A SURVEY OF STUDENT ATTITUDES TOWARD SCIENCE AND SOCIETY

by

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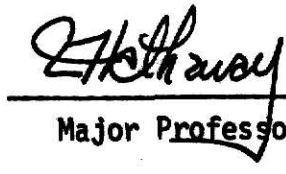

Major Professor

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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 fluorish, 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."[4]

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 Remmers[12] substantiate these dimensions of the image as well as many others. The generally accepted dimensions include:[13]

(1) scientist is more likly 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 definiitive 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]