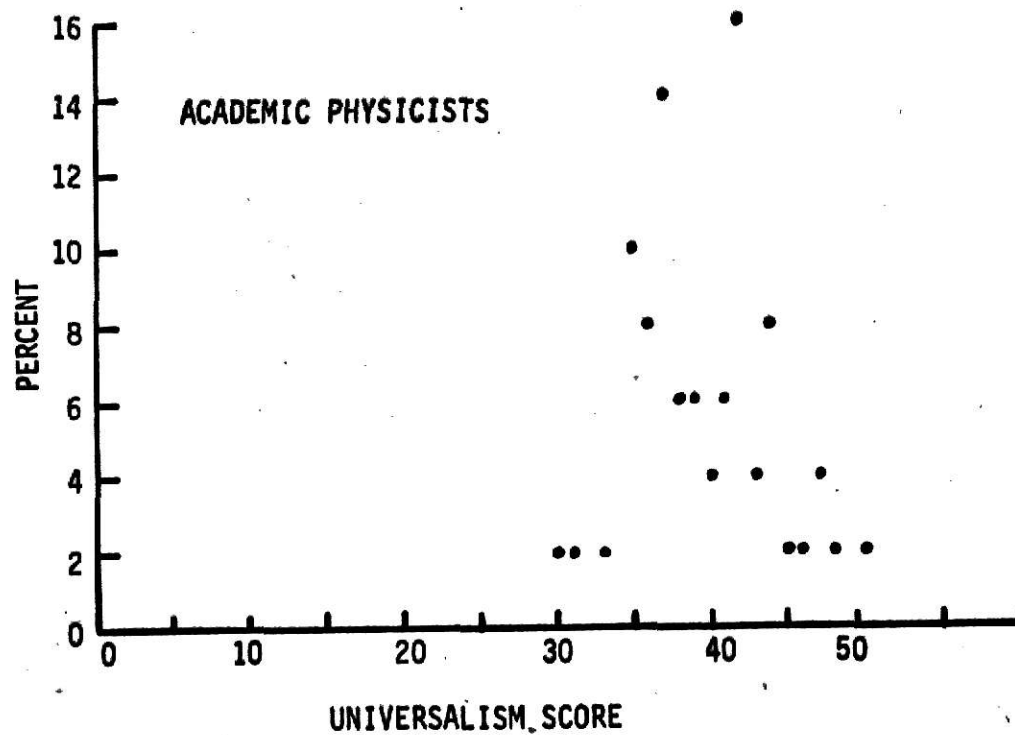
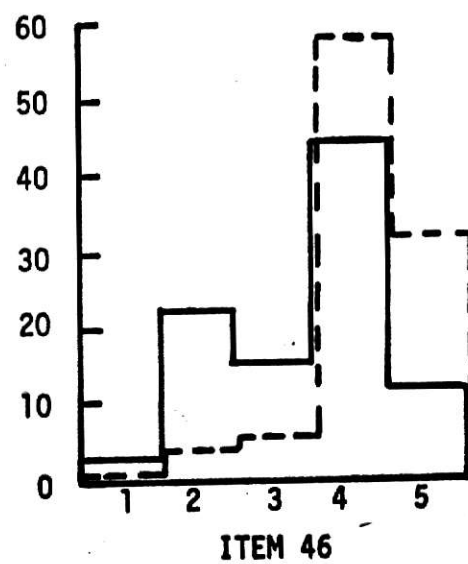
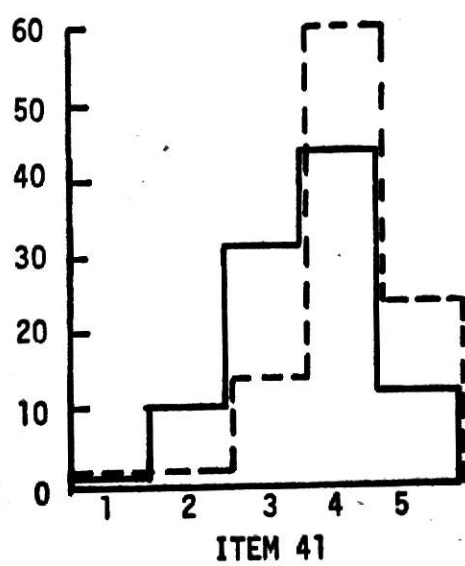
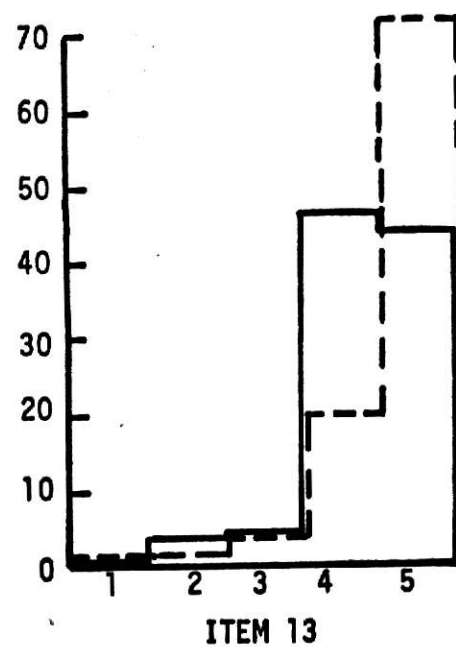
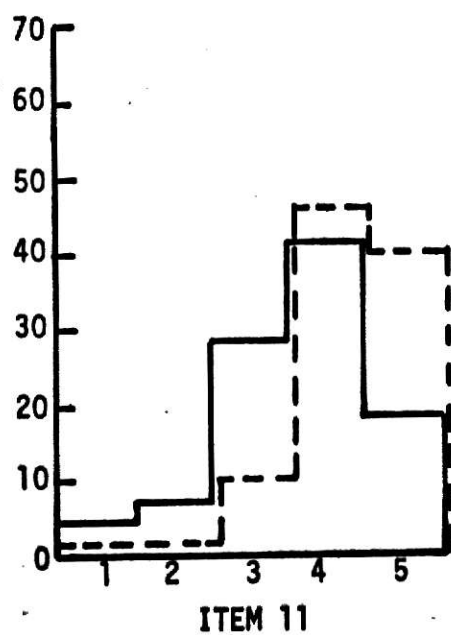


PLATE XXIII. Items from the universalism dimension with chi-square statistic significant at the .05 level. Likert scores are plotted along the abscissa and percent receiving that score along the ordinate. The solid line represents the General Physics population, and the broken line represents the Academic Physicist population.

PLATE XXIII



to rely upon the judgement of experts in science rather than trusting his own evaluation of the scientist's work.

The GenP students were committed to universalism, although not quite as strongly as the Physicists. Differences lay in the expression of universalism toward the mentally ill or sexually deviant. In addition, both populations were not particularly strong in the support of foreign students studying science at American universities. In the case of the Physicist, this was primarily a result of the lean financial years science is presently facing. It is unlikely that the same explanation was responsible for the response given by the GenP student. Although the GenP students were supportive of judging the work of a scientist by his experimental procedures, a significant percentage were willing to judge his work equally upon his reputation.

The next value dimension included in the Science Support Scale was individualism. The distributions of total scores for the two populations are displayed in Plate XXIV. The Physicist was more supportive of individualism, with the difference of mean response being approximately three points. The items in this dimension that yielded chi-square values significant at the .05 level are listed below. Their respective distributions are displayed in Plate XXV.

INDIVIDUALISM

3. If one or two scientists have evidence which appears to contradict current scientific belief, they are probably wrong.
43. It is not always appropriate for the Federal government to demand that the scientific research it sponsors serve the national policy ends.
48. Scientific work should be judged primarily by the political and social necessities of the nation and the world.

PLATE XXIV. Distributions of scores received for the
individualism value dimension by General
Physics and Academic Physicist populations.

PLATE XXIV

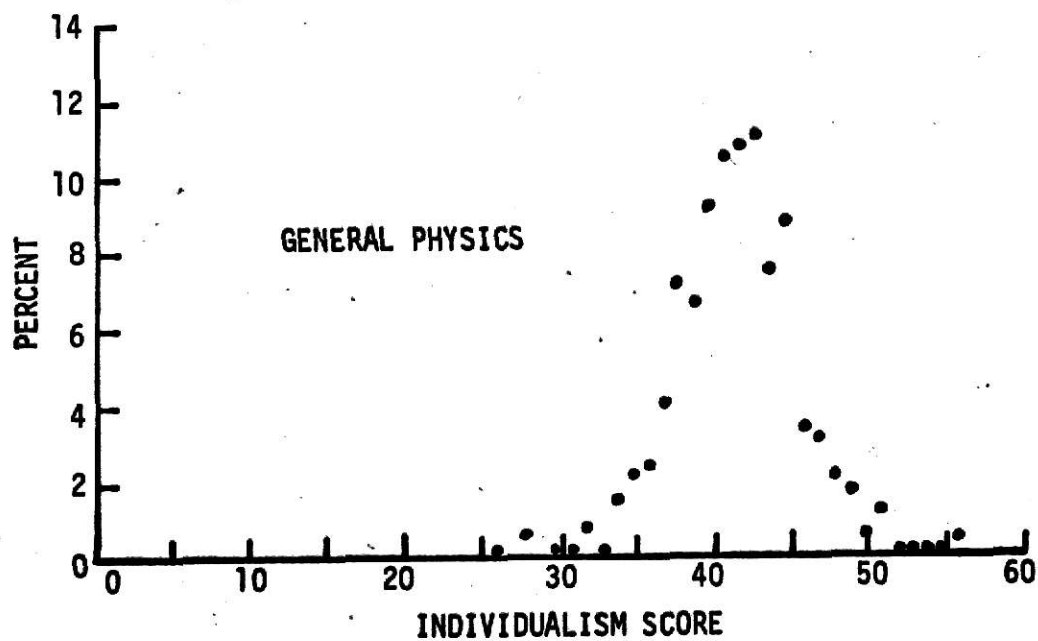
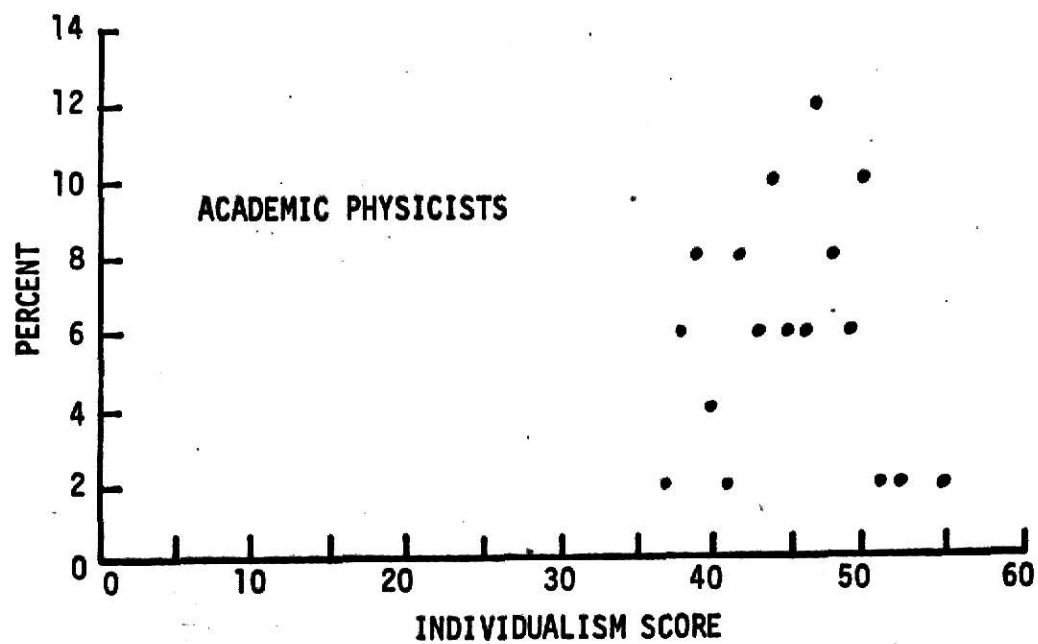
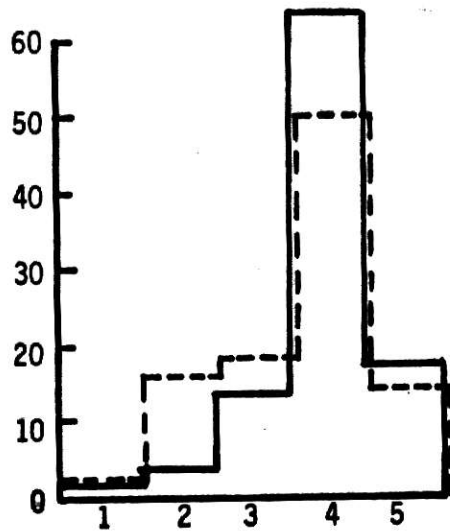
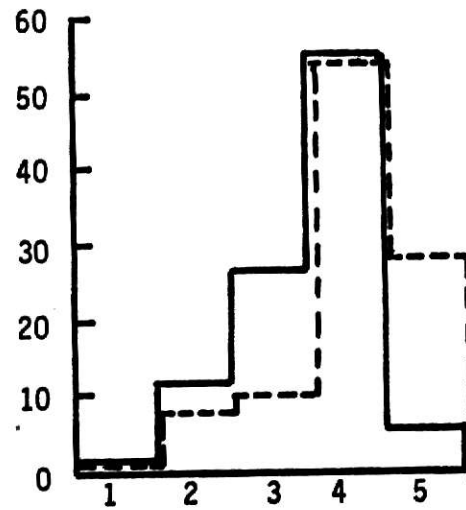


PLATE XXV. Items from the individualism dimension with chi-square statistic significant at the .05 level. Likert scores are plotted along the abscissa and percent receiving that score along the ordinate. The solid line represents the General Physics population, and the broken line represents the Academic Physicist population.

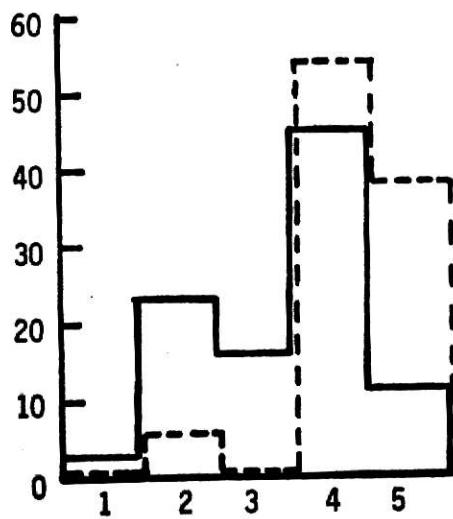
PLATE XXV



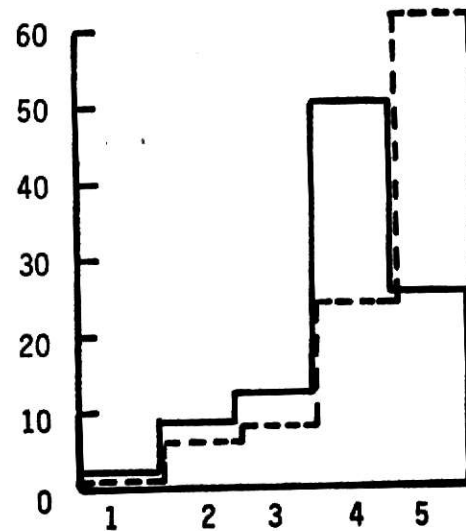
ITEM 3



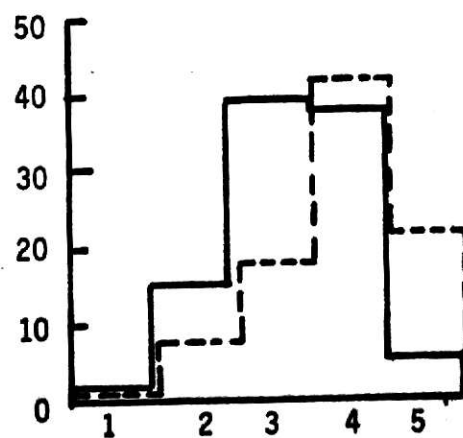
ITEM 43



ITEM 48



ITEM 49



ITEM 57

- 49. Scientists could work more effectively if they were organized and guided in their work by a Congressional committee which was aware of national needs.
- 57. More federal support to science should be in the form of grants for general scholarship and exploratory research rather than contracts for specified product research.

Items 3, 43, 48, and 49 all indicated that a majority of individuals in both populations supported individualism. Support was particularly strong on items 3 and 49. In the case of item 3 the GenP students were more strongly supportive of individualism than the Physicists. Apparently more scientists felt that the probability of an individual scientist being right as opposed to the majority of scientists is quite low. This seems to be common of all areas of specialized study, where the new idea is always viewed very skeptically by others in the field. It is indeed interesting that the students had a better perception of individualism in this case than the actual practitioners in the field. Item 49 differentiated between the two populations only in the percentages receiving Likert scores of four as opposed to Likert scores of five. Both groups felt very strongly that scientific research should not be organized by a Congressional committee. Items 43 and 49 showed basic support of individualism, but more GenP students expressed indecision or nonsupport of the value. There was apparently some concern as to the role of science within society, and whether science should be directed toward the problems of society.

Item 57 was the only item in the individualism dimension that showed a sharp distinction between the GenP population and the Physicist population. A large percentage of GenP students were undecided about the item, while the majority of Physicists indicated support. Since the item dealt with the question of 'applied research' as opposed to 'basic research', it would seem

that this question indicates the trend established in items 43 and 49. There seemed to be a question as to what degree the government should direct science toward national needs, although most felt science should not be entirely directed in such a manner as indicated in item 43.

Two exceptions to the support of individualism not mentioned earlier were expressed by both populations in items 40 and 32, shown below.

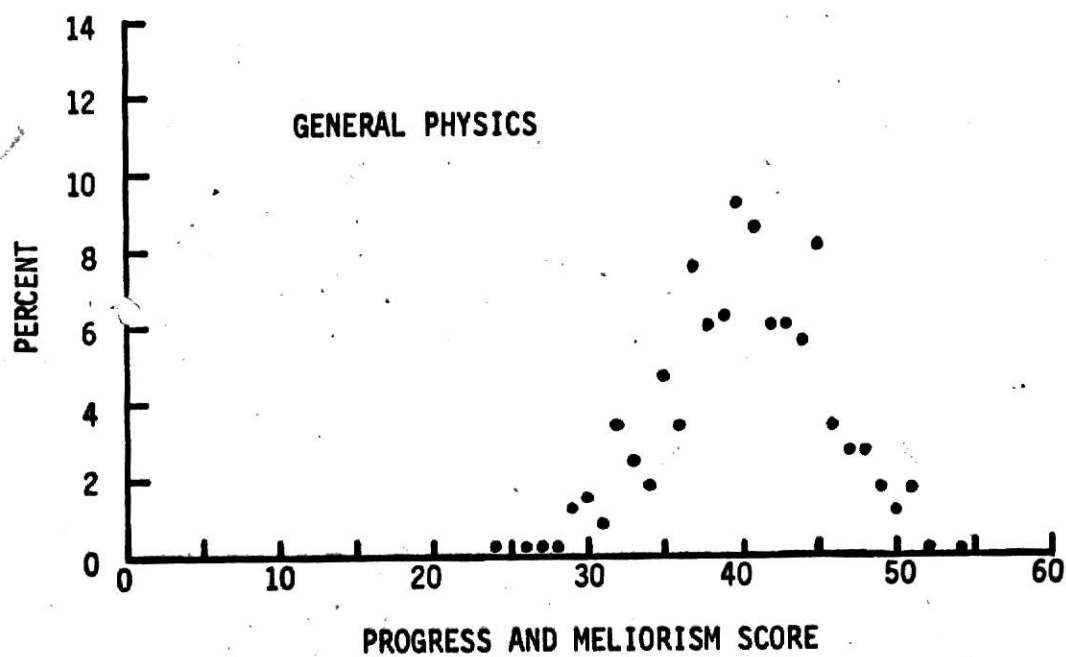
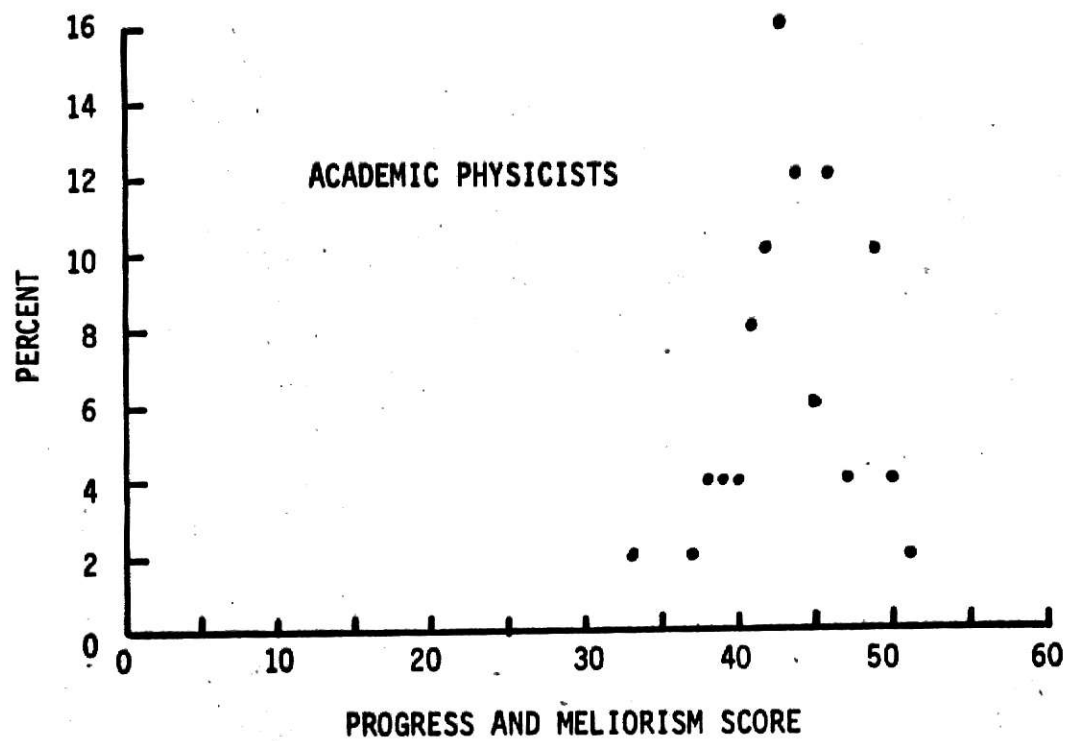
- 32. The scientist's activities must not violate the basic values of his society.
- 40. In times of national emergency a scientist's utmost concern should be for the contribution he can make to his country's needs rather than his own specific research interests.

Item 32 resulted in a bimodal distribution for both populations, while item 40 showed definite nonsupport of individualism. The second of these contradicts the view of the scientist as one interested only in his own research and unconcerned with the society around him. Item 32 perhaps reflects the willingness of the scientist to work within the moral constraints of his society with the prospect that those moral values are in part dependent upon his work. The remaining items in the individualism subset indicated differences between the two populations only in the degree of support of the value. The single concern voiced by the GenP students lay with the role of science toward dealing with societal problems as indicated in the responses to items 43, 49, and 57.

The last value dimension to be considered is progress and meliorism. The distributions of total scores for the two populations are shown in Plate XXVI. The difference in mean response between the two populations was approximately three points, with the Physicists more strongly supportive of the value. Those items that yielded a chi-square statistic significant at the .05 level are listed on the next page. Their respective distributions are

**PLATE XXVI. Distributions of scores received for the progress
and meliorism value dimension by General Physics
and Academic Physicist populations.**

PLATE XXVI



contained in Plate XXVII.

PROGRESS AND MELIORISM

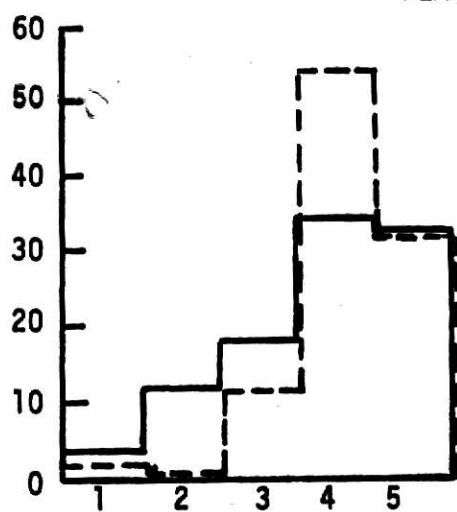
- 8. Scientific inventions and discoveries have done more good than bad for mankind.
- 14. It is not appropriate for man to tamper with the order and intentions of Nature.
- 36. The scientific information which has been gathered as a result of manned and unmanned space shots is well worth the large sums of money which have been spent on the projects.
- 47. The increased efficiency of computers does not justify their use because of all the unemployment produced when computers replace men.
- 55. It will be a good thing when machines free men of all manual labor.

Items 8, 14, and 47 showed both populations supportive of progress and meliorism, the Physicists more supportive than the GenP students. Items 8 and 47 showed particular support of the value, indicating that the GenP students felt scientific discoveries have contributed beneficially to the world and that projected progress is worthwhile. Item 14 dealt with a common objection to science; i.e., that man should not tamper with nature. Nearly forty percent of the GenP students were either undecided or non-supportive of progress in this context. Such an attitude is often associated with strong religious inclinations, and this forty percent corresponds to similar responses in the utilitarianism scale. (See items 1 and 31)

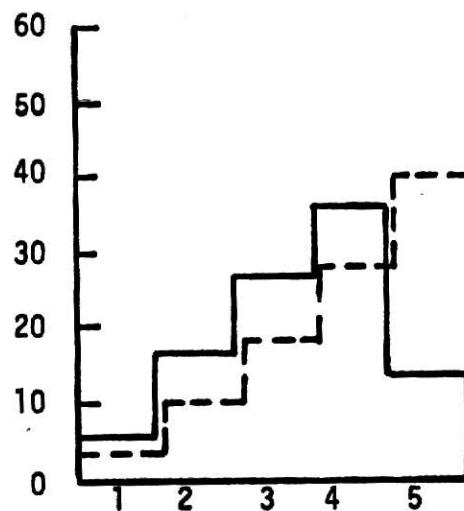
Item 36 showed the greatest differences between the populations. The GenP students were primarily undecided about the issue, with as many supporting the value as not supporting it. The majority of Physicists were supportive of progress and meliorism in this item. These results indicate concern with the priority given research in science, as represented by manned and unmanned space shots. This response corresponds to the concern expressed in the individualism subset toward research being applied to

PLATE XXVII. Items from the progress and meliorism dimension with chi-square statistic significant at the .05 level. Likert scores are plotted along the abscissa and percent receiving that score along the ordinate. The solid line represents the General Physics population, and the broken line represents the Academic Physicist population.

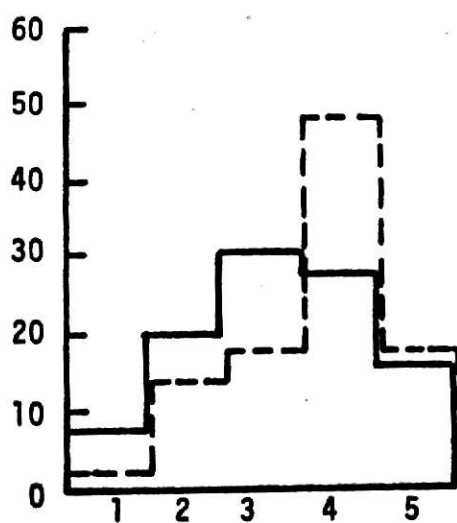
PLATE XXVII



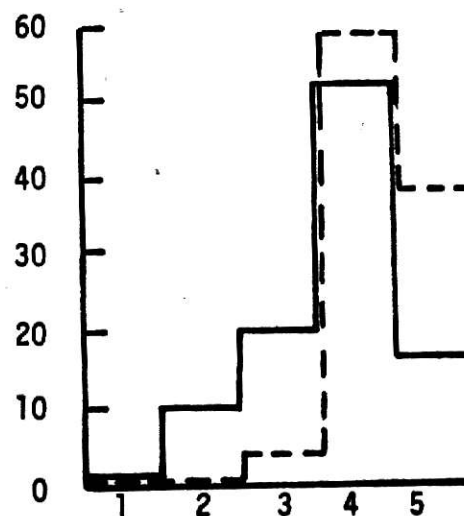
ITEM 8



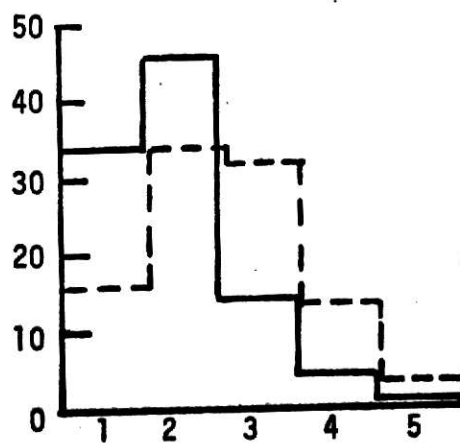
ITEM 14



ITEM 36



ITEM 47



ITEM 55

societal problems, as in item 57. Thus the results from this item seem to align the item with the individualism subset.

Item 55 showed neither population supporting progress and meliorism. The GenP students were particularly strong in their disagreement with the statement, while the Physicists had nearly thirty percent of the respondents undecided. While this item says nothing as to whether scientists feel their work should be curtailed, it does suggest that they are aware of modern man's difficulties in dealing with a highly technological world. The GenP students felt even more strongly about this item, to the extent they were actually nonsupportive of the value of progress and meliorism.

In general, both populations supported progress and meliorism. The GenP students indicated concerns that had been reflected in earlier value dimensions, namely concern as to the appropriateness of man's developments in science and the place these developments have in modern society. Both the GenP students and the Physicists expressed awareness that modern man is not entirely capable of adapting to the freedom from manual labor increasing technology can provide.

In attempting to summarize these results, it appears that GenP students and Physicists differed primarily in their support of rationality, individualism, and progress and meliorism. They differed to a lesser extent in their support of universalism and utilitarianism. The difference in support was primarily one of degree. However, there were several items in which the GenP students were in the majority undecided or split between support and nonsupport of a given statement. In the case of each of these items, the Physicist population was in decided support of the value in question. These items are listed on the following page.

- 29. When the findings or theories of science conflict with religious belief, it is better to accept the religious belief.
- 31. While man has become physically richer from the fruits of science, he has become spiritually poorer.
- 36. The scientific information which has been gathered as a result of manned and unmanned space shots is well worth the large sums of money which have been spent on the projects.
- 53. All miracles have a scientific explanation.
- 57. More federal support to science should be in the form of grants for general scholarship and exploratory research rather than contracts for specified product research.

Two general themes emerge from these items. The first represents a concern for the relationship between religion and science (items 29, 31, and 53). All three items seem to place science and religion as antagonistic to one another, requiring the respondent to choose between seemingly different ways of viewing the world. They seem to indicate that the GenP student is unwilling to support science to the exclusion of religion, but neither is he willing to support religion to the exclusion of science. Item 31 perhaps suggests a question as to the balance to be maintained between science and religion.

The second theme that appears to be present is concern for the type of scientific research conducted. While the GenP population seemed unwilling to suggest that all research be applied, items 36 and 57 indicate that there is some question as to the usefulness of basic research. The difference seems to be one of assignment of priority. The GenP students are apparently aware of the usefulness of basic research, but feel that such research should address itself more toward problems of an immediate need. The recent environmental problems seem to have provided a more urgent push toward this attitude. While the GenP student does not suggest cessation of basic research, he does express concern as to whether more applied research

should receive higher priority. This theme was also observed in the Man's Physical World population.

Engineering Physics versus Academic Physicists

The total score distributions for the rationality value dimension are displayed in Plate XXVIII. As was the case with the other two student distributions, the Physicists were more supportive of rationality. The mean score for the Physicists was 45.3, while the mean score for the Engineering Physics (EngP) population was 42.5. The items that yielded chi-square values significant at the .05 level are listed below. Their respective distributions are contained in Plates XXIX and XXX.

RATIONALITY

7. The skepticism of the scientist should be limited to his work.
22. The unbounded inquiry of the scientists has had a bad effect on society's moral standards.
35. It is unlikely that a young scientist will make important discoveries.
51. It is a good policy to base an important decision purely on evidence even if it is the opposite of the decision based on common sense.
53. All miracles have a scientific explanation.
54. Scientists go overboard on demanding evidence before drawing conclusions.

Items 7, 22, 35, and 54 all indicated that the EngP students were indeed supportive of rationality, however, not as strongly as the Physicists. As is indicated in the histograms, small differences existed in each of the lower Likert scores, with considerable differences in the most supportive category. The Physicist was more willing to strongly commit himself to the value of rationality than the EngP student.

Item 51 has been discussed earlier in that the Physicists were not supportive of rationality in the context of this item. The EngP students were even less supportive of rationality in this item. It would appear that

**PLATE XXVIII. Distributions of scores received for the
rationality value dimension by Engineering
Physics and Academic Physicist populations.**

PLATE XXVIII

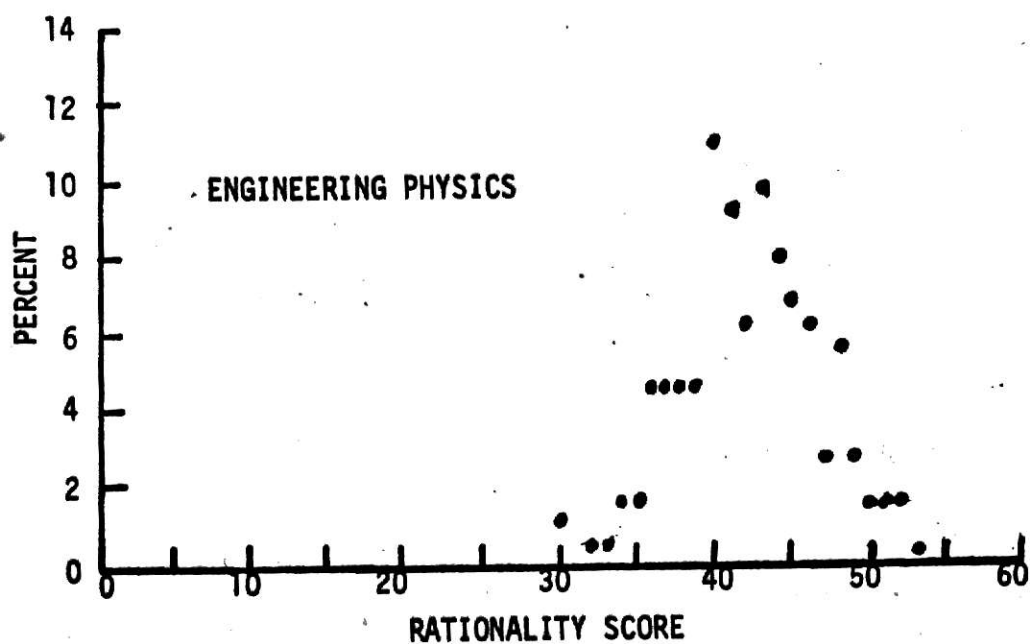
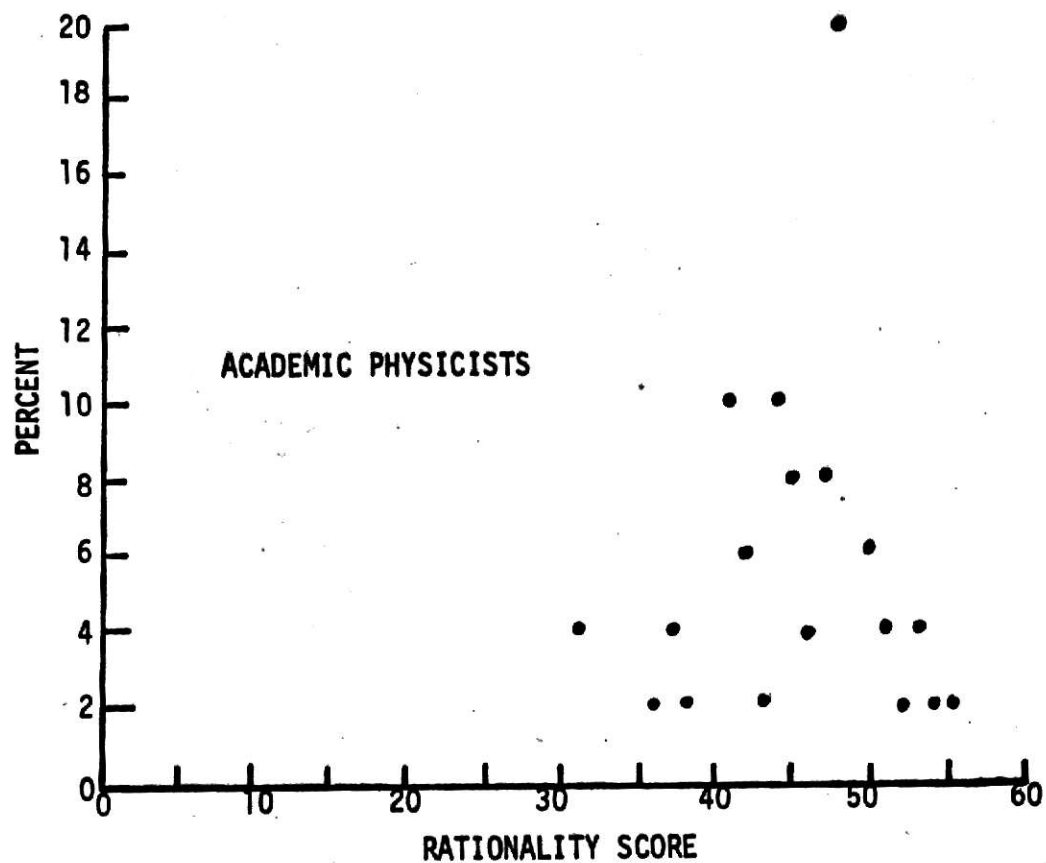


PLATE XXIX. Items from the rationality dimension with chi-square statistic significant at the .05 level. Likert scores are plotted along the abscissa and percent receiving that score along the ordinate. The solid line represents the Engineering Physics population, and the broken line represents the Academic Physicist population.

PLATE XXIX

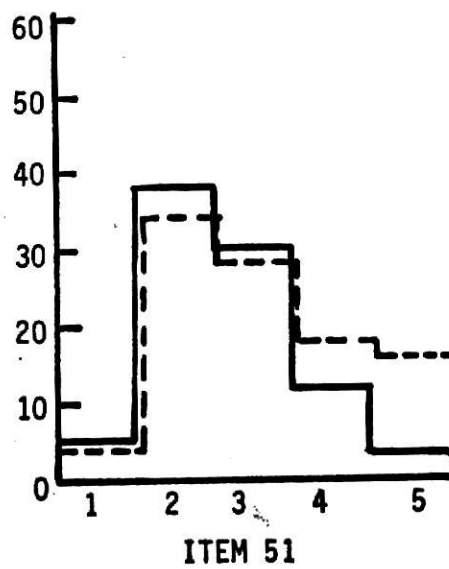
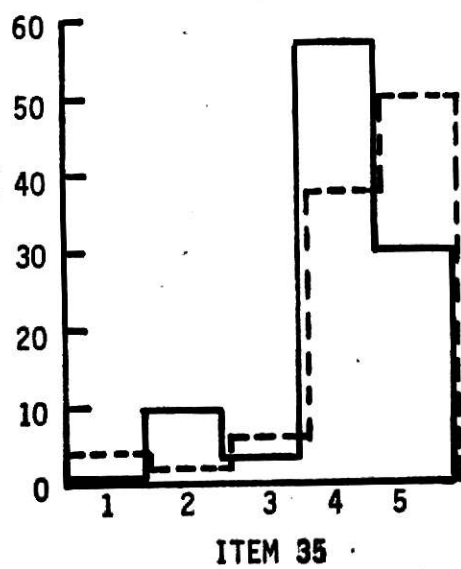
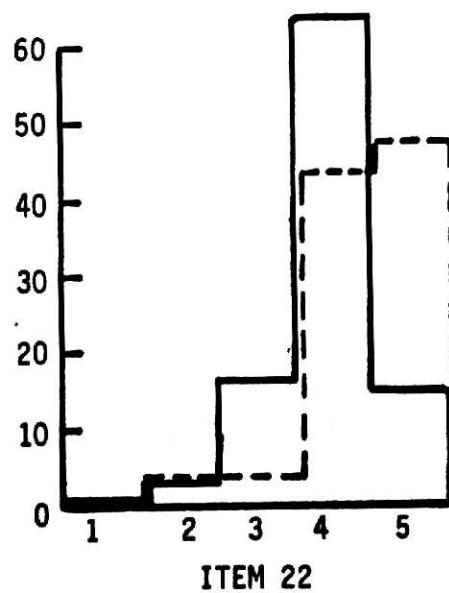
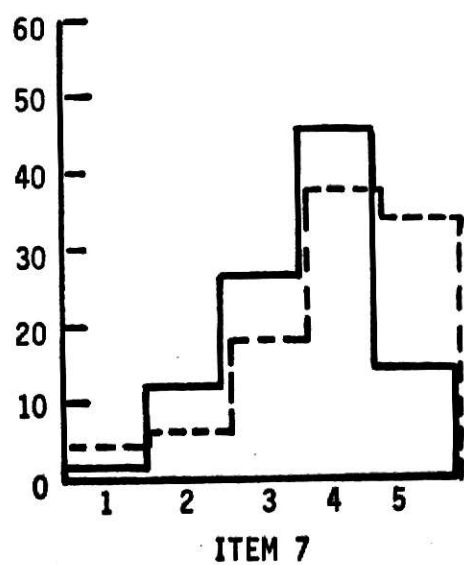
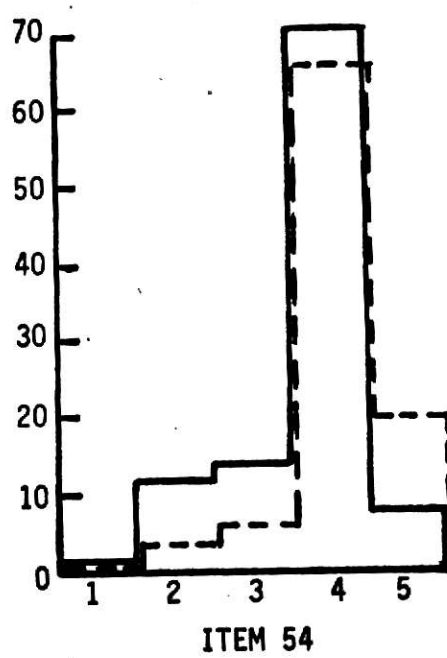
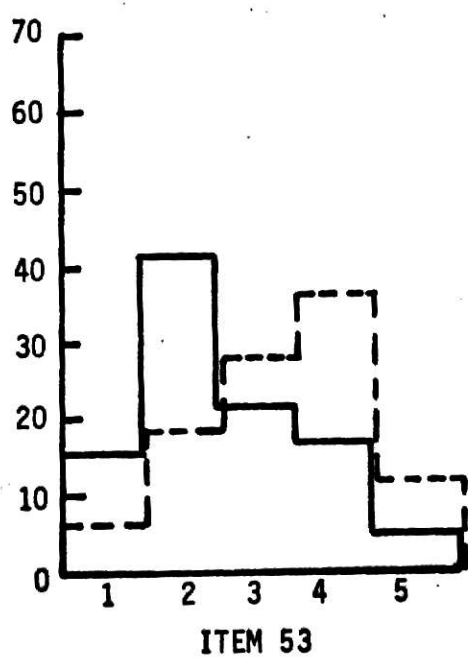


PLATE XXX. Items from the rationality dimension with chi-square statistic significant at the .05 level. Likert scores are plotted along the abscissa and percent receiving that score along the ordinate. The solid line represents the Engineering Physics population, and the broken line represents the Academic Physicist population.

PLATE XXX



the engineering student is more dependent upon common sense in judging results than the Physicist. Such a trend would appear to indicate differences between those working in applied fields rather than basic fields in science. Applications seem to demand more utilization of common sense.

Item 53 was the single item that revealed differences in support or nonsupport of rationality between the two populations. As can be observed from the histogram, the EngP student was not supportive of the value, remaining consistent with other student groups. The Physicists, while not overwhelmingly committed to rationality in this case, were certainly far more committed as a group than the EngP population. The EngP student did not appear to be willing to support rationality to the exclusion of other explanations of miracles.

The total score distributions for the utilitarianism dimension are displayed in Plate XXXI. The Physicist appeared more supportive of the value, with the difference in mean response being approximately two points. The mean score for the Physicist population was 43.9, while the mean score for the EngP population was 42.2. The items included in this value dimension that yielded a chi-square statistic significant at the .05 level are listed below. Their respective histograms are contained in Plate XXXII.

UTILITARIANISM

1. One important function of science is to demonstrate the wonder and orderliness of God's universe.
5. Religious leaders should be constantly on guard against the ideas and theories that scientists produce and explore.
6. Science is bound to lead our society into Godliness.
26. The meaning of any discovery should be judged by man's moral standards rather than by his intellectual need for truth.
37. The material progress of science has made men care less than they should about the prospect of eternal life.

**PLATE XXXI. Distributions of scores received for the
utilitarianism value dimension by Engineering
Physics and Academic Physicist populations.**

PLATE XXXI

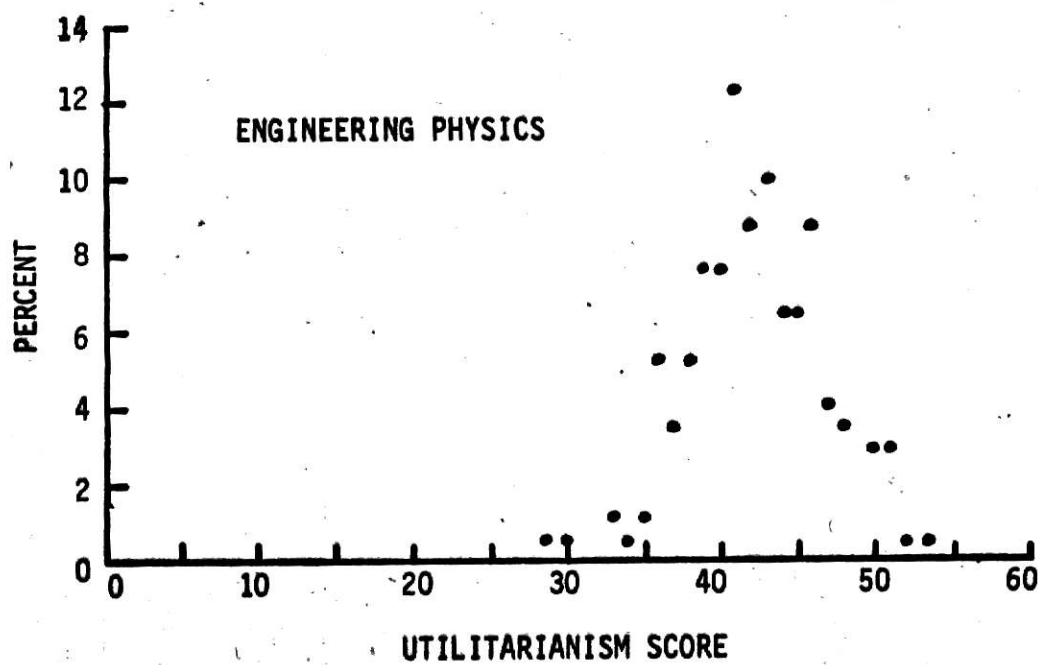
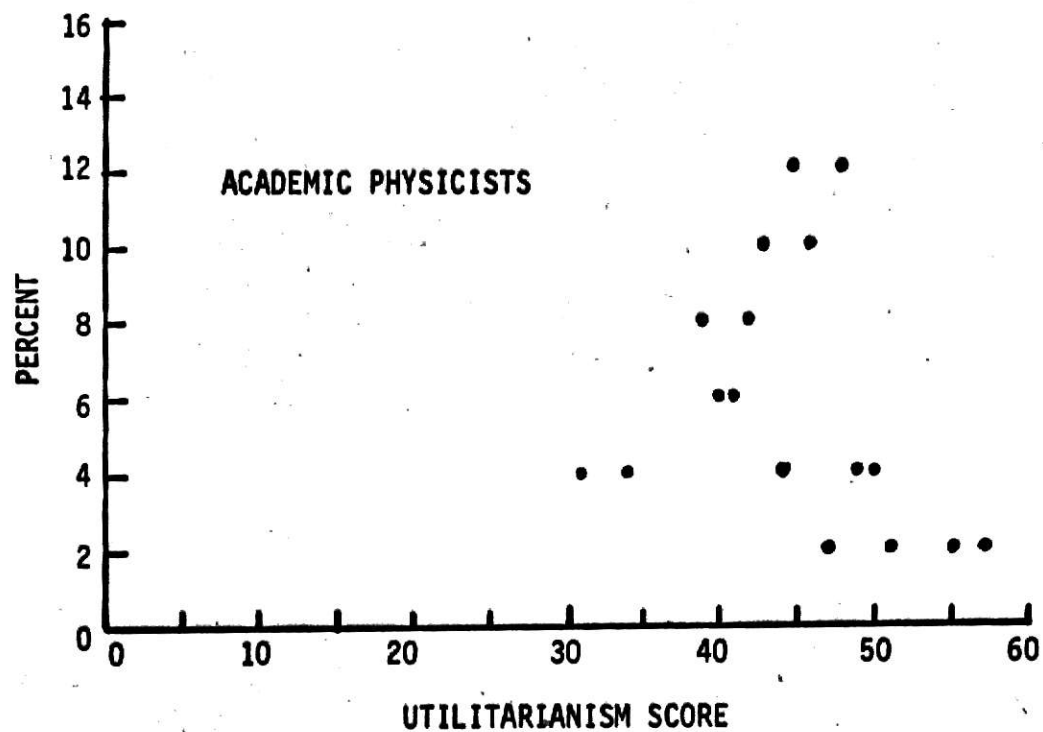
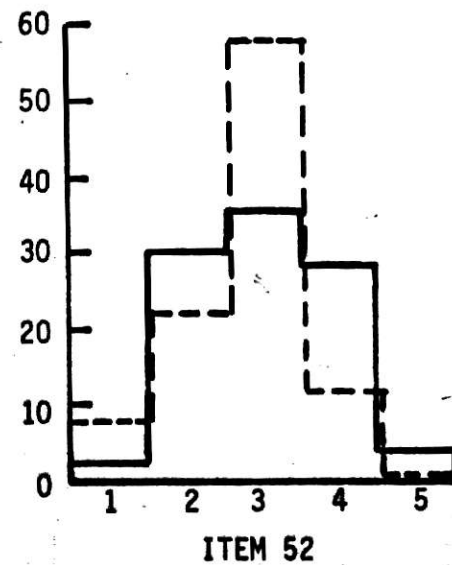
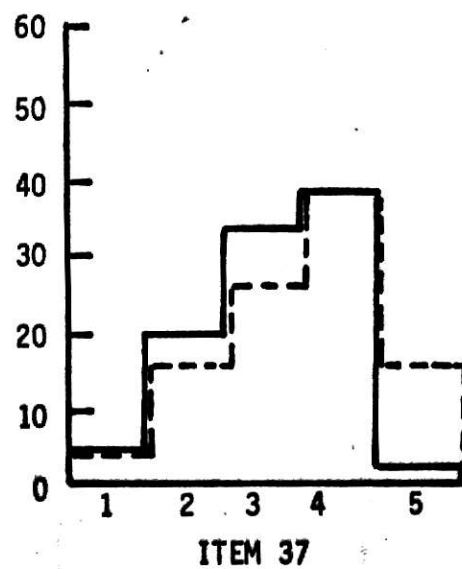
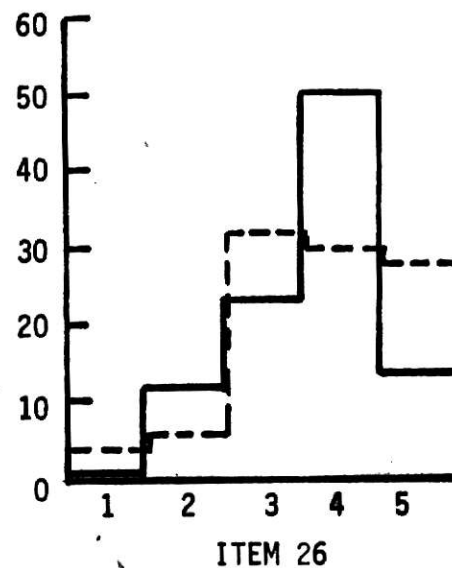
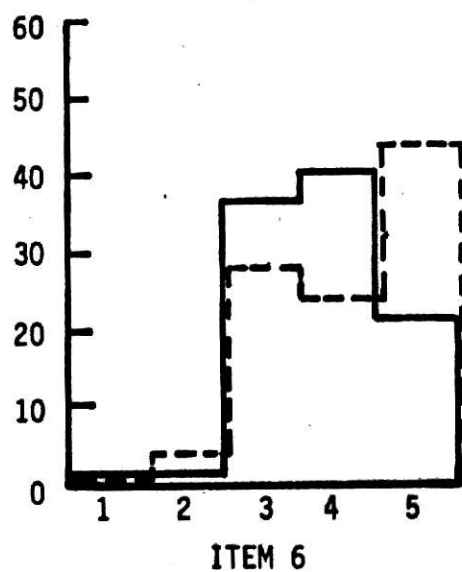
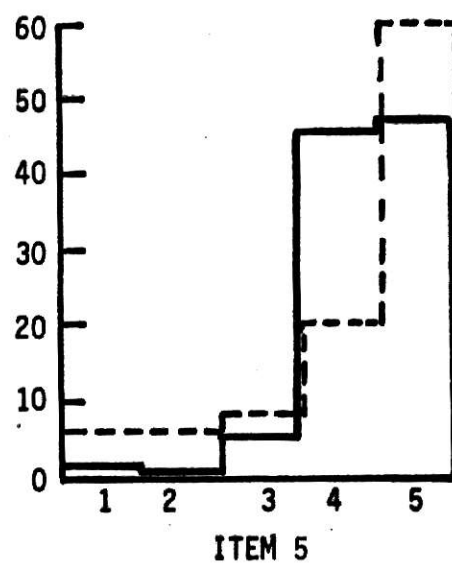
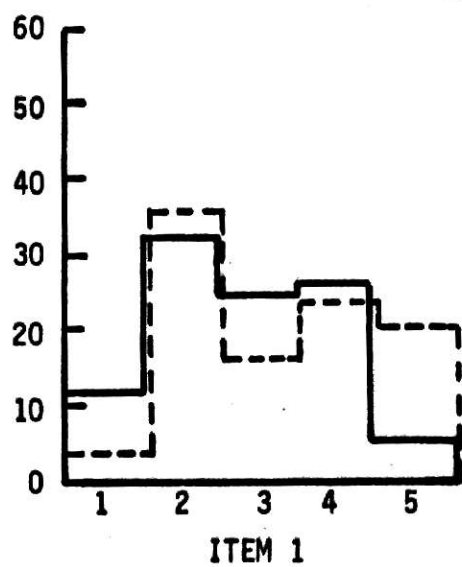


PLATE XXXII. Items from the utilitarianism dimension with chi-square statistic significant at the .05 level. Likert scores are plotted along the abscissa and percent receiving that score along the ordinate. The solid line represents the Engineering Physics population, and the broken line represents the Academic Physicist population.

PLATE XXXII



52. The true meaning of any discovery should be judged by man's physical wants and needs rather than by his moral standards.

Differences between the two populations were not as clear as was the case in the rationality dimension. Items 5, 6, and 26 indicated support of utilitarianism by both populations, with the Physicists more strongly supportive. Two of the items dealt with the relationship between science and religion, while item 26 dealt with the relationship between science and morality. The response to the items indicated that the EngP student does not perceive science as a threat to religion, nor does he feel moral standards should govern the work of scientists. Item 1 resulted in a bimodal distribution for both the Physicists and the EngP students. However, significantly fewer EngP students were willing to support utilitarianism; these students split between being undecided and nonsupportive of the value. It would appear that a larger percentage of EngP students accept science within the context of religion than do the Physicists.

Item 37 showed differences between the two populations in support of utilitarianism as opposed to remaining undecided. The Physicists were more strongly supportive of the value, although the EngP students were generally supportive of utilitarianism. Item 5 indicated that while EngP students feel that religion should not fear the developments of science, they still express considerable concern about the effect science has had upon man's relationship to religion.

Item 52 showed both populations largely undecided. The EngP population, however, had a much larger percentage both supportive and nonsupportive of the item than did the Physicists. Both populations seemed to support intellectual need for truth more strongly than man's physical wants and

needs. This is probably a reflection of today's security toward the physical necessities of life.

In general, both the Physicists and the Engineering Physics students supported utilitarianism. The lack of any concrete pattern of differences is a reflection of the small difference in mean scores for this dimension. It would seem that the Engineering Physics student differs little from the Academic Physicist in his acceptance of utilitarianism.

The third value dimension in the Science Support Scale was universalism. The universalism score distributions for both populations are shown in Plate XXXIII. The mean response of the Physicist population was 39.7, and the mean score of the EngP population was 37.8. The items in this dimension that yielded chi-square statistics significant at the .05 level are listed below. Their respective histograms are displayed in Plate XXXIV.

UNIVERSALISM

11. There is no place in science for sexual deviants such as homosexuals.
13. The work of any scientist should be judged without regard for his political views.
41. Those who have had a history of mental illness cannot be trusted to do important scientific work.
42. A scientist's reputation should be as important in judging his findings as the techniques he uses in his research.

All four items showed both populations supportive of universalism. Item 13 indicated only a difference in the degree of commitment to universalism, with the Physicists being much more strongly committed. Items 11 and 41 indicated much the same trend. However, both items 11 and 13 show thirty percent of the EngP students undecided. Evidently sexual deviants and the mentally ill are subject to some type of prejudice, although the prejudice is not overtly expressed.

**PLATE XXXIII. Distributions of scores received for the
universalism value dimension by Engineering
Physics and Academic Physicist populations.**

PLATE XXXIII

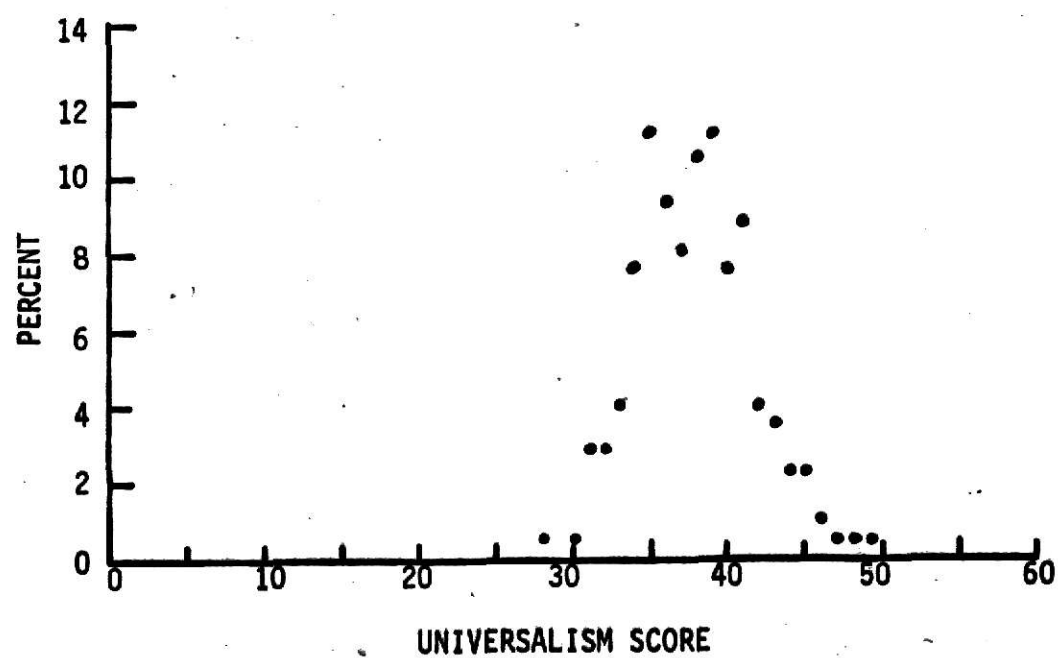
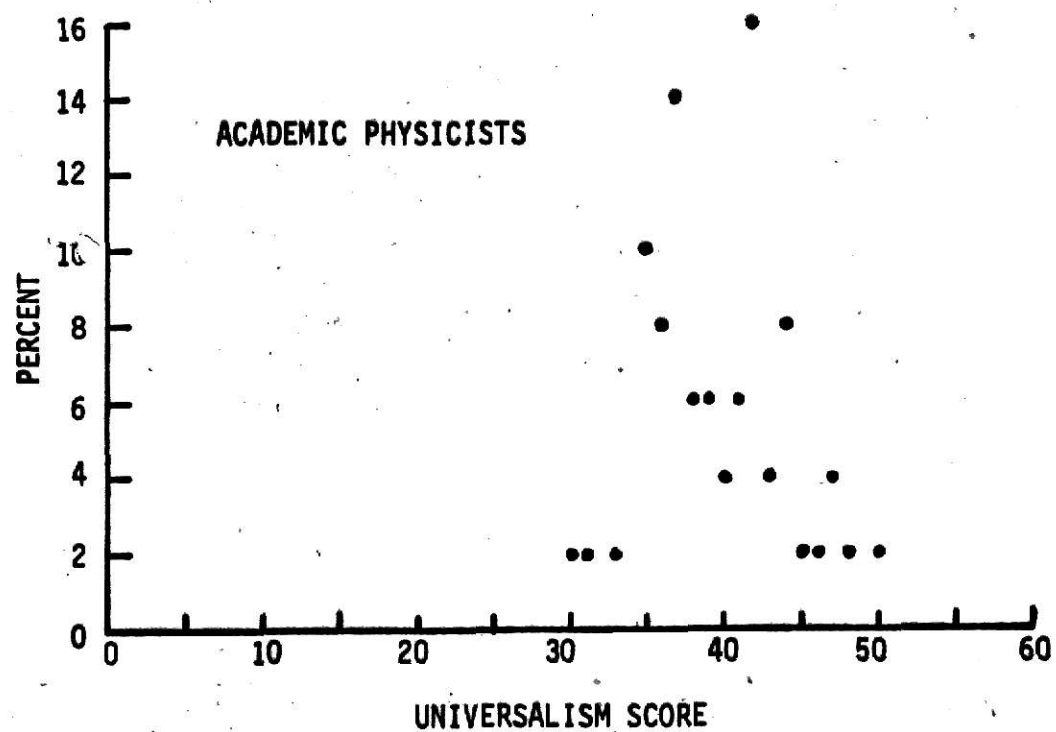
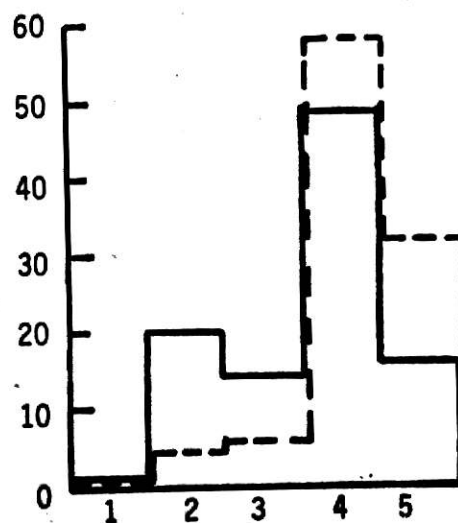
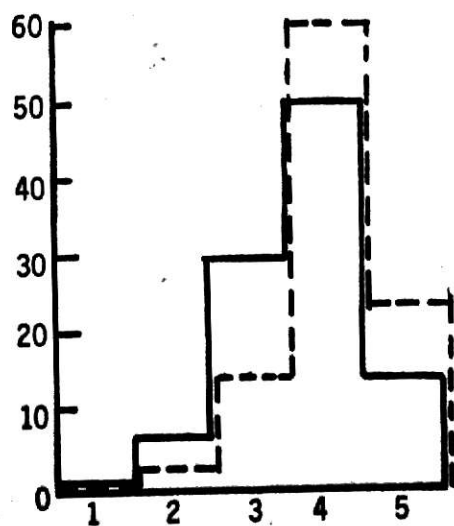
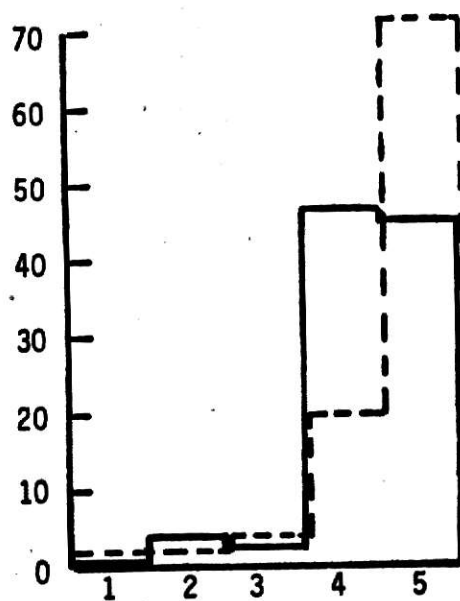
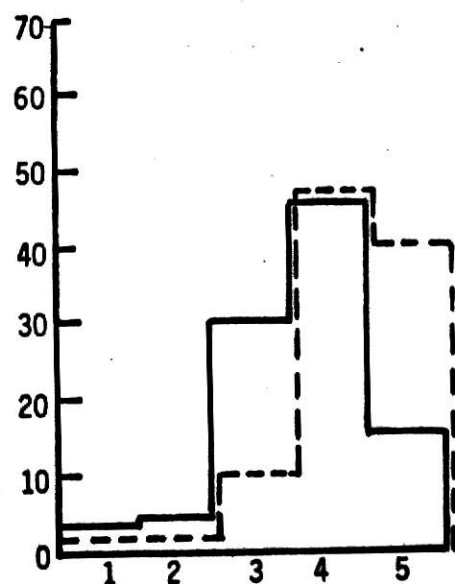


PLATE XXXIV. Items from the universalism dimension with chi-square statistic significant at the .05 level. Likert scores are plotted along the abscissa and percent receiving that score along the ordinate. The solid line represents the Engineering Physics population, and the broken line represents the Academic Physicist population.

PLATE XXXIV



Item 46 showed both populations supportive of universalism. However, the distributions indicated that twenty percent of the EngP students did not support the value dimension. A number of Engineering Physics students would judge a scientist's results as much upon his reputation as his experimental procedure. Such a result is surprising in that it represents the most significant deviation from support of universalism, and interestingly enough deals with science itself.

The fourth value dimension to be considered is individualism. The subset score distributions are shown in Plate XXXV. The Physicists were more supportive of individualism than were the EngP students. The mean score of the Physicist population was 44.9, while the mean score for the EngP student population was 41.9. The items yielding a chi-square statistic significant at the .05 level are listed below. Their respective histograms are shown in Plate XXXVI.

INDIVIDUALISM

9. The administration of colleges or universities should not discharge scientists whose political views are unpopular.
19. The individual scientist is the best judge of what research he should do.
43. It is not always appropriate for the Federal government to demand that the scientific research it sponsors serve the national policy ends.
48. Scientific work should be judged primarily by the political and social necessities of the nation and the world.
49. Scientists could work more effectively if they were organized and guided in their work by a Congressional committee which was aware of national needs.

All these items showed both populations supportive of individualism. Item 49 showed only that a larger percentage of Physicists were willing to strongly commit themselves to individualism, although both populations were definitely supportive of the value. The remaining items, while they showed

**PLATE XXXV. Distributions of scores received for the
individualism value dimension by Engineering
Physics and Academic Physicist populations.**

PLATE XXXV

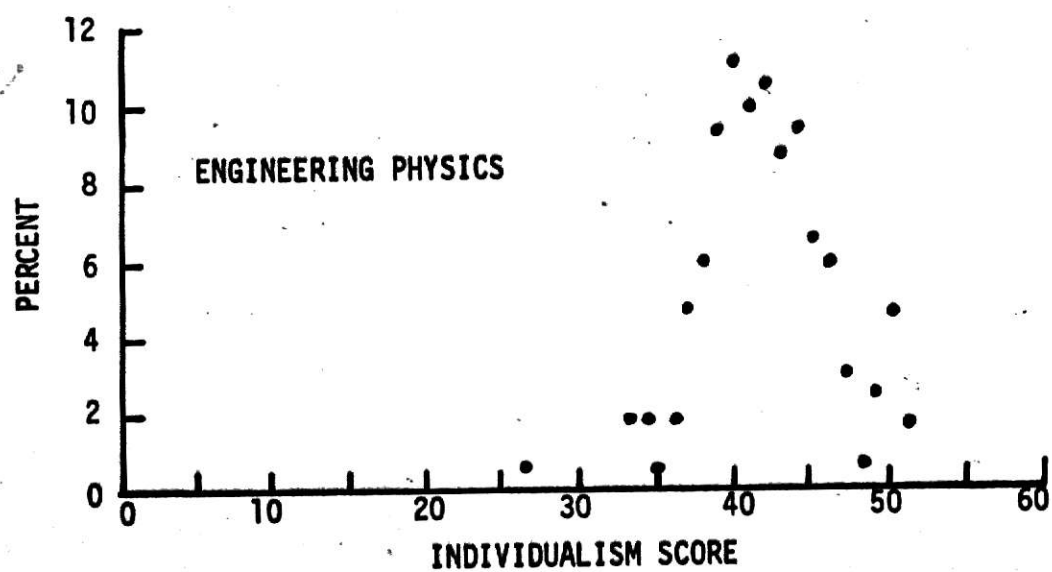
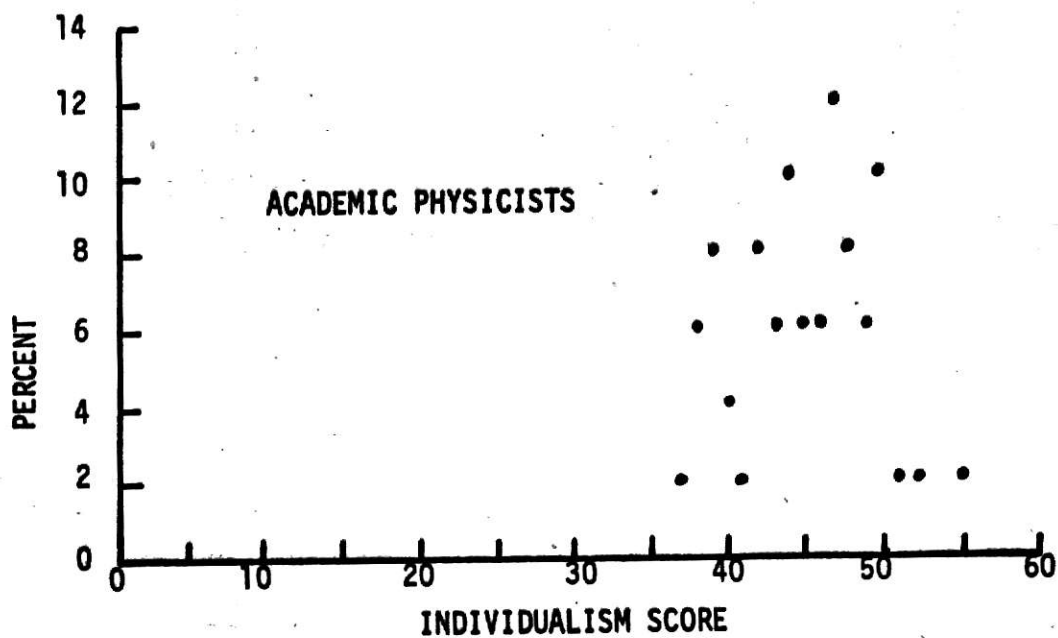
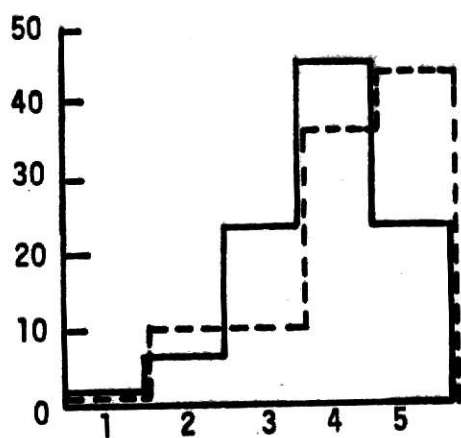
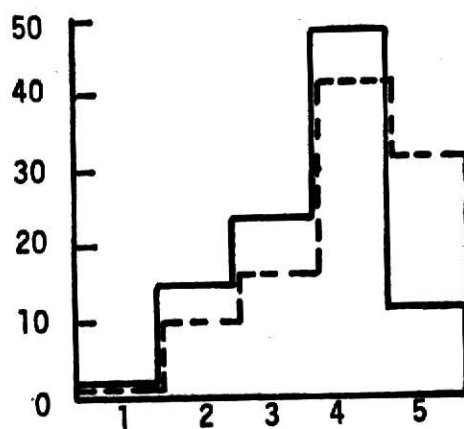


PLATE XXXVI. Items from the individualism dimension with chi-square statistic significant at the .05 level. Likert scores are plotted along the abscissa and percent receiving that score along the ordinate. The solid line represents the Engineering Physics population, and the broken line represents the Academic Physicist population.

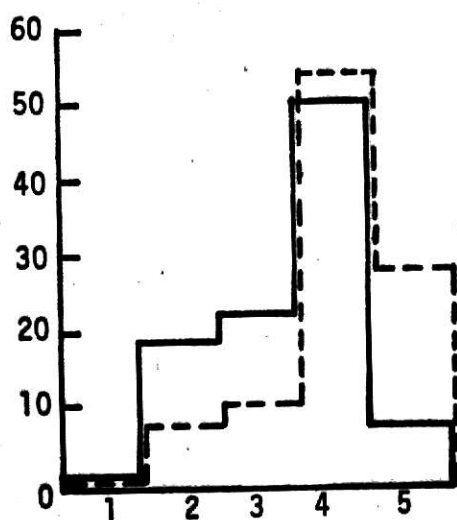
PLATE XXXVI



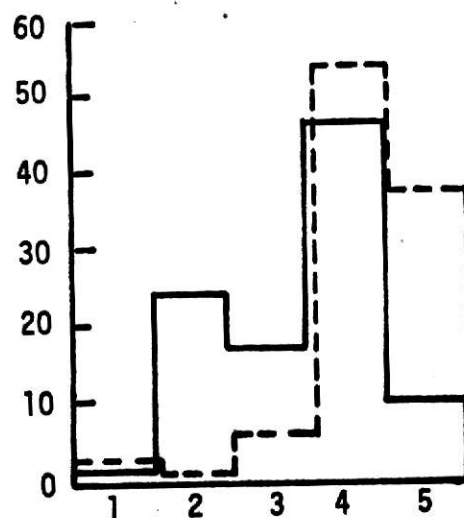
ITEM 9



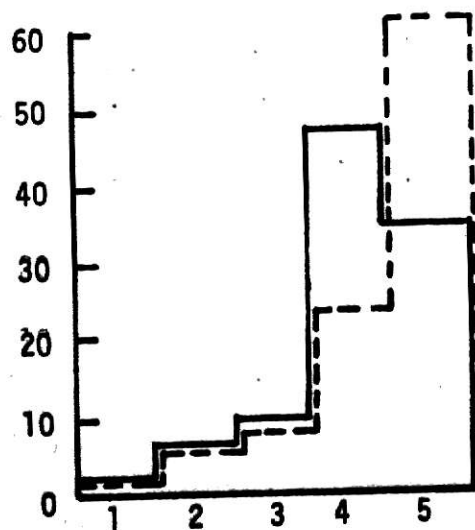
ITEM 19



ITEM 43



ITEM 48



ITEM 49

populations supportive of individualism, had significantly larger percentages of EngP students undecided or nonsupportive of the value. Items 43 and 48 both dealt with the relationship between government and science. Approximately twenty-five percent of the EngP students felt that scientific work should be considered in light of the needs of the society. This difference between Physicists and EngP students is not surprising, as the work of the engineer is highly oriented toward meeting some expressed need of the public. These items additionally indicated, however, that the EngP students also perceive the more basic role of science as a valid one as indicated by their overall support of individualism. Items 19 and 43 supported this same observation.

The last value dimension to be considered is progress and meliorism. The subset score distributions are shown in Plate XXXVII. The Physicists were more supportive of the value. The mean score of the Physicist population was 43.7, and the mean score of the EngP population was 41.8. Only three items yielded a chi-square statistic significant at the .05 level. These items are listed below, and their respective histograms are shown in Plate XXXVIII.

PROGRESS AND MELIORISM

14. It is not appropriate for man to tamper with the order and intentions of Nature.
28. Technological advances in the future will probably be nowhere as great as they have been in the past thirty years.
55. It will be a good thing when machines free men of all manual labor.

Items 14 and 28 indicated that both populations support progress and meliorism. Item 14 showed the Physicists more strongly supportive of the value, while item 28 showed the EngP students more strongly supportive of

**PLATE XXXVII. Distributions of scores received for the
progress and meliorism value dimension by
Engineering Physics and Academic Physicist
populations.**

PLATE XXXVII

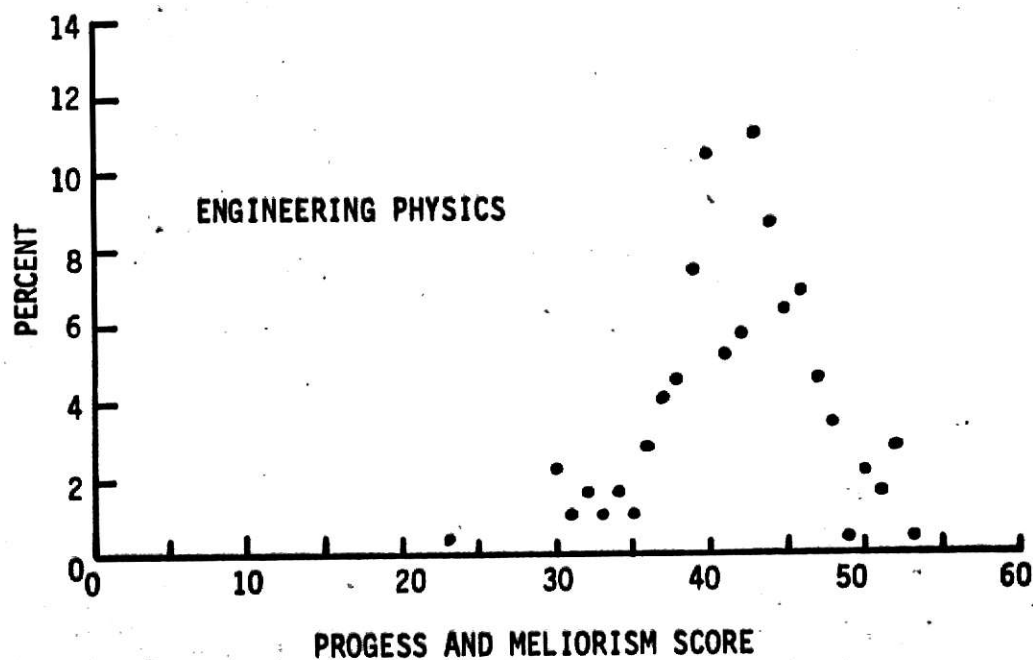
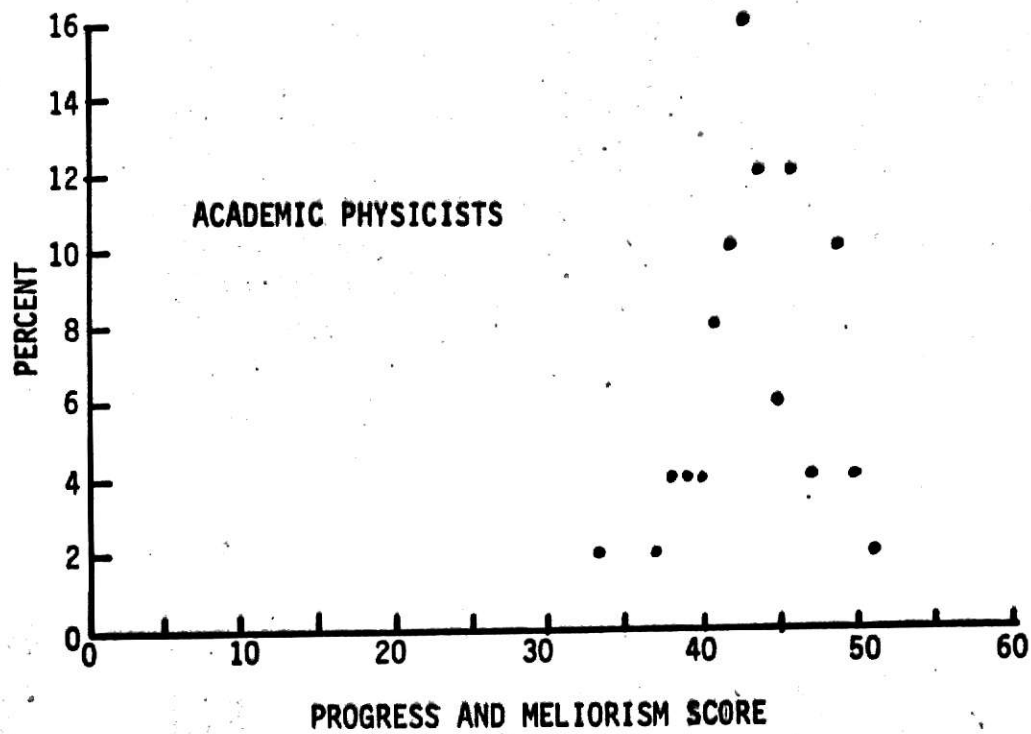
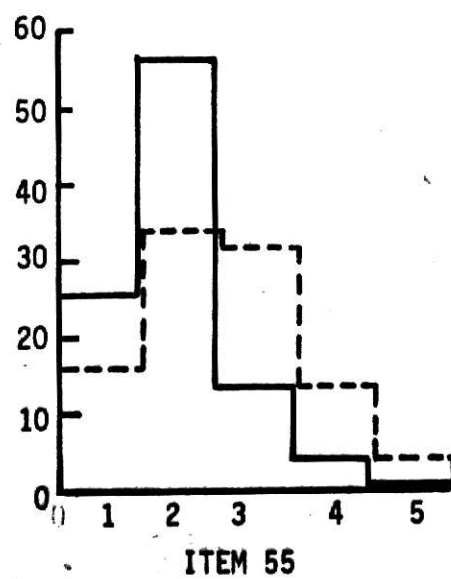
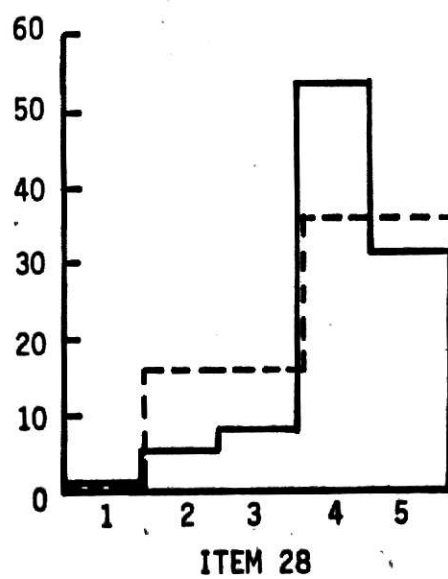
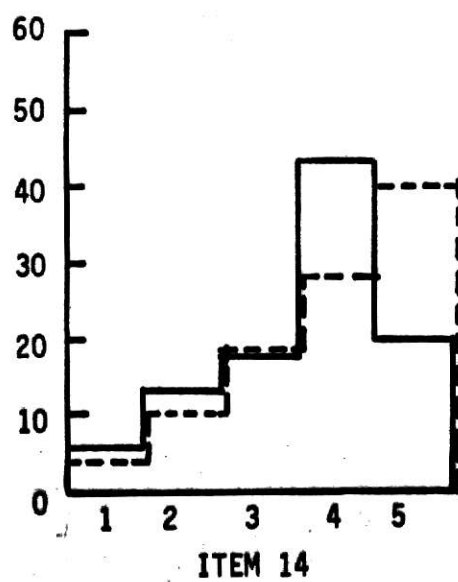


PLATE XXXVIII. Items from the progress and meliorism dimension with chi-square statistic significant at the .05 level. Likert scores are plotted along the abscissa and percent receiving that score along the ordinate. The solid line represents the Engineering Physics population, and the broken line represents the Academic Physicist population.

PLATE XXXVIII



the value. Item 14 perhaps indicated a difference in the development of the respective fields. Many physicists feel that the last half century has witnessed major breakthroughs in science, and that the next few decades may witness only minor developments. Engineering personnel are just now encountering applications of many of the more recent breakthroughs, and hence anticipate accelerated technological progress. Additionally, the physicists might tend to be more conservative than engineers in their categorization of advances in a field.

Item 55 showed neither population supportive of progress and meliorism. The EngP students were particularly strong in their disagreement with the statement. The EngP students appeared to be more like the student populations in their response to this item, which seems rather surprising. It would seem that the EngP students would support the development of better technology, and hence would support the development of machines to replace men in doing menial tasks. However, their response to this item suggests that the EngP student, like other students, feels a concern as to man's ability to adapt to increasing technology that would free him from manual labor.

In trying to summarize these comparisons, the EngP and Physicist populations differed to some extent on the value dimensions of rationality and individualism, and to a lesser extent on the value dimensions of utilitarianism, universalism, and progress and meliorism. The vast majority of differences in item scores were differences in degree of support of the particular value. Item 53 was the only item upon which the EngP population was undecided or nonsupportive of the value, while the Physicists were supportive of the value. This item dealt with miracles, and placed the

EngP population clearly with other student populations. Item 26 showed the Physicists undecided about the item with the EngP population clearly in support of utilitarianism. With the exception of these items, the two populations differed only in their degree of response to the various items. This difference in committed response accounted for the population differences in total score. The Engineering Physics population appears to be similar to the Academic Physicists in their general support of Barber's value dimensions.

Summary

In attempting to summarize these results it is useful to recall the mean total scores presented in Table V. The three student populations had mean total scores at least twelve points below the mean total score of the Academic Physicists, thus indicating a different attitude toward the societal values supportive of science. Differences within the three student populations were much smaller, with no apparent difference between the General Physics population and the Engineering Physics population. There was a trend of increasing mean total score from Man's Physical World to General Physics to Engineering Physics as was expected, with the General Physics population being more similar to the Engineering Physics population in attitude score.

The results of the subset scores for the five value dimensions suggested by Barber are summarized in Table VI. Except for the universalism dimension, there was a trend of increasing subset score from Man's Physical World at one extreme to the Academic Physicists at the other extreme. The three student populations were nearly alike in their support of universalism, supporting it less than the Academic Physicists. The dimensions were all

TABLE VI. Summary of mean scores obtained from the Man's Physical World, General Physics, Engineering Physics, and Academic Physicist populations for Barber's value dimensions.

TABLE VI

<u>Dimension</u>	<u>MPW</u>	<u>GenP</u>	<u>EngP</u>	<u>Physicist</u>
Rationality	41.4	42.2	42.3	45.3
Utilitarianism	40.4	41.9	42.2	43.9
Universalism	37.6	37.4	37.8	39.7
Individualism	40.4	41.7	42.0	44.9
Progress and Melliorism	39.2	40.3	41.9	43.7

well supported, the total possible score being sixty for all dimensions except universalism, which had a maximum possible score of fifty. The universalism score was lower due to fewer items. If the resulting scores for the universalism dimension were adjusted to a twelve-item score like the other four dimensions, the mean would be approximately six or seven points higher for each population. Thus, universalism was the most accepted value dimension by all populations. The Academic Physicists supported rationality and individualism slightly more than utilitarianism and progress and meliorism. The Engineering Physics population supported all four of these dimensions equally well. Both General Physics and Man's Physical World populations supported progress and meliorism slightly less than the other four dimensions.

In considering the individual items within these dimensions, the items listed below resulted in no concrete differentiation among the populations.

4. Science would be better off if scientists of Communist and non-Communist countries could work together. (Universalism)
10. An important function of the scientist today is to question what man says he believes. (Rationality)
15. The United States should encourage more students from foreign countries to study science in American universities. (Universalism)
16. Scientists should be free to explore all phases of man's life and the universe about him. (Rationality)
20. Teaching machines promote improved education. (Progress and Meliorism)
21. One important function of science is to teach people to be critical thinkers, not believing everything they are told. (Rationality)
24. The questions which are really important to man can never be solved by science. (Utilitarianism)
30. Science, rather than religion, helps rid people of superstitious fears. (Rationality)
32. The scientist's activities must not violate the basic values of his society. (Individualism)
33. Science should remain a predominantly male profession. (Universalism)

- 39. It would be much more pleasant to live in a country in which you didn't even know about the rest of the world's problems. (Progress and Meliorism)
- 58. In the long run, man's lot will be improved by scientific knowledge. (Progress and Meliorism)

Five of these items, items 4, 10, 20, 30, and 32, were items that were removed from the refined Science Support Scale because of low critical ratios; thus it was not surprising they did not differentiate between the various populations. These items come from all five value dimensions, and at most differentiate between two student populations.

Items 23, 27 and 42 differentiated the Man's Physical World population from the remaining three populations. These three items are listed below.

- 23. The primary function of a college education in science is to teach an appreciation for the findings of the past great scientists. (Individualism)
- 27. It is possible for a man to be a dedicated scientist and to be highly committed to his religious convictions. (Utilitarianism)
- 42. A return to a simpler, less mechanized life would result in happier, more contented people. (Progress and Meliorism)

In looking at the distributions for these items, the Man's Physical World population differed in degree of support of items 23 and 27, and was undecided on item 42. The remaining student populations were very much like the Academic Physicists in their response to these three items. The differences in item 42 are perhaps the more significant, as they represent a deviation from support of progress and meliorism. The Man's Physical World students apparently felt that the mechanization of society could be responsible for the discontent of modern man. The remaining student populations appeared to be more aware of the responsibility of man's usage of the results of science.

Items 6, 11, 26, 35, 51, 52, and 54 all differentiated principally between the student groups and the Academic Physicists. The student

populations were all very similar in their responses to these items, responses that were significantly different from those of the Academic Physicists. These items and their respective dimensions are listed below.

- 6. Science is bound to lead our society into Godliness. (Utilitarianism)
- 11. There is no place in science for sexual deviants such as homosexuals. (Universalism)
- 26. The meaning of any discovery should be judged by man's moral standards rather than by his intellectual need for truth. (Utilitarianism)
- 35. It is unlikely that a young scientist will make important discoveries. (Rationality)
- 51. It is a good policy to base an important decision purely on evidence even if it is the opposite of the decision based on common sense. (Rationality)
- 52. The true meaning of any discovery should be judged by man's physical wants and needs rather than by his moral standards. (Utilitarianism)
- 54. Scientists go overboard on demanding evidence before drawing conclusions. (Rationality)

With the exception of item 11, the remaining items all come from the rationality and utilitarianism value dimensions. It appears that the student populations shared differences in these two particular value dimensions.

Two of the rationality items (items 51 and 54) referred to the individual's image of how a scientist applies rationality. It is not surprising that the student populations responded similarly to these items. A significant percentage of students were undecided about items 6, 26, and 52; thus differentiating the student populations from the Academic Physicists. The student populations appeared to be concerned with the method of judging the worth of scientific endeavor.

A number of items provided no clear pattern of differentiation. These items included items 3, 9, 17, 19, 34, 38, 41, 44, and 28. Each of these items differentiated between at least two populations, but not between all populations. The populations differentiated were different for each item,

thus providing a list of isolated items. For this reason these items will not be discussed further. They are only of interest in a more detailed analysis of pairs of populations.

The remaining items showed a trend from support of the value dimension to less support or nonsupport of the value dimension from Academic Physicist to Man's Physical World student. Some of the student populations grouped together on a particular item, but the overall trend was still apparent. These items indicated a dependence of the item response upon the student population, establishing a trend in item response toward more support of the value dimension. These items and their respective dimensions are listed below.

2. It is likely that much of the scientific information we have today will be demonstrated to be inaccurate or inadequate in the future. (Rationality)
5. Religious leaders should be constantly on guard against the ideas and theories that scientists produce and explore. (Utilitarianism)
7. The skepticism of the scientist should be limited to his work. (Rationality)
8. Scientific inventions and discoveries have done more good than bad for mankind. (Progress and Meliorism)
12. Modern science and inventions are responsible for much of man's personal discontent and frustration. (Progress and Meliorism)
13. The work of any scientist should be judged without regard for his political views. (Universalism)
14. It is not appropriate for man to tamper with the order and intentions of Nature. (Utilitarianism)
18. In order to be more effective, religious leaders should know about recent major advances and developments in science. (Utilitarianism)
22. The unbounded inquiry of the scientists has had a bad effect on society's moral standards. (Rationality)
29. When the findings or theories of science conflict with religious belief, it is better to accept the religious belief. (Rationality)
31. While man has become physically richer from the fruits of science, he has become spiritually poorer. (Utilitarianism)

36. The scientific information which has been gathered as a result of manned and unmanned space shots is well worth the large sums of money which have been spent on the projects. (Individualism)
37. The material progress of science has made men care less than they should about the prospect of eternal life. (Utilitarianism)
43. It is not always appropriate for the Federal government to demand that the scientific research it sponsors serve the national policy ends. (Individualism)
45. Scientific findings should not be made public if they will create social unrest. (Rationality)
46. A scientist's reputation should be as important in judging his findings as the techniques he uses in his research. (Universalism)
47. The increased efficiency of computers does not justify their use because of all the unemployment produced when computers replace men. (Progress and Meliorism)
48. Scientific work should be judged primarily by the political and social necessities of the nation and the world. (Individualism)
49. Scientists could work more effectively if they were organized and guided in their work by a Congressional committee which was aware of national needs. (Individualism)
50. Men are worthy of enjoying the fruits of scientific discovery. (Utilitarianism)
53. All miracles have a scientific explanation. (Rationality)
55. It will be a good thing when machines free men of all manual labor. (Progress and Meliorism)
56. When doing medical research, scientists should be able to collect information of a highly personal nature. (Progress and Meliorism)
57. More federal support to science should be in the form of grants for general scholarship and exploratory research rather than contracts for specified product research. (Individualism)

These items may be thought to be a scale which differentiates between students in differing fields of study as well as differentiating between students and Academic Physicists. All of the value dimensions are equally represented with the exception of universalism. This distribution of items from the value dimensions seems consistent with the mean score comparisons for the various populations. These items differentiate over the widest range of populations tested, and show a trend toward more support of the various values as a function of degree of technical major pursued.

CHAPTER IV

FACTORED DIMENSIONS

Another approach to analyzing the population differences in attitude toward societal values supportive of science is to assume no prior value dimensions. The Science Support Scale is assumed to consist of fifty-eight items representative of attitudes toward science and society. Factor analysis is then applied to the fifty-eight variables to determine whether any of the variables cluster into factors or value dimensions. The questions being pursued by this approach are: (1) Do the items cluster in value dimensions different from Barber's value dimensions? and (2) Do the items cluster in different factors for different populations?

Factor analysis is essentially a mathematical model whereby a set of variables may be resolved linearly in terms of a smaller number of factors. In the method of principal components utilized for this study, the variables are expressed as a linear sum of factors, as shown in the equations below.

$$\begin{array}{rcl}
 z_1 & = & a_{11}F_1 + a_{12}F_2 + \dots + a_{1m}F_m \\
 z_2 & = & a_{21}F_1 + a_{22}F_2 + \dots + a_{2m}F_m \\
 \vdots & & \vdots \\
 z_n & = & a_{n1}F_1 + a_{n2}F_2 + \dots + a_{nm}F_m
 \end{array}$$

In these equations z_i represents the standard score for variable (item) i , a_{11} is the factor loading for variable 1 on factor 1, n is the number of variables, and m is the number of factors. The sum of the squares of the factor loadings for a given variable is called the communality of that variable and is an expression of the portion of variance in that variable accounted for by the factors. The sum of communalities is thus the total variance accounted for by the factor pattern, where the total variance of

the variables is just equal to the number of variables. The sum of the squares of the factor loadings for a given factor is called the eigenvalue of that factor, and represents the variance of the items accounted for by that factor. For exact reproduction of the correlations among the variables the number of factors would have to be equal to the number of variables. However such a solution provides no economy of description. Hence in a practical situation, only a few factors that account for a maximum percentage of the variance are retained.

The factor analyses were performed using POLFAC, Political Science Multi-Set Factor Analysis Program, by Lon Mackelprang, University of Iowa.⁴⁹ Factors were extracted by the principal axis method of Hotelling.^{50,51} Thus unities were retained in the diagonal of the correlation matrix, and eigenvalues were restricted to 2.0 or greater. The resulting factor matrix was rotated according to the Varimax method to obtain the best solution of factors.⁵² For comparison purposes with the work done by Schwirian, factor loadings of 0.4 or greater were used to identify variables constructing the factors.⁵³ All computations were performed using an IBM 360/50 computer. The Man's Physical World and General Physics populations both yielded four factors. The Engineering Physics population yielded a solution of six factors, and the Academic Physicist population yielded a solution of ten factors. The factor loadings, communalities, and resulting variable constructs are discussed in the pages to follow.

Man's Physical World

Factor analysis of the Man's Physical World population yielded four factors with eigenvalues of 2.0 or greater. These four factors accounted for 25.3 percent of the total variance. The factor loadings and communalities are contained in Table VII.

The first and strongest factor obtained for Man's Physical World students contained the following items:

5. Religious leaders should be constantly on guard against the ideas and theories that scientists produce and explore. (Utilitarianism)
11. There is no place in science for sexual deviants such as homosexuals. (Universalism)
22. The unbounded inquiry of the scientists has had a bad effect on society's moral standards. (Rationality)
33. Science should remain a predominantly male profession. (Universalism)
34. Fellowships and scholarships in the sciences are better spent on men than on women. (Universalism)
35. It is unlikely that a young scientists will make important discoveries. (Rationality)
38. If a student is very bright, he should be channeled into science because we need good scientists. (Universalism)
41. Those who have had a history of mental illness cannot be trusted to do important scientific work. (Universalism)
49. Scientists could work more effectively if they were organized and guided in their work by a Congressional committee which was aware of national needs. (Individualism)
55. It will be a good thing when machines free men of all manual labor. (Progress and Meliorism)

The majority of items come from the original universalism dimension. The inclusion of item 35 in this factor seems appropriate as the possibility of a young person or an older person making discoveries should be independent of their age and dependent upon their training in science. They should be judged upon criteria associated with the probability of making discoveries, not upon age. Items 5 and 22 suggest that those who accept universalism as a worthwhile value also extend this universalism in judging the impact science has had upon religion and morality. Similarly item 49 suggests that a

TABLE VII. Factor loadings above 0.4 and communalities for each item are shown for the factors extracted from the Man's Physical World population.

TABLE VII

Item Number	Factors				Communalities
	1	2	3	4	
1.		.529			0.334
2.					0.029
3.					0.194
4.			-.495		0.295
5.	-.474				0.317
6.					0.192
7.					0.136
8.					0.245
9.			-.410		0.306
10.					0.108
11.	-.429				0.249
12.				-.470	0.280
13.			-.535		0.402
14.				-.515	0.273
15.					0.169
16.			-.519		0.339
17.					0.071
18.					0.180
19.					0.143
20.					0.095
21.			-.476		0.260
22.	-.459				0.339
23.					0.178
24.				-.458	0.267
25.				-.489	0.356
26.					0.285
27.					0.201
28.					0.169
29.		.528			0.450
30.		.429			0.321

TABLE VII: (continued)

Item Number	Factors				Communalities
	1	2	3	4	
31.				-.473	0.251
32.		.458			0.252
33.	-.584				0.428
34.	-.555				0.349
35.	-.482				0.301
36.				-.542	0.329
37.				-.403	0.230
38.	-.525				0.281
39.					0.240
40.		.423			0.247
41.	-.552				0.331
42.				-.574	0.359
43.					0.133
44.					0.149
45.					0.178
46.					0.224
47.					0.256
48.					0.195
49.	-.457				0.326
50.					0.236
51.					0.212
52.					0.311
53.		.462			0.389
54.					0.135
55.	.531				0.359
56.					0.135
57.					0.142
58.			-.414	-.511	0.448

Congressional committee's ability to organize and guide science be judged against the guidelines of a scientist's ability to organize scientific research. Thus this factor seems to represent the universalism dimension in that it suggests that people be judged equally upon criteria that are relevant to the task at hand.

The second factor obtained included the items listed below.

1. One important function of science is to demonstrate the wonder and orderliness of Gods's universe. (Utilitarianism)
29. When the findings or theories of science conflict with religious belief, it is better to accept the religious belief. (Rationality)
30. Science, rather than religion, helps rid people of superstitious fears. (Utilitarianism)
32. The scientist's activities must not violate the basic values of his society. (Individualism)
40. In times of national emergency a scientist's utmost concern should be for the contribution he can make to his country's needs rather than his own specific research interests. (Individualism)
53. All miracles have a scientific explanation. (Rationality)

Four of these items were part of Factor 1 obtained by Schwirian.⁵⁴

Schwirian called this factor the Realm of Science - Real of Religion Factor. The items obtained in this study suggest much the same interpretation. All of the items deal with some type of conflict, either between science and morality in the case of items 32 and 40, or between science and religion in the remaining items. This factor suggests concern with what regions of man's life and behavior science should attempt to explain. As Schwirian states, "We are apparently dealing here with the views that individuals hold regarding what is the business of science and what is the business of religion in regard to explanations of man's world and man's behavior."⁵⁵

From Table VII it may be seen that six items cluster together to form the third factor. These items are listed on the following page.

4. Science would be better off if scientists from Communist and non-Communist countries could work together. (Universalism)
9. The administration of colleges and universities should not discharge scientists whose political views are unpopular. (Individualism)
13. The work of any scientist should be judged without regard for his political views. (Universalism)
16. Scientists should be free to explore all phases of man's life and the universe around him. (Rationality)
21. One important function of science is to teach people to be critical thinkers, not believing everything they are told. (Rationality)
58. In the long run, man's lot will be improved by scientific knowledge. (Progress and Meliorism)

The first three of these deal with science and politics, and in some sense refer back to the universalism scale. The inclusion of item 21 indicates that the function of science in teaching people to be critical thinkers is congruent with allowing the scientist to feel as he wishes toward political groups. This activity of science does not conflict with society, but rather complements the values already accepted by individuals within that society. Item 58 suggests a basic optimism toward the inclusion of science within society, and suggests that it may be successful in this role. However, it should be noted that item 58 loads more heavily in the next factor group. This dimension seems to place science within a role that would have it contribute to individuals thinking more for themselves and being free to make decisions they feel are acceptable. This factor is distinguished from Factor 2 in that it omits any items dealing with such an attitude toward religion and morality.

The items clustering together to form Factor 4 are listed below.

12. Modern science and inventions are responsible for much of man's personal discontent and frustration. (Progress and Meliorism)
14. It is not appropriate for man to tamper with the order and intentions of Nature. (Progress and Meliorism)

- 24. The questions which are really important to man can never be solved by science. (Utilitarianism)
- 25. The United States government should not take on the function of directing and coordinating American science as a whole. (Individualism)
- 31. While man has become physically richer from the fruits of science, he has become spiritually poorer. (Utilitarianism)
- 36. The scientific information which has been gathered as a result of manned and unmanned space shots is well worth the large sums of money which have been spent on the projects. (Progress and Meliorism)
- 37. The material progress of science has made men care less than they should about the prospect of eternal life. (Utilitarianism)
- 42. A return to a simpler, less mechanized life would result in happier, more contented people. (Progress and Meliorism)
- 58. In the long run, man's lot will be improved by scientific knowledge. (Progress and Meliorism)

The majority of items refer in some manner to the mechanical results of science, as in items 12, 31, 37, and 42. These items coupled with the utilitarianism items (items 14, 24, and 31) indicate a relationship between the technology and impact of science upon man. This factor represents a dimension associated with the impact technology has had upon man. This factor appears to be similar to Factor 3 obtained by Schwirian.⁵⁶

Thus it appears that the factors extracted from a factor analysis of the Man's Physical World population are different from Barber's original value dimensions. The first factor could certainly be considered the universalism dimension. But the remaining three factors are blends of the value dimensions and represent distinct values. The second factor essentially represents a value distinguishing between the roles of science and religion in dealing with man. The third factor identified a distinct role of science as one of encouraging free thought toward some areas of society. The fourth factor suggests a concern toward technology and its impact upon man.

General Physics

Factor analysis of the General Physics population also yielded four factors with eigenvalues of 2.0 or greater. These factors accounted for 25.1 percent of the total variance. Thus these factors seem to be equally comprehensive as those identified for Man's Physical World. The factor loadings and communalities are contained in Table VIII.

The first and strongest factor obtained for the General Physics population contained the following items:

11. There is no place in science for sexual deviants such as homosexuals. (Universalism)
33. Science should remain a predominantly male profession. (Universalism)
34. Fellowships and scholarships in the sciences are better spent on men than on women. (Universalism)
38. If a student is very bright, he should be channeled into science because we need good scientists. (Universalism)
49. Scientists could work more effectively if they were organized and guided in their work by a Congressional committee which was aware of national needs. (Individualism)
54. Scientists go overboard on demanding evidence before drawing conclusions. (Rationality)

With the exception of item 54, these items were also contained in Factor 1 extracted from the Man's Physical World population. The majority of items come from the universalism dimension. The inclusion of item 54 seems to suggest that the activity of scientists in demanding evidence is congruent with the application of universalistic norms in judging people, phenomena, etc. Thus item 54 seems to fit this dimension in its concern for critical judgement of all things. This factor represents the universalism dimension identified by Barber.

As indicated in Table VIII, the items making up the second factor for the General Physics population are as listed on the next page.

TABLE VIII. Factor loadings above 0.4 and communalities for each item are shown for the factors extracted from the General Physics population.

TABLE VIII

Item Number	Factors				Communalities
	1	2	3	4	
1.		-.410			0.428
2.					0.067
3.					0.066
4.			-.426		0.192
5.					0.241
6.					0.128
7.					0.192
8.					0.145
9.			-.408		0.203
10.					0.200
11.	.442				0.226
12.				.582	0.349
13.			-.474		0.260
14.					0.227
15.			-.413		0.218
16.			-.472		0.364
17.					0.085
18.					0.157
19.					0.071
20.					0.108
21.			-.533		0.313
22.				.601	0.410
23.					0.226
24.					0.238
25.					0.212
26.					0.287
27.					0.287
28.					0.176
29.		-.461			0.416

TABLE VIII: (continued)

Item Number	Factors				Communalities
	1	2	3	4	
30.		-.512			0.351
31.				.613	0.391
32.		-.412			0.280
33.	.487				0.386
34.	.480				0.299
35.			-.409		0.280
36.					0.225
37.				.560	0.330
38.	.434				0.256
39.					0.117
40.					0.136
41.					0.298
42.				.450	0.287
43.					0.157
44.					0.250
45.					0.211
46.					0.182
47.				.575	0.459
48.					0.253
49.	.511				0.268
50.			-.470		0.331
51.		-.516			0.280
52.		-.586			0.350
53.		-.576			0.337
54.	.465				0.320
55.		-.489			0.372
56.					0.244
57.					0.081
58.			-.529		0.365

1. One important function of science is to demonstrate the wonder and orderliness of God's universe. (Utilitarianism)
29. When the findings or theories of science conflict with religious belief, it is better to accept the religious belief. (Rationality)
30. Science, rather than religion, helps rid people of superstitious fears. (Utilitarianism)
32. The scientist's activities must not violate the basic values of his society. (Individualism)
51. It is a good policy to base an important decision purely on evidence even if it is the opposite of the decision based on common sense. (Rationality)
52. The true meaning of any discovery should be judged by man's physical wants and needs rather than by his moral standards. (Utilitarianism)
53. All miracles have a scientific explanation. (Rationality)
55. It will be a good thing when machines free men of all manual labor. (Progress and Meliorism)

Items 1, 29, 30, 32, and 53 were all items in the second factor extracted from the Man's Physical World population. Items 51, 52, and 55 were added to this dimension by the General Physics population. This factor is concerned with the conflict between science and other aspects of society such as morality and religion. Item 51 adds an additional aspect of society to this list of conflicts, in that it deals with science versus common sense. This dimension is slightly altered from the form identified in the Man's Physical World analysis, but still contains the overall theme of concern with the business of science as opposed to the business of other aspects of society in dealing with man.

Factor 3 contained nine items, many of which were similar to the items found in Factor 3 for the Man's Physical World population. The items that may be identified with Factor 3 for the General Physics population are listed below.

4. Science would be better off if scientists of Communist and non-Communist countries could work together. (Universalism)
9. The administration of colleges or universities should not discharge scientists whose political views are unpopular. (Individualism)

- 13. The work of any scientist should be judged without regard for his political views. (Universalism)
- 15. The United States should encourage more students from foreign countries to study science in American universities. (Universalism)
- 16. Scientists should be free to explore all phases of man's life and the universe around him. (Rationality)
- 21. One important function of science is to teach people to be critical thinkers, not believing everything they are told. (Rationality)
- 35. It is unlikely that a young scientist will make important discoveries. (Rationality)
- 50. Men are worthy of enjoying the fruits of scientific discovery. (Utilitarianism)
- 58. In the long run, man's lot will be improved by scientific knowledge. (Progress and Meliorism)

This factor contained all the items identified in Factor 3 of the Man's Physical World population. Items 15, 35, and 50 were added to this factor by the General Physics population. The addition of these items does not appear to appreciably change the orientation of the dimension. These items have in common an attempt to judge people, evidence, results on the basis of some universalistic standards. This factor is distinguished from Factor 1 in that the items deal more specifically with the interaction of scientists within society or the role of science in a society, rather than with the choice of individuals judged suitable for going into science as a career.

The fourth and last factor identified for the General Physics population contains the items listed below.

- 12. Modern science and inventions are responsible for much of man's personal discontent and frustration. (Progress and Meliorism)
- 22. The unbounded inquiry of scientists has had a bad effect on society's moral standards. (Rationality)
- 31. While man has become physically richer from the fruits of science, he has become spiritually poorer. (Utilitarianism)
- 37. The material progress of science has made men care less than they should about the prospect of eternal life. (Utilitarianism)
- 42. A return to a simpler, less mechanized life would result in happier, more contented people. (Progress and Meliorism)

47. The increased efficiency of computers does not justify their use because of all the unemployment produced when computers replace men. (Progress and Meliorism)

Once again this factor is very similar to Factor 4 obtained by the Man's Physical World population. With the exception of item 22, the items refer in some manner to the mechanical or physical results of science. This dimension represents an area of concern toward the effects of scientific research with respect to increasing technology, and technology's impact upon man.

The factors extracted from the factor analysis of the General Physics population are remarkably similar to the Man's Physical World population. It appears that the two populations have similar concerns, in particular the concerns reflected in General Physics Factors 2 and 4. Factor 1 appears to be similar to the universalism dimension described by Barber and seems to be restricted to items dealing with judging individuals worthy of pursuing science. Factor 2 deals with the conflict between religion and science in dealing with man, and to some degree extends the conflict to include other aspects of society. Factor 3 seems to express an acceptable role for science within society. It carefully distinguishes, however, such interactions from the concerns expressed in Factor 2. The fourth and last factor expresses a concern for the impact of technology upon man.

Engineering Physics

Factor analysis of the Engineering Physics population yielded six factors with eigenvalues of 2.0 or greater. These factors accounted for 32.0 percent of the total variance, slightly more than was accounted for by factoring in the other two student populations. The factor loadings and communalities are contained in Table IX.

TABLE IX. Factor loadings above 0.4 and communalities for each item are shown for the factors extracted from the Engineering Physics population.

TABLE IX

Item Number	Factors						Communalities
	1	2	3	4	5	6	
1.						-.445	0.522
2.							0.109
3.							0.072
4.							0.175
5.			-.504				0.299
6.		.610					0.420
7.	.583						0.423
8.	.515						0.359
9.							0.163
10.							0.340
11.					-.557		0.458
12.							0.299
13.					-.525		0.403
14.	.601						0.453
15.							0.166
16.							0.353
17.				.496			0.318
18.							0.287
19.							0.156
20.	.445						0.270
21.							0.297
22.			-.489				0.300
23.		.564					0.383
24.		-.412					0.484
25.				-.445			0.355
26.							0.439
27.						.435	0.241
28.				-.447			0.319
29.			-.503			-.416	0.419
30.							0.337

TABLE IX: (continued)

Item Number	Factors						Communalities
	1	2	3	4	5	6	
31.			-.482				0.344
32.						-.420	0.440
33.					-.439		0.305
34.					-.435		0.383
35.							0.329
36.				-.577			0.431
37.			-.520				0.383
38.	-.438						0.392
39.							0.258
40.			-.430				0.409
41.						.499	0.411
42.							0.388
43.							0.164
44.			-.464				0.300
45.							0.231
46.					-.418		0.307
47.				-.570			0.456
48.							0.236
49.			-.413				0.280
50.							0.156
51.							0.260
52.						-.487	0.287
53.						-.610	0.434
54.							0.133
55.							0.186
56.	.402						0.332
57.					-.454		0.229
58.	.490						0.380

As can be seen from Table IX, seven items clustered together to form Factor 1. These items are listed below.

- 7. The skepticism of the scientist should be limited to his work. (Rationality)
- 8. Scientific inventions and discoveries have done more good than bad for mankind. (Progress and Meliorism)
- 14. It is not appropriate for man to tamper with the order and intentions of Nature. (Progress and Meliorism)
- 20. Teaching machines promote improved education. (Progress and Meliorism)
- 38. If a student is very bright, he should be channeled into science because we need good scientists. (Universalism)
- 56. When doing medical research, scientists should be able to collect information of a highly personal nature. (Progress and Meliorism)
- 58. In the long run, man's lot will be improved by scientific knowledge. (Progress and Meliorism)

The thread linking these items seems to be a belief in progress and meliorism, and a belief in the ability of science to contribute positively to that progress. Item 7 seems consistent with this attitude, in that one who feels that science could contribute to progress would similarly feel that science and its techniques should be extended to other areas of life. Item 38 also seems consistent in that those who are highly committed to progress based on science would want the bright students channeled into fields based on their inclinations. In essence this factor represents one aspect of the progress and meliorism dimension suggested by Barber.

The second factor extracted from the Engineering Physics population consisted of only three items. Three items was judged too small a number of items to represent an actual value dimension by Schwirian.⁵⁷ The items in this factor are listed below.

- 6. Science is bound to lead our society into Godliness. (Utilitarianism)
- 23. The primary function of a college education in science is to teach an appreciation for the findings of the past great scientists. (Individualism)

24. The questions which are really important to man can never be solved by science. (Utilitarianism)

Two of the items come from the original utilitarianism scale and the third item comes from the individualism scale. It is difficult to recognize a common thread in just three items, but it should be pointed out that this particular factor accounted for nearly as much variance as other factors containing more items.

The third factor extracted by the factor analysis consisted of the items listed below.

- 5. Religious leaders should be constantly on guard against the ideas and theories that scientists produce and explore. (Utilitarianism)
- 22. The unbounded inquiry of the scientists has had a bad effect on society's moral standards. (Rationality)
- 29. When the findings or theories of science conflict with religious belief, it is better to accept the religious belief. (Rationality)
- 31. While man has become physically richer from the fruits of science, he has become spiritually poorer. (Utilitarianism)
- 37. The material progress of science has made men care less than they should about the prospect of eternal life. (Utilitarianism)
- 40. In times of national emergency a scientist's utmost concern should be for the contribution he can make to his country's needs rather than his own specific research interests. (Individualism)
- 44. Scientists could work more effectively if they were organized and guided in their work by a man who has proved himself to be an outstanding scientists. (Individualism)
- 49. Scientists could work more effectively if they were organized and guided in their work by a Congressional committee which was aware of national needs. (Individualism)

The first six items clearly address themselves to the conflict between science and religion or moral standards. Thus they are similar in nature to Factor 2 obtained for the Man's Physical World and General Physics populations. The inclusion of items 44 and 49 seem congruent, in that those who were concerned about the role of science as opposed to the role of religion, moral standards, or societal standards might favor some type of control of science. They

would thus impose limitations upon individualism in an effort to exert better control over the impact of science upon religious and moral standards.

Table IX shows five items clustering to form Factor 4. These items are listed below.

- 17. Federal scholarship programs for training scientists should be limited to citizens of the United States. (Universalism)
- 25. The United States government should not take on the function of directing and coordinating American science as a whole. (Individualism)
- 28. Technological advances in the future will probably be nowhere as great as they have been in the past thirty years. (Progress and Meliorism)
- 36. The scientific information which has been gathered as a result of manned and unmanned space shots is well worth the large sums of money which have been spent on the projects. (Progress and Meliorism)
- 47. The increased efficiency of computers does not justify their use because of all the unemployment produced when computers replace men. (Progress and Meliorism)

The last three items clearly set the tone of the dimension as being one of support of the progress represented by science. The inclusion of items 17 and 25 seem inconsistent. Perhaps if an individual supported the degree of progress and expenditures provided science during the past decade, he would see no reason for an outside agency to control and direct science. Along this same vein, it would seem that this individual would see no reason to limit the United States' resources in science by restricting scholarship program to American citizens. This factor is distinguished from Factor 1 in that it refers to concrete results of science rather than general viewpoints toward science, and represents a belief that the progress science has provided during the past few decades has been worthwhile.

Factor 5 was found to be constructed primarily from six items. These items are listed below.

- 11. There is no place in science for sexual deviants such as homosexuals. (Universalism)

13. The work of any scientist should be judged without regard for his political views. (Universalism)
33. Science should remain a predominantly male profession. (Universalism)
34. Fellowships and scholarships in the sciences are better spent on men than on women. (Universalism)
46. A scientist's reputation should be as important in judging his findings as the techniques he uses in his research. (Universalism)
57. More federal support to science should be in the form of grants for general scholarship and exploratory research rather than contracts for specified product research. (Individualism)

All but one of these items came from the original universalism dimension. Item 57 came from the individualism subset and does not seem to fit with the other items, although its factor loading clearly places it in this factor. Perhaps this item implies a relationship between judging a man upon his work, and then allowing him to pursue the work he perceives as being worthwhile. In any case, this factor clearly represents the universalism dimension defined by Barber.

The last factor extracted from the Engineering Physics population consisted of seven items. These items are listed below.

1. One important function of science is to demonstrate the wonder and orderliness of God's universe. (Utilitarianism)
27. It is possible for a man to be a dedicated scientist and to be highly committed to his religious convictions. (Utilitarianism)
29. When the findings or theories of science conflict with religious belief, it is better to accept the religious belief. (Rationality)
32. The scientist's activities must not violate the basic values of his society. (Individualism)
41. Those who have had a history of mental illness cannot be trusted to do important scientific work. (Universalism)
52. The true meaning of any discovery should be judged by man's physical wants and needs rather than by his moral standards. (Utilitarianism)
53. All miracles have a scientific explanation. (Rationality)

This factor corresponds to Factor 2 extracted from both the Man's Physical World and General Physics populations. The addition of item 27 to this

factor seems congruent, and probably reflects concern on the part of the engineer as to his relationship to science and religion. The addition of item 41 to this factor, however, is rather surprising. This particular factor appears to address itself to the conflict between science and other aspects of society which at times compete in dealing with man's behavior.

In general, five useful factors were extracted from the data obtained from the Engineering Physics population. Two of the factors, Factor 1 and Factor 4, both deal with aspects of progress and meliorism. The Engineering Physics population seems to have differentiated between these two aspects although the original progress and meliorism dimension did not. These two factors dealing with progress and meliorism are quite distinct, one based upon an idealistic view and the other on a more materialistic view. Factor 4 refers to support of the various results and developments made by science in the past few decades, while Factor 1 refers to the general philosophical support of the trends of scientific research. Factor 5 clearly represents the universalism dimension as originally defined. Factors 3 and 6 both deal with the conflict between science and other aspects of society, such as religion, moral standards, and societal standards. The items in Factor 3 seem to refer more specifically to the results of scientific research, while the items in Factor 6 seem to address themselves to the approach taken by scientists in general. Factor 3 in essence is concerned primarily with the actual impact science has had upon religion, while Factor 6 is concerned with whether science and religion can theoretically coexist.

Academic Physicists

Factor analysis of the Academic Physicist population yielded ten factors with eigenvalues of 2.0 or greater. Of these ten factors, only seven were of

reasonable size for consideration. These ten factors accounted for 60.6 percent of the total variance. The Academic Physicist population appears to have been a more homogenous population. The factor loadings and communalities are contained in Table X.

As can be seen from Table X, five items clustered to form the first factor. These items are listed below.

4. Science would be better off if scientists of Communist and non-Communist countries could work together.
13. The work of any scientist should be judged without regard for his political views. (Universalism)
19. The individual scientist is the best judge of what research he should do. (Individualism)
27. It is possible for a man to be a dedicated scientist and to be highly committed to his religious convictions. (Utilitarianism)
37. The material progress of science has made men care less than they should about the prospect of eternal life. (Utilitarianism)

Although only one item came from the individualism subset, the focus of this factor seems to be upon individualism. This individualism is extended beyond deciding what research to do, to deciding what political views to hold, to what religious convictions to accept, and to what type of scientists with whom to interact. The last items seems to suggest that man decides for himself whether to care about eternal life, and thus science itself has no impact upon that decision.

The second factor extracted from the Academic Physicist population was the strongest factor and consisted of nine items. The items that clustered to form Factor 2 are listed below.

7. The skepticism of the scientist should be limited to his work. (Rationality)
8. Scientific inventions and discoveries have done more good than bad for mankind. (Progress and Meliorism)

Page numbers 174 and 175 inadvertently omitted from the page sequence used for the text of this thesis.

9. The administration of colleges and universities should not discharge scientists whose political views are unpopular. (Individualism)
33. Science should remain a predominantly male profession. (Universalism)
34. Fellowships and scholarships in the sciences are better spent on men than on women. (Universalism)
35. It is unlikely that a young scientist will make important discoveries. (Rationality)
38. If a student is very bright, he should be channeled into science because we need good scientists. (Universalism)
52. The true meaning of any discovery should be judged by man's physical wants and needs rather than by his moral standards. (Utilitarianism)
57. More federal support to science should be in the form of grants for general scholarship and exploratory research rather than contracts for specified product research. (Individualism)

Although no one dimension clearly dominates, it appears as though this factor is emphasizing the universalism dimension. Items 9, 33, 34, 35, and 38 clearly reflect this dimension. The remaining four items do not seem to readily fit this trend. Perhaps individuals supportive of universalism similarly are supportive of general research, scientific progress and the extension of skepticism to many fields of endeavor. Regardless of these items, however, the trend of universalism appears to be the dominant theme.

The third factor obtained consisted of six items. These items are listed below.

22. The unbounded inquiry of the scientists has had a bad effect upon society's moral standards. (Rationality)
28. Technological advances in the future will probably be nowhere as great as they have been in the past thirty years. (Progress and Meliorism)
35. It is unlikely that a young scientist will make important discoveries. (Rationality)
44. Scientists could work more effectively if they were organized and guided in their work by a man who has proved himself to be an outstanding scientist. (Individualism)
53. All miracles have a scientific explanation. (Rationality)
56. When doing medical research, scientists should be able to collect information of a highly personal nature. (Progress and Meliorism)

TABLE X. Factor loadings above 0.4 and communalities for each item are shown for the factors extracted from the Academic Physicist population

TABLE X

Item Number	Factors										Communalities
	1	2	3	4	5	6	7	8	9	10	
1.										.557	0.690
2.											0.340
3.								-.633			0.580
4.	.497				.571						0.671
5.					.442						0.744
6.										.709	0.616
7.		-.429									0.564
8.		.500									0.471
9.		-.593					.595				0.642
10.											0.468
11.											0.414
12.					.567						0.590
13.	.559										0.678
14.											0.522
15.				.471							0.626
16.						-.592					0.701
17.					.489						0.608
18.							.757				0.651
19.	.539										0.489
20.											0.552
21.				-.446							0.673

TABLE X: (continued)

Item Number	Factors										Communalities
	1	2	3	4	5	6	7	8	9	10	
43.									.500	.451	0.746
44.			-.616								0.532
45.										.535	0.601
46.										.572	0.612
47.						-.459					0.670
48.											0.700
49.						-.649					0.671
50.											0.334
51.									.612		0.574
52.		.426									0.609
53.			.587								0.624
54.								.717			0.646
55.							-.442				0.409
56.			.645					.495			0.792
57.		-.490		.457							0.553
58.				.447							0.587

Except for item 44, this factor consists of rationality and progress and meliorism items. This combination seems consistent, in that an individual supportive of rationality will similarly feel that the progress resulting from the application of rationality is favorable. Items 22, 28, and 56 are particularly reflective of this general support of science as having a favorable impact upon society. Item 53 is reflective of a commitment to the further extension of rationality. Items 35 and 44 refer to individuals within the scientific community, and perhaps suggest that traditionalism as vested in age or in authority should not guide a scientist's work. Thus in this sense they both refer to the rationality dimension. The general thrust of this factor is toward rationality, with a lesser theme of progress. Factor 3 suggests a support of science, its methods, and its impact upon society.

The fourth factor extracted from the Academic Physicist population contained only four items. These items are listed below.

15. The United States should encourage more students from foreign countries to study science in American universities. (Universalism)
21. One important function of science is to teach people to be critical thinkers, not believing everything they are told. (Rationality)
25. The United States government should not continue to support science as it has in the past decade. (Progress and Meliorism)
57. More federal support to science should be in the form of grants for general scholarship and exploratory research rather than contracts for specified product research. (Individualism)

Three of these items, items 15, 25, and 57 are concerned in some manner with the financial support of science. However, no single theme appears to emerge from this collection of items. Thus it does not appear useful in judging differences.

The fifth factor extracted from the factor analysis of the Academic Physicist population consisted of nine items. These items are listed below.

4. Science would be better off if scientists of Communist and non-Communist countries could work together. (Universalism)
5. Religious leaders should be constantly on guard against the ideas and theories that scientists produce and explore. (Utilitarianism)
12. Modern science and inventions are responsible for much of man's personal discontent and frustration. (Progress and Meliorism)
17. Federal scholarship programs for training scientists should be limited to citizens of the United States. (Universalism)
22. The unbounded inquiry of the scientists has had a bad effect on society's moral standards. (Rationality)
26. The meaning of any discovery should be judged by man's moral standards rather than by his intellectual need for truth. (Utilitarianism)
29. When the findings or theories of science conflict with religious belief it is better to accept the religious belief. (Rationality)
30. Science, rather than religion, helps rid people of superstitious fears. (Utilitarianism)
58. In the long run, man's lot will be improved by the work of scientists. (Progress and Meliorism)

The primary theme contained in this factor seems to lie with the interface between science and morality, science and religion, and science and mankind. In this sense, it deals with the relationship between science and other approaches by which man deals with reality. Items 4 and 17 are the only items which do not address themselves to this theme. Both these items come from the universalism dimension and deal with attitudes toward foreigners. Perhaps these items are included in this factor in that individuals generally concerned with these problems regarding science and other more humanistic approaches would similarly be concerned with the inclusion of foreigners. In this sense the dimension represents a conservative-liberal view toward science and its relationship to other aspects of society. Items 4 and 17 are included as indicators of this conservative-liberal trend.

The sixth factor obtained from analysis of the Academic Physicist population contained six items. These items are listed below.

16. Scientists should be free to explore all phases of man's life and the universe about him. (Rationality)
23. The primary function of a college education in science is to teach an appreciation for the findings of past great scientists. (Utilitarianism)
42. A return to a simpler, less mechanized life would result in happier, more contented people. (Progress and Meliorism)
47. The increased efficiency of computers does not justify their use because of all the unemployment produced when computers replace men. (Progress and Meliorism)
49. Scientists could work more effectively if they were organized and guided in their work by a Congressional committee which was aware of national needs. (Individualism)

Once again, no single value dimension seems to dominate in this factor.

The items do deal with the actions of the scientist. Item 16 deals with the actions of the scientist in his research. Item 23 deals with the actions of the scientist in the classroom. Items 42 and 47 deal with the actions of scientists as related to increased mechanization. Item 49 deals with the actions of the scientist as related to national needs. Thus this factor seems to unite items that specifically refer to the actions of the scientist as related to his society.

Factor 7 consisted of six items. These items are listed below.

10. One important function of the scientist today is to question what man says he believes. (Utilitarianism)
18. In order to be more effective, religious leaders should know more about recent major advances and developments in science. (Utilitarianism)
27. It is possible for a man to be a dedicated scientist and to be highly committed to his religious convictions. (Utilitarianism)
31. While man has become physically richer from the fruits of science he has become spiritually poorer. (Utilitarianism)
39. It would be much more pleasant to live in a country in which you didn't even know about the rest of the world's problems. (Progress and Meliorism)

55. It will be a good thing when machines free men of all manual labor. (Progress and Meliorism)

Items 10, 18, 27, and 31 deal specifically with the relationship between science and religion. The inclusion of items 39 and 55 seems to indicate that individuals unsure as to the relationship between science and religion similarly are unsure as to man's ability to cope with the progress induced by science. The major theme of this factor, however, seems to be the relationship between science and religion.

The eighth and ninth factors extracted from the Academic Physicist population contained only four items. The items that clustered together to form Factor 8 are listed below.

- 3. If one or two scientists have evidence which appears to contradict current scientific belief, they are probably wrong. (Rationality)
- 32. The scientist's activities must not violate the basic values of his society. (Individualism)
- 54. Scientists go overboard on demanding evidence before drawing conclusions. (Rationality)
- 56. When doing medical research, scientists should be able to collect information of a highly personal nature. (Progress and Meliorism)

As was the case with Factor 6, all these items seem to refer to the actions of the scientist. However, in this factor the actions of the scientist are restricted to his own research activities. Although this factor is too short to be of significant use, the unity of the items should be noted.

The items included in Factor 9 are listed below.

- 24. The questions which are really important to man can never be solved by science. (Utilitarianism)
- 36. The scientific information which has been gathered as a result of manned and unmanned space shots is well worth the large sums of money which have been spent on the projects. (Progress and Meliorism)
- 43. It is not always appropriate for the Federal government to demand that the scientific research it sponsors serve the national policy ends. (Individualism)

51. It is a good policy to base an important decision purely on evidence even if it is the opposite of the decision based on common sense. (Rationality)

Once again, this factor contains too few items to be of comparative value. However, it should be noted that three of the items deal specifically with the relationship between scientific research and society. In this sense they refer to the question as to whether science should be more responsive to the needs of society.

The tenth and last factor extracted from the factor analysis of the Academic Physicist population contained seven items. These items are listed below.

1. One important function of science is to demonstrate the wonder and orderliness of God's universe. (Utilitarianism)
5. Science is bound to lead our society into Godliness. (Utilitarianism)
28. Technological advances in the future will probably be nowhere as great as they have been in the past thirty years. (Progress and Meliorism)
40. In times of national emergency a scientist's utmost concern should be for the contribution he can make to his country's needs rather than his own specific research interests. (Individualism)
43. It is not always appropriate for the Federal government to demand that the scientific research it sponsors serve the national policy ends. (Individualism)
45. Scientific findings should not be made public if they will create social unrest. (Rationality)
46. A scientist's reputation should be as important in judging his findings as the techniques he uses in his research. (Universalism)

Items 28, 40, 43, 45, and 46 seem to have in common a reference to the place and actions of the scientist within his society. It differs from earlier factors in its restrictive referrals to society. Items 1 and 6 deal with science and religion, although item 6 could be considered an interaction between science and society. It would seem that this factor is referring to the social commitment of the scientist as a member of society.

In general, the factors obtained from the Academic Physicist population seem more difficult to interpret than those obtained from the student populations. Of the ten factors obtained for the Academic Physicist population, three of them were only four items in length and thus were not considered differentiating factors. The themes included in the remaining factors included individualism (Factor 1), universalism (Factor 2), support of the methods and impact of science (Factor 3), relationship between science and other approaches toward dealing with reality (Factors 5 and 7), and the actions and responsibilities of the scientist to his society (Factors 6 and 10).

Summary

The questions being pursued by factor analysis of the data were:

(1) Do the items cluster in value dimensions different from Barber's value dimensions? (2) Do the items cluster in different factors for different populations? With respect to the first question, all four populations seemed to link items into factors very similar to the universalism dimension. Thus, this factor seems to be consistent with Barber's theoretical identification of universalism. The remaining factors for all populations seemed to be a blend of several dimensions. The most common overlap of dimensions occurred between rationality and utilitarianism and between individualism and progress and meliorism. Some factors reflected particular concern for the relationship between science and religion, thus linking items from both the rationality and utilitarianism dimensions. Other factors reflected concern for the impact and responsibility of science toward society, thus linking items from the individualism and progress and meliorism dimensions. Thus, it would seem that the value dimensions emerging from these populations

reflect societal difficulties associated with science. Because of the seemingly transient nature of these concerns, none of the factors can be considered valid value dimensions.

Factor scores can be calculated for the factors identified by factor analysis as value dimension scores were calculated in the analysis described in Chapter III. This analysis was conducted and the means of the various distributions are shown in Table XI. As was indicated in Table VI, there appears to be a trend toward increasing factor score as a function of the population. The trends indicated in the value dimensions appear to be exactly the same as those identified by these factor scores, in that the Man's Physical World students are the least supportive and the Academic Physicist population is the most supportive. The differences between these two extremes vary from less than one point to a maximum of four points. Thus these factors do not provide dimensions that differentiate between populations to a greater extent than did the hypothesized value dimensions.

Considering now the second of these questions, it appears that the four populations differed with respect to the factors that emerged. Some of the factors reflected the concerns identified from the dimensional analysis described in Chapter III. However, the various factors distinguished additional differences not readily observable from the various histograms. In this sense, the factor analysis proved to be a better technique by which to understand differences other than degree of support of the various values.

The Man's Physical World and General Physics populations proved to be remarkably similar in the emergent factors. The factors contained themes

TABLE XI. Summary of factor scores received by the various populations. The number recorded represents the mean score received by that population for the factors identified with the population factor score.

TABLE XI

MAN'S PHYSICAL WORLD FACTOR SCORES	1	2	3	4
Man's Physical World	36.8	16.7	23.5	29.9
General Physics	37.1	17.4	24.2	30.2
Engineering Physics	38.0	17.5	24.6	31.7
Academic Physicist	40.2	19.5	25.1	30.1
Total Possible	50.0	30.0	30.0	45.0

GENERAL PHYSICS FACTOR SCORES	1	2	3	4
Man's Physical World	23.2	22.4	34.8	19.3
General Physics	23.2	22.7	35.4	20.4
Engineering Physics	23.6	23.1	35.7	21.1
Academic Physicist	24.8	25.5	36.5	23.0
Total Possible	30.0	40.0	45.0	30.0

ENGINEERING PHYSICS FACTOR SCORES	1	2	3	4	5	6
Man's Physical World	24.5	10.5	26.1	17.3	22.5	21.9
General Physics	25.1	10.8	27.4	18.2	22.6	22.4
Engineering Physics	25.7	10.9	27.8	18.6	23.3	22.7
Academic Physicist	26.6	11.4	30.1	18.8	25.0	24.2
Total Possible	35.0	15.0	40.0	25.0	30.0	35.0

ACADEMIC PHYSICIST FACTOR SCORES	1	2	3	4	5
Man's Physical World	18.7	33.5	20.6	14.6	32.0
General Physics	19.6	33.4	21.1	14.8	32.8
Engineering Physics	19.4	34.3	21.1	14.9	33.2
Academic Physicist	20.3	35.2	23.0	15.0	34.5
Total Possible	25.0	45.0	30.0	20.0	45.0

ACADEMIC PHYSICIST FACTOR SCORES	6	7	8	9	10
Man's Physical World	17.5	19.6	13.7	12.7	22.0
General Physics	18.6	19.7	14.0	13.0	23.1
Engineering Physics	19.5	19.7	13.8	13.1	23.5
Academic Physicist	20.2	20.9	14.4	14.2	25.7
Total Possible	25.0	30.0	20.0	20.0	35.0

dealing with universalism, science and other aspects of society, science and religion, and the impact of technology upon man. The Engineering Physics population showed similar factors with themes of universalism, the impact of technology upon man, and the relationship between science and religion. Items dealing with science and its impact upon man were essentially separated into two factors. These two factors were distinguished according to items dealing specifically with the concrete results of science and items dealing with a philosophy supportive of scientific progress. Items dealing with the relationship between science and society were similarly split into two factors; one dealing with the actual impact of science upon society, and the other dealing specifically with science and religion. Thus all student populations seemed to group items dealing with a confrontation between science and religion.

The factors obtained for the Academic Physicist population showed much more differentiation than those determined by student populations. The increased homogeneity of the population was indicated by the increased variance accounted for by the factor solution. Two of the factors referred to universalism and the relationship between science and religion, as had the student populations. Additionally, one of the factors seemed to refer to the individualism dimension identified by Barber. The remaining four factors dealt specifically with the interface between science and society. Factor 3 was unique to the Academic Physicists in its general commitment toward rationality and the impact of science upon society. Factor 5 seemed to group items concerned with the impact of science upon moral values, religion, etc., in a fashion similar to the student populations. Factors 6 and 10 were unique to the Academic Physicist population, in that they dealt with the

actions and responsibilities of the scientist to the society within which he works. These factors seem understandable, in that the Academic Physicists would have had more reason to consider carefully their role and responsibility within the society.

CHAPTER V

SUMMARY AND CONCLUSIONS

The purpose of this study was to examine the attitudes of various student populations toward science and society, and to compare these attitudes with the attitudes of Academic Physicists. The total score received on the Science Support Scale was considered a measure of the position of an individual along a linear continuum extending from unfavorable to favorable with respect to attitudes toward societal values conducive to the growth of science. Distributions of individuals within each population showed all student groups generally supportive of the values operationalized in the Science Support Scale. The Academic Physicist population was more supportive of the values than the student groups, however, the difference was not as great as was anticipated. The student populations grouped together approximately ten points below the Academic Physicists. This grouping of student populations reflects different levels of maturity in accepting a set of values as well as differentiating personal commitments toward science as a career. There was a trend of increasing support of these societal values as a function of the student population, i.e., Man's Physical World, General Physics, and Engineering Physics. These differences, however, were much smaller than the difference between the Academic Physicists and the student populations. Differences in attitude toward science and society between the engineering student and the nonscience student, as measured by the Science Support Scale, were not as pronounced as many have suggested.

Two experimental approaches were utilized in investigating the nature of the differences of the various populations along the attitude continuum. The

first of these compared attitudes toward five societal values conducive to the growth of science which formed the structure of the Science Support Scale. The second of these investigated population perceptions of additional value dimensions within the item content of the Science Support Scale. The first approach was limited to comparisons of the student populations with the Academic Physicist population. This approach provided little information as to the nature of the support expressed by the Academic Physicist. The second approach provided more information as to population perceptions of the relationships between science and society, particularly for the Engineering Physics and Academic Physicist populations. However, it provided little additional insight into the differences of populations along the attitude continuum.

Contrasting these two approaches, the Man's Physical World and Academic Physicist populations differed little in their support of universalism, but differed more significantly in support of rationality, utilitarianism, individualism, and progress and meliorism. Although differences were primarily reflected in the degree of support of the value, a number of items showed the Man's Physical World population nonsupportive of the value in question. The themes present in this list of items were identified as: (1) Should scientific work be directed toward national needs? (2) What impact has science had upon religion? (3) What impact has science and its resulting technology had upon people and their well-being? Comparing these themes with the factors extracted in the second approach shows some similarities. Factor 2 identified for the Man's Physical World population dealt with the relationship between science and religion in dealing with man's world and man's behavior. The items identified in the themes

expressed above similarly clustered with additional items as further indication of this concern. In conjunction with this theme, the factor analysis indicated a factor which could not be observed by item differences within the structure of Barber's value dimensions. Factor 3, identified for the Man's Physical World population, seemed to define a role of science in society as one of encouraging critical thought and acceptance of different ideas. This role, however, was perceived to exclude references to religion and morality. Factor 1, identified for the Man's Physical World population, corresponded to Barber's universalism dimension and was not a differentiating theme between the Academic Physicist and nonscience student populations. The remaining two themes, the impact of science upon man and the responsibility of science toward societal needs, were combined into Factor 4 with the latter theme being weakly expressed. This factor suggests concern for technology and increased change thrust upon society by the application of science.

Analysis of the responses of General Physics students showed differences with respect to the Academic Physicists in the value dimensions of rationality, individualism, and progress and meliorism. Much smaller differences were encountered in utilitarianism and universalism. As was the case with the Man's Physical World population, themes resided in items not supported by the General Physics population. These themes indicated: (1) concern for the relationship between science and society and (2) concern as to the responsibility of science toward solving societal problems. The factors obtained for the General Physics population were remarkably similar to those obtained for the Man's Physical World population. Factor 2 thus substantiated the first theme. The second theme did not emerge from the factor analysis.

The remaining factors contained themes of universalism, concern for the impact of science upon man, and the role of science in encouraging critical thought.

Analysis of the Engineering Physics population showed differences with respect to the Academic Physicists in the value dimensions of rationality and individualism, with much smaller differences toward utilitarianism, universalism, and progress and meliorism. No themes emerged from the differences, however, and the Engineering Physics population was considered to be similar to the Academic Physicists in nature but not in degree of acceptance of these values. The factor analysis did result in factors, however, that revealed information about this population. As was the case with the other two student populations, a factor dealing with universalism was extracted. The factors observed in the other two student populations dealing with the impact of science upon man were resolved into two factors by the Engineering Physics population. One factor dealt with the impact of the mechanization and specific technological products upon man, and the other factor dealt with the general idealized impact of science upon man. The factors observed in the student populations dealing with science and religion were similarly resolved by the Engineering Physics population. One factor dealt with the perceived impact science has had upon religion, and the second factor dealt with the perceived compatibility of science and religion.

It would seem that neither approach utilized in this study was entirely successful in investigating the nature of population differences in attitudes toward societal values supportive of science. The two approaches complemented one another for the Man's Physical World and General Physics populations, providing some overlap in resulting themes. The factor analysis

provided the most information for the Engineering Physics and Academic Physicist populations.

Based upon the information obtained from the Science Support Scale, some general comments may be made as to the various perceptions of the values supportive of science. Although a general trend toward increased support of the value dimensions in the Science Support Scale from Man's Physical World to General Physics to Engineering Physics to Academic Physicist was observed, a natural division seems to occur between the Man's Physical World and General Physics populations at one end and the Engineering Physics and Academic Physicist populations at the other end. This separation emerges more from the factor analysis than from the dimensional studies. However, the lack of any concrete thematic differences in the dimensional studies gives further evidence of this division. It seems useful to summarize the observed differences in terms of this dichotomy.

The General Physics and Man's Physical World populations were acceptive of Barber's value dimensions with the following qualifications. Rationality as a way of dealing with reality was well accepted by both populations. However, if rationality is presented as the only method by which man deals with his experiences, then rejection of the value occurred. Thus nonscience students accept the role of rationality and hence the role of science as a valid societal activity, but do not accept rationality as the only valid activity in interacting with man and his society. Utilitarianism was a well accepted value dimension except with items posing a conflict between science and religion. Both populations seemed to indicate concern for the impact science has had upon or might have upon religion, although they did not actually view science as being threatening to religion. However, a large

number of nonscience students feel concern for the relationship between science and religion. Universalism was a highly accepted value as operationalized in this inventory. However, a considerable number of Man's Physical World students were willing to support a scientist's work based upon his reputation as well as his experimental procedures. Such a result should be particularly distressing to physicists-educators. Both Man's Physical World and General Physics populations expressed concern and indecision as to the degree to which science should be involved with societal problems. They expressed the opinion, however, that such involvement should not be imposed by the government. With respect to progress and meliorism, both populations expressed commitment to progress but concern as to man's ability to adapt positively to the pace of progress.

Of these concerns, at least two areas seem to be readily accessible by the physicist-educator. The first of these is, of course, the tendency to judge scientific work as much by reputation as by the experimental procedures. While such an attitude may be judged necessary in the age of specialization, its acceptance is a function of the criteria upon which a man's reputation is constructed. Thus science education should concern itself with providing the skills and understanding by which a nonscience student can begin to judge scientific experiments by their procedures and method. The second concern lies with the responsibility of science toward solving societal problems. Although the nonscience student was not actually nonsupportive in this dimension, it seems that he was unsure as to the usefulness of basic research. This area seems to be one to which the physicist-educator may address himself. The other areas of concern appear to be more difficult to deal with in the context of an information-centered

physical science course. However, discussing the interrelationships between science and religion, the increasing complexity of modern life, ways of dealing with such complexity, etc., are suggested as being relevant topics for a science and society course for the nonscience student.

The Engineering Physics population seemed more similar to the Academic Physicist population, particularly in the nature of their attitudes. Primary differences between the two populations resulted from degree of support of the values rather than nature of support. The only major exception to this trend was displayed in items which attempted to support science to the exclusion of religion and morality, in which the Engineering Physics population responded much as had the other student populations. The differences between the Engineering Physics population and other student populations were most visible from the factors derived from the factor analysis. In the case of the nonscience student populations, many items from the utilitarianism and progress and meliorism dimensions were combined into a factor that thematically addressed itself to the impact science and technology has had upon man. In the case of the Engineering Physics population, two factors were extracted which consisted predominantly of progress and meliorism items. A similar separation occurred in factors dealing with the relationship between science and other aspects of society. The nature of these factors have been discussed previously. Thus the Engineering Physics population, in addition to being more supportive of the various dimensions, resolved items differently than had the other student populations.

In addition to noting population differences, it seems useful to discuss the Science Support Scale itself as an instrument with which to measure such differences. Schwirian obtained a reliability of 0.77 for the unrefined

Science Support Scale.⁵⁸ Slightly higher reliabilities were obtained for the nonscience populations included in this study. The reliability of the instrument for the Man's Physical World population was 0.84, for the General Physics population 0.85, for the Engineering Physics population 0.77, and for the Academic Physicist population 0.80. Thus the reliabilities obtained seem consistent with the results obtained by Schwirian.

By summing the communalities reported by Schwirian, approximately thirty-eight percent of the variance was explained by the factor solution obtained for the unrefined Science Support Scale.⁵⁹ Of the eight factors contributing to these communalities, however, only five were considered usable factors. The factor solutions obtained for the populations utilized in this study ranged in percent total variance explained from twenty-five percent for the Man's Physical World population to sixty percent in the Academic Physicist population. The addition of factors with eigenvalues less than 2.0 is not likely to significantly increase these percentages. These differences seem consistent, as a profession in the field of science would be expected to apply a value system or structure more consistently on the Science Support Scale than would student populations. From the results obtained for the Academic Physicists, the variance specific to the inventory can be restricted to less than twenty percent.

This study has probed the attitudes of various student populations toward science and society. While the results do not indicate significant nonsupport of science, areas of concern are present within the nonscience populations. The ability of scientists and educators to respond to these concerns is crucial to successfully educating a society to deal with the future.

APPENDIX I

We would like to know your opinions regarding the following 58 statements about science and scientists. Please indicate the extent of your agreement or disagreement with each statement by marking the appropriate areas at the right of each statement.

- 1 -- I STRONGLY AGREE with the statement.
- 2 -- I AGREE with the statement.
- 3 -- I am UNDECIDED about the statement.
- 4 -- I DISAGREE with the statement.
- 5 -- I STRONGLY DISAGREE with the statement.

	1	2	3	4	5
	SA	A	U	D	SD
1. One important function of science is to demonstrate the wonder and orderliness of God's universe.					X
2. It is likely that much of the scientific information we have today will be demonstrated to be inaccurate or inadequate in the future.	X				
3. If one or two scientists have evidence which appears to contradict current scientific belief, they are probably wrong.					X
4. Science would be better off if scientists of Communist and non-Communist countries could work together.	X				
5. Religious leaders should be constantly on guard against the ideas and theories that scientists produce and explore.					X
6. Science is bound to lead our society into Godliness.					X
7. The skepticism of the scientist should be limited to his work.					X
8. Scientific inventions and discoveries have done more good than bad for mankind.	X				
9. The administration of colleges or universities should not discharge scientists whose political views are unpopular.	X				
10. An important function of the scientist today is to question what man says he believes.	X				

	1	2	3	4	5
	SA	A	U	D	SD
11. There is no place in science for sexual deviants such as homosexuals.					X
12. Modern science and inventions are responsible for much of man's personal discontent and frustration.					X
13. The work of any scientist should be judged without regard for his political views.	X				
14. It is not appropriate for man to tamper with the order and intentions of Nature.					X
15. The United States should encourage more students from foreign countries to study science in American universities.	X				
16. Scientists should be free to explore all phases of man's life and the universe about him.	X				
17. Federal scholarship programs for training scientists should be limited to citizens of the United States.					X
18. In order to be more effective, religious leaders should know about recent major advances and developments in science.	X				
19. The individual scientist is the best judge of what research he should do.	X				
20. Teaching machines promote improved education.	X				
21. One important function of science is to teach people to be critical thinkers, not believing everything they are told.	X				
22. The unbounded inquiry of the scientists has had a bad effect on society's moral standards.					X
23. The primary function of a college education in science is to teach an appreciation for the findings of the past great scientists.					X
24. The questions which are really important to man can never be solved by science.					X

	1	2	3	4	5
	SA	A	U	D	SD
25. The United States government should not continue to support science as it has in the past decade.					X
26. The meaning of any discovery should be judged by man's moral standards rather than by his intellectual need for truth.					X
27. It is possible for a man to be a dedicated scientist and to be highly committed to his religious convictions.	X				
28. Technological advances in the future will probably be nowhere as great as they have been in the past thirty years.					X
29. When the findings or theories of science conflict with religious belief, it is better to accept the religious belief.					X
30. Science, rather than religion, helps rid people of superstitious fears.	X				
31. While man has become physically richer from the fruits of science, he has become spiritually poorer.					X
32. The scientist's activities must not violate the basic values of his society.					X
33. Science should remain a predominantly male profession.					X
34. Fellowships and scholarships in the sciences are better spent on men than on women.					X
35. It is unlikely that a young scientist will make important discoveries.					X
36. The scientific information which has been gathered as a result of manned and unmanned space shots is well worth the large sums of money which have been spent on the projects.	X				
37. The material progress of science has made men care less than they should above the prospect of eternal life.					X

	1	2	3	4	5
	SA	A	U	D	SD
38. If a student is very bright, he should be channeled into science because we need good scientists.					X
39. It would be much more pleasant to live in a country in which you didn't even know about the rest of the world's problems.					X
40. In times of national emergency a scientist's utmost concern should be for the contribution he can make to his country's needs rather than his own specific research interests.					X
41. Those who have had a history of mental illness cannot be trusted to do important scientific work.					X
42. A return to a simpler, less mechanized life would result in happier, more contented people.					X
43. It is not always appropriate for the federal government to demand that the scientific research it sponsors serve the national policy ends.	X				
44. Scientists could work more effectively if they were organized and guided in their work by a man who has proved himself to be an outstanding scientist.					X
45. Scientific findings should not be made public if they will create social unrest.					X
46. A scientist's reputation should be as important in judging his findings as the techniques he uses in his research.					X
47. The increased efficiency of computers does not justify their use because of all the unemployment produced when computers replace men.					X
48. Scientific work should be judged primarily by the political and social necessities of the nation and the world.					X

	1	2	3	4	5
	SA	A	U	D	SD
49. Scientists could work more effectively if they were organized and guided in their work by a Congressional committee which was aware of national needs.					X
50. Men are worthy of enjoying the fruits of scientific discovery.	X				
51. It is a good policy to base an important decision purely on evidence even if it is the opposite of the decision based on common sense.	X				
52. The true meaning of any discovery should be judged by man's physical wants and needs rather than by his moral standards.	X				
53. All miracles have a scientific explanation.	X				
54. Scientists go overboard on demanding evidence before drawing conclusions.					X
55. It will be a good thing when machines free men of all manual labor.	X				
56. When doing medical research, scientists should be able to collect information of a highly personal nature.	X				
57. More federal support to science should be in the form of grants for general scholarship and exploratory research rather than contracts for specified product research.	X				
58. In the long run, man's lot will be improved by scientific knowledge.	X				

APPENDIX II

TABLE XII. Item analysis for Man's Physical World population.

TABLE XII

Item Number	Likert Score					Mean	Standard Deviation
	1	2	3	4	5		
1	109	324	130	118	20	2.45	1.04
2	29	192	121	262	97	3.29	1.14
3	16	43	95	419	128	3.85	0.87
4	23	44	80	277	277	4.06	1.03
5	31	43	92	313	222	3.93	1.04
6	13	43	249	276	120	3.64	0.91
7	16	101	219	303	62	3.42	0.92
8	46	55	123	279	198	3.75	1.14
9	22	72	137	290	180	3.76	1.04
10	17	129	193	303	59	3.37	0.96
11	14	55	209	273	150	3.70	0.96
12	33	213	168	238	49	3.08	1.05
13	7	56	50	362	226	4.06	0.90
14	54	102	214	270	61	3.26	1.06
15	21	88	236	280	76	3.43	0.95
16	15	59	77	391	159	3.88	0.92
17	52	154	147	270	78	3.24	1.14
18	14	89	179	355	64	3.52	0.90
19	10	83	148	369	91	3.64	0.90
20	31	130	339	171	30	3.06	0.88
21	15	58	61	391	176	3.93	0.93
22	5	52	225	354	65	3.60	0.79
23	9	146	111	370	65	3.48	0.96
24	51	94	175	301	80	3.38	1.08
25	12	53	86	354	196	3.95	0.93
26	14	74	203	313	97	3.58	0.92
27	19	52	88	340	202	3.93	0.98
28	16	69	118	343	155	3.79	0.97
29	25	84	278	231	83	3.38	0.96
30	32	117	212	267	73	3.33	1.02

TABLE XII: (continued)

Item Number	Likert Score					Mean	Standard Deviation
	1	2	3	4	5		
31	42	179	182	252	46	3.12	1.05
32	26	247	205	199	24	2.93	0.96
33	20	23	27	323	308	4.25	0.90
34	13	56	83	300	249	4.02	0.98
35	7	45	46	363	240	4.13	0.86
36	66	146	232	183	74	3.08	1.12
37	27	167	276	209	22	3.05	0.90
38	8	49	71	423	150	3.94	0.83
39	26	100	93	323	159	3.70	1.08
40	153	369	117	50	12	2.14	0.90
41	13	59	160	351	118	3.72	0.91
42	31	123	253	233	61	3.24	0.99
43	5	94	291	272	39	3.35	0.81
44	11	182	186	282	40	3.22	0.95
45	17	125	169	317	73	3.43	0.98
46	25	219	132	265	60	3.16	1.07
47	19	158	209	263	52	3.24	0.97
48	14	213	167	274	33	3.14	0.97
49	8	101	155	319	118	3.62	0.96
50	9	35	126	449	82	3.80	0.76
51	24	257	220	172	28	2.89	0.95
52	29	217	230	199	26	2.97	0.95
53	109	252	238	89	13	2.49	0.96
54	7	79	154	398	63	3.62	0.84
55	215	353	89	36	8	1.96	0.86
56	15	112	249	278	47	3.33	0.90
57	5	102	307	248	39	3.30	0.81
58	17	36	170	337	141	3.78	0.91

R Split = 0.72

R Corr = 0.84

TABLE XIII. Item Analysis for General Physics population.

TABLE XIII

Item Number	Likert Score					Mean	Standard Deviation
	1	2	3	4	5		
1	43	127	79	41	25	2.61	1.12
2	19	67	37	140	52	3.44	1.17
3	6	11	43	200	55	3.91	0.78
4	9	14	23	107	162	4.27	0.98
5	4	8	40	126	137	4.22	0.86
6	4	14	117	115	65	3.71	0.89
7	9	42	70	143	51	3.59	1.00
8	12	38	58	107	100	3.78	1.13
9	16	32	50	135	82	3.75	1.10
10	9	80	79	110	37	3.27	1.06
11	14	22	90	131	58	3.62	1.00
12	12	100	71	98	34	3.13	1.10
13	1	12	15	147	140	4.31	0.76
14	19	52	85	114	45	3.36	1.10
15	14	51	111	110	29	3.28	0.99
16	6	24	40	146	99	3.98	0.96
17	44	74	75	99	23	2.95	1.18
18	5	34	80	136	60	3.67	0.96
19	3	55	63	144	50	3.58	0.98
20	17	58	140	83	17	3.08	0.94
21	3	22	23	172	95	4.06	0.86
22	3	18	69	162	63	3.84	0.84
23	3	53	25	201	33	3.66	0.91
24	22	46	67	139	41	3.42	1.10
25	2	9	31	165	108	4.17	0.77
26	3	32	89	139	52	3.65	0.91
27	7	17	23	133	135	4.18	0.94
28	5	20	33	143	114	4.08	0.93
29	14	13	138	96	54	3.52	0.97
30	16	48	92	131	28	3.34	1.00

TABLE XIII: (continued)

Item Number	Likert Score					Mean	Standard Deviation
	1	2	3	4	5		
31	15	80	80	120	20	3.16	1.03
32	14	98	80	107	16	3.04	1.02
33	4	16	17	163	115	4.17	0.84
34	8	45	45	138	79	3.75	1.06
35	4	17	21	189	84	4.05	0.81
36	23	59	96	87	50	3.26	1.15
37	13	57	119	101	25	3.22	0.97
38	1	12	35	177	90	4.09	0.76
39	16	57	49	140	53	3.50	1.12
40	51	162	61	36	5	2.31	0.93
41	3	32	98	143	39	3.58	0.87
42	11	59	106	108	31	3.28	0.99
43	5	35	83	175	17	3.52	0.82
44	12	76	88	119	20	3.19	1.00
45	5	60	77	131	42	3.46	1.00
46	11	72	50	141	41	3.41	1.08
47	3	32	62	164	54	3.74	0.89
48	9	74	51	144	37	3.40	1.06
49	7	27	39	159	84	3.90	0.96
50	4	17	62	184	48	3.81	0.80
51	23	107	107	68	10	2.79	0.97
52	15	102	102	86	10	2.92	0.95
53	40	116	107	45	7	2.56	0.96
54	5	34	54	183	39	3.69	0.88
55	107	146	46	15	1	1.91	0.84
56	10	53	90	137	25	3.36	0.96
57	5	48	124	121	17	3.31	0.85
58	4	16	77	145	73	3.85	0.88

R Split = 0.74

R Corr = 0.85

TABLE XIV. Item Analysis for Engineering Physics population.

TABLE XIV

Item Number	Likert Score					Mean	Standard Deviation
	1	2	3	4	5		
1	20	56	42	45	9	2.81	1.11
2	14	57	16	61	24	3.14	1.25
3	1	11	24	111	25	3.86	0.76
4	3	7	7	70	85	4.32	0.87
5	2	1	10	78	81	4.37	0.72
6	1	1	63	70	37	3.82	0.79
7	2	21	46	78	25	3.60	0.92
8	8	3	21	84	56	4.03	0.97
9	2	11	41	77	41	3.84	0.90
10	5	46	42	64	15	3.22	1.03
11	7	8	52	78	27	3.64	0.94
12	8	43	27	78	16	3.30	1.09
13	1	7	4	81	79	4.34	0.77
14	10	23	30	75	34	3.58	1.12
15	8	31	66	50	17	3.22	1.01
16	1	8	16	87	60	4.14	0.81
17	24	56	36	45	11	2.78	1.17
18	6	13	44	84	25	3.36	0.94
19	0	27	41	83	21	3.57	0.90
20	7	28	81	47	9	3.13	0.89
21	2	18	9	85	58	4.04	0.97
22	1	6	28	110	27	3.91	0.71
23	1	22	21	100	28	3.77	0.89
24	11	28	41	75	17	3.34	1.07
25	1	7	12	94	58	4.17	0.77
26	1	20	41	87	23	3.64	0.88
27	5	16	11	78	62	4.02	1.03
28	2	9	14	93	54	4.09	0.84
29	4	16	53	69	30	3.61	0.96
30	4	37	46	66	19	3.34	1.01

TABLE XIV: (continued)

Item Number	Likert Score					Mean	Standard Deviation
	1	2	3	4	5		
31	8	39	35	74	16	3.30	1.06
32	5	63	43	55	6	2.96	0.97
33	2	3	7	98	62	4.25	0.72
34	2	11	25	92	42	3.94	0.87
35	0	16	6	99	51	4.08	0.84
36	10	21	47	60	34	3.51	1.12
37	8	34	58	67	5	3.16	0.93
38	0	6	18	108	40	4.06	0.69
39	10	29	22	85	26	3.51	1.12
40	37	86	30	14	5	2.21	0.97
41	0	11	51	86	24	3.73	0.78
42	5	30	46	73	18	3.40	0.99
43	1	33	38	87	13	3.45	0.91
44	5	50	40	67	10	3.16	1.00
45	2	20	54	76	20	3.54	0.89
46	1	35	25	84	27	3.59	1.00
47	0	8	17	102	45	4.07	0.74
48	2	42	30	81	17	3.40	1.00
49	3	11	16	82	60	4.08	0.92
50	2	6	42	104	18	3.76	0.73
51	10	65	53	38	6	2.80	0.97
52	4	51	61	49	7	3.02	0.92
53	27	71	37	29	8	2.54	1.09
54	0	21	24	114	13	3.69	0.78
55	44	97	23	7	1	1.98	0.78
56	3	32	50	79	8	3.33	0.89
57	1	13	72	70	16	3.51	0.79
58	3	5	27	101	36	3.94	0.80

R Split = 0.63

R Corr = 0.77

TABLE XV. Item analysis for Academic Physicist population.

TABLE XV

Item Number	Likert Score					Mean	Standard Deviation
	1	2	3	4	5		
1	2	18	8	12	10	3.20	1.24
2	8	14	5	17	6	2.98	1.33
3	1	8	9	25	7	3.58	0.99
4	2	2	1	21	24	4.26	0.99
5	3	3	4	10	30	4.22	1.20
6	0	2	14	12	22	4.08	0.94
7	2	3	9	19	17	3.92	1.07
8	1	0	6	27	16	4.14	0.78
9	0	5	5	18	22	4.14	0.97
10	3	13	8	21	5	3.24	1.14
11	1	1	5	23	20	4.20	0.86
12	2	11	7	23	7	3.44	1.11
13	1	1	2	10	36	4.58	0.84
14	2	5	9	14	20	3.90	1.16
15	1	10	20	17	2	3.18	0.87
16	2	4	2	25	17	4.02	1.04
17	6	8	15	16	5	3.12	1.17
18	3	3	5	30	9	3.78	1.02
19	0	5	8	21	16	3.96	0.95
20	1	5	33	9	2	3.12	0.72
21	1	0	2	32	15	4.20	0.70
22	0	2	2	22	24	4.36	0.75
23	1	6	2	33	8	3.82	0.92
24	0	9	14	22	5	3.46	0.91
25	0	7	7	22	14	3.86	0.99
26	2	3	16	15	14	3.72	1.07
27	4	3	0	22	21	4.06	1.18
28	0	8	8	17	17	3.86	1.07
29	2	2	9	21	16	3.94	1.02
30	3	7	7	25	8	3.56	1.11

TABLE XV: (continued)

Item Number	Likert Score					Mean	Standard Deviation
	1	2	3	4	5		
31	0	7	7	29	7	3.72	0.88
32	1	18	12	14	5	3.08	1.07
33	1	0	2	26	21	4.32	0.74
34	1	4	7	25	13	3.90	0.95
35	2	1	3	19	25	4.28	0.97
36	1	7	9	24	9	3.66	1.02
37	2	8	13	19	8	3.46	1.07
38	0	5	6	26	13	3.94	0.89
39	1	11	7	24	7	3.50	1.06
40	6	23	14	6	1	2.46	0.93
41	0	1	7	30	12	4.06	0.68
42	1	6	12	22	9	3.64	0.98
43	0	3	6	27	14	4.02	0.84
44	0	9	12	21	8	3.56	0.97
45	0	2	13	24	11	3.88	0.80
46	0	2	3	29	16	4.18	0.72
47	0	0	2	29	19	4.34	0.56
48	1	0	3	27	19	4.26	0.75
49	0	3	4	12	31	4.42	0.88
50	1	1	10	26	12	3.94	0.84
51	2	17	14	9	8	3.08	1.16
52	4	11	29	6	0	2.74	0.78
53	3	9	14	18	6	3.30	1.09
54	0	2	3	35	10	4.06	0.65
55	8	17	16	7	2	2.56	1.05
56	2	2	12	30	4	3.64	0.85
57	0	4	14	21	11	3.78	0.89
58	0	1	13	24	12	3.94	0.77

R Split = 0.67

R Corr = 0.80

FOOTNOTES

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**A SURVEY OF STUDENT ATTITUDES
TOWARD SCIENCE AND SOCIETY**

by

**JACQUELINE DEE SPEARS
B.S., Kansas State University, 1969**

AN ABSTRACT OF A MASTER'S THESIS

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MASTER OF SCIENCE

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Attitudes of student populations toward societal values conducive to the growth of science were measured using the Science Support Scale. Three student populations, Man's Physical World students, General Physics students, and Engineering Physics students, were utilized in the study. All student attitudes were contrasted to the attitudes of the faculty and graduate students from the Department of Physics. Total score distributions for the four populations showed the Academic Physicists most supportive of the societal values. A trend of increasing support was observed from Man's Physical World to General Physics to Engineering Physics to Academic Physicist populations. Two experimental approaches were utilized to study the nature of the population differences reflected in the total score distributions. In the first approach the chi-square test of independence was applied to item distributions to ascertain population differences within the value constructs of the Science Support Scale. The second approach utilized factor analysis to observe additional value constructs within each population. Results indicate concern by Man's Physical World and General Physics students for the relationship between science and religion and for the impact increased technology is having upon man. Engineering Physics students differed from the Academic Physicists primarily with respect to the degree of support of the various values.