ED 259 941

Blosser, Patricia E.


ERIC Clearinghouse for Science, Mathematics, and Environmental Education, Columbus, Ohio.

National Inst. of Education (ED), Washington, DC.

SMEAC Information Reference Center, The Ohio State University, 1200 Chambers Road, 3rd Floor, Columbus, OH 43212 ($1.00).

Information Analyses - ERIC Information Analysis Products (071)

*Attitude Change; *Attitude Measures; *Attitudes; Elementary Secondary Education; Higher Education; Literature Reviews; *Research Methodology; Research Needs; *Science Education; *Scientific Attitudes; Student Attitudes; Teacher Attitudes

ERIC Digests; *Science Education Research

This information bulletin provides an overview of some of the documents that were identified as a result of limited searches of the literature related to science education attitude research and highlights some of the problems and concerns involved in this research. Major areas considered include: (1) problems of defining scientific attitudes; (2) attitudes toward science; (3) attitude measurement techniques; (4) methodological issues; (5) Hugh Munby's investigation of attitude measurements ("An Investigation into the Measurement of Attitudes in Science Education"); (6) recommendations for improving attitude research; and (7) implications. A list of references cited (with ED numbers for documents in "Resources in Education") and related references is included. (JN)
EDITOR’S COMMENTS

Several years ago Wayne W. Welch made a presentation at a science education meeting in which he characterized the situation in science learning by saying that students were learning less science but enjoying it more. Science educators of students at varying educational levels are interested not only in their students' achievements but also in producing positive attitudes about science. This information bulletin is designed to provide readers with an overview of studies in attitude research. It was prepared by Patricia E. Blosser, Associate Director, User Services.

Introduction

Several years ago the National Science Teachers Association (NSTA) issued a position statement titled "Science-Technology-Society: Science Education for the 1980s." (1982) In this statement committee members identified some problems they felt were indicative of a crisis in science education. Among these problems were a decline in public appreciation for science, decreased support for science education, an increasing number of problems related to science-generated technology that have an impact on the quality of life, and the under-representation of women, minorities, and handicapped persons in "nearly all professional and technical roles in science and technology."

The committee's thesis was that scientific literacy was basic for living, working, and decision making in the 1980s and beyond. Attributes that characterize a scientifically literate person were listed. Some of these attributes were of the cognitive knowledge variety. Others related to the affective domain of science education. For example, according to the position statement,

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

... has a richer and more exciting view of the world as the result of science education... (1982)

While no teachers would quarrel with these objectives, they might ask how they were to design curriculum and instruction to lead to their attainment, and how their attainment was to be measured. Science teachers are accustomed to dealing with, and attempting to measure, cognitive objectives in their classes. Getting a handle on the affective aspects of science education appears to present some problems. Researchers in science education have attempted to deal with the affective domain primarily through the investigation of attitudes.

The Literature Base

It is easy to get an idea of the amount of material related to attitudes and science education research by doing a computer search of the ERIC data base. For example, in November 1984, a computer search of relevant descriptors resulted in the following document counts:

<table>
<thead>
<tr>
<th>Descriptor Combination</th>
<th>Number of Documents</th>
</tr>
</thead>
<tbody>
<tr>
<td>science education + research + attitudes</td>
<td>398</td>
</tr>
<tr>
<td>research + scientific attitudes</td>
<td>243</td>
</tr>
</tbody>
</table>

It would appear that the investigation of attitudes in science education has resulted in a large number of publications.

The Purpose of This Bulletin

The purpose of this information bulletin is to provide the reader with an overview of some of the documents that were identified as a result of limited searches of the literature related to science education research of attitudes and to highlight some of the problems and concerns involved in this research.

Some Problems of Definition

One of the problems in attitude research in science education is that of finding a clear definition of what is meant by “science attitudes.” Some researchers appear to be investigating scientific attitudes while others are studying attitudes toward science. Gardner discussed this difference, writing that attitudes toward science always have “…some distinct attitude object to which the respondent is invited to react favourably or unfavourably…” while the scientific attitudes category is composed of traits “…better described as styles of thinking which scientists are presumed to display.” (1975:1-2)

Scientific attitudes: In a journal article published in 1982 Gauld provided an amplified description of what constitutes the “scientific attitude.”

The scientific attitude as it appears in the science education literature embodies the adoption of a particular approach to solving problems, to assessing ideas and information or to making decisions. Using this approach evidence is collected and evalu¬ed objectively so that the idiosyncratic prejudices of the one making the judgment do not intrude. No source of relevant information is rejected before it is fully evaluated and all available evidence is care-
fully weighed before the decision is made. If the evidence is considered to be insufficient then judgment is suspended until there is enough information to enable a decision to be made. No idea, conclusion, decision or solution is accepted just because a particular person makes a claim but it is treated skeptically and critically until its soundness can be judged according to the weight of evidence which is relevant to it. A person who is willing to follow such a procedure (and who regularly does so) is said by science educators to be motivated by the scientific attitude. (1982:110)

Two years earlier, Gauld and Hukins published a review of the literature on scientific attitudes, using those studies fitting Gardner's definition. (The 1982 article from which the quotation was taken was a critical reappraisal of the situation.) In the 1980 article Gauld and Hukins said that philosophies of science imply different conceptions of scientific attitude, but people do not seem to realize this. As a result, there is an inadequate theoretical framework in the research literature of scientific attitudes and in attitude measurement.

Gauld and Hukins considered that the concept of scientific attitude has two main dimensions: a scientific one, dealing with the nature of scientific activity, and an affective or attitudinal one. They identified three broad groups into which components of the scientific attitude as described in the literature might be classified:

1. General attitude towards ideas and information (e.g. curiosity, open-mindedness, scepticism, humility, anti-authoritarianism, creativity).

2. Attitudes related to the evaluation of ideas and information (e.g. critical-mindedness — including objectivity, intellectual honesty, caution when drawing conclusions or making decisions).

3. Commitment to particular (scientific) belief (e.g. loyalty to truth, belief in the understandability of nature, existence of natural cause and effect relationships, lack of foundation for superstition) (1980:133).

Readers are probably familiar with one of the more influential publications dealing with the scientific dimension of the scientific attitude concept, the Educational Policies Commission's 1966 document entitled "Education and the Spirit of Science." In the recommendations section of this document, the writers urge that schools promote understanding of the values on which science is everywhere based. We believe that the following values underlie science.

1. Longing to know and to understand
2. Questioning of all things
3. Search for data and their meaning
4. Demand for verification
5. Respect for logic
6. Consideration of premises
7. Consideration of consequences (1986:15)

The members of the Educational Policies Commission believe that "... the values of science are the most complete expression of one of the deepest of humane values—the belief in human dignity." (1966:16) This is one justification for the importance of developing a scientific attitude in students. Gauld and Hukins present two other reasons: such an attitude helps students have a better understanding of the nature of the scientific process by acting out the role of a scientist, and it is important for all students in their everyday lives, independent of the supposed importance of scientists, to be rational thinkers (1980:140).

Again, questions are raised relative to instruction and evaluation. What should science teachers do? What should be done to measure success? Nay and Crocker developed an inventory of the affective attributes of scientists which they reported in an article published in "970 in Science Education. They grouped selected attributes of scientists on five components considered by Krathwohl as part of the affective domain: appreciations, interests, attitudes, values and beliefs, and adjustments. Nay and Crocker's inventory is shown below:

1. Interests
   - Longing to know and to understand
   - Questioning of all things
   - Search for data and their meaning
   - Demand for verification
   - Respect for logic
   - Consideration of premises
   - Consideration of consequences

2. Operational Adjustments
   - Dedication or commitment
   - Perseverance (persistence)
   - Patience
   - Self-discipline
   - Selflessness
   - Responsibility
   - Dependability
   - Experimental requirements
   - Systematism (methodicalness)
   - Thoroughness

3. Attitudes or Intellectual Adjustments
   - Scientific integrity
   - Objectivity
   - Open-mindedness
   - Honesty
   - Suspended judgment
   - Respect for evidence

4. Appreciations
   - Value of science
   - Scientific theory
   - Technological development
   - Scientific community

5. Values
   - Precision
   - Sensitivity
   - Alertness for the unexpected
   - Initiative and resourcefulness
   - Pragmatism (commonsense)
   - Courage (daring, venturesomeness)
   - Self-direction
   - Self-reliance
   - Confidence
   - Flexibility
   - Aggressiveness

6. Relationships with peers
   - Cooperation
   - Compromise
   - Modesty (humbility)
   - Tolerance

7. Attitudes toward school
   - Acceptance of new scientific knowledge
   - Commitment to science
   - Appreciation of science

8. Attitudes toward other areas
   - Appreciation of the humanities
   - Appreciation of the social sciences

9. Attitudes toward society
   - Appreciation of the social sciences
   - Appreciation of the humanities

10. Attitudes toward science teachers
    - Respect for science teachers
    - Appreciation of science teachers

11. Attitudes toward science education
    - Appreciation of science education
    - Respect for science education
5. Values and/or Beliefs
(In the realm of philosophy, ethics, politics, etc.)

5.1 Philosophy
5.11 The universe is "real"
5.12 The universe is comprehensible (knowable) through observation and rational thought
5.13 The universe is not capricious

5.2 Ethical
5.21 Science is amoral but scientists have the responsibility to interpret the consequences of their work
5.22 Humanism is the highest ideal

5.3 Social
5.31 Science must serve the needs of society
5.32 Science flourishes best in a free and democratic society

(1970:61-62)

Nay and Crocker said that the science teacher was the key to successfully promoting such affective attributes in students. The science teacher needs to have a good knowledge of the nature of the scientific enterprise and must be a good role model. Students may perform experiments or do laboratory research, or they may read science case histories. Students may also solve problems which they identify or which the teacher supplies, using the processes involved in scientific inquiry. (1970:65).

These suggestions speak to the question of instruction. What about evaluation? Problems related to the measurement of attitudes will be discussed in a later section. There are other problems to be considered relative to scientific attitudes.

Gauld (1982) said that a great deal of effort has been devoted to identifying the nature of the scientific attitude. Most of the work has involved detailed analyses of the writings of scientists, philosophers of science, and science educators. Much of the material was the work of philosophers of science who looked at science from an empiricist perspective. As a result, the concept of scientific attitude has an emphasis. Little research has been done to see if scientists do possess the affective characteristics attributed to them. Gauld cited the work of Mahoney who examined the extent to which scientists possessed the characteristics of objectivity, rationality, open-mindedness, superior intelligence, integrity, and communality. The data Mahoney obtained produced a picture of "real" scientists that was different from that in science education literature. Practicing scientists displayed both objectivity and emotionality, open-mindedness and tenacity, depending on the situation. (1982:112-113).

Gauld suggested that science educators need to consider Holton's distinction between "public science" and "private science." Holton said that the way in which arguments and evidence are publicly presented is not the way they were originally conceived, clarified and tested (private science). However, the public science image is that of the detached, impartial scientist. Gauld concluded that the distinction between 'public' and 'private' science is a valid one, it means that the attitudes toward scientists held by science educators and science students can be expected to have little, if any, necessary connection with the personal characteristics of scientists. (1982:117)

Gauld argued that.

... development of the scientific attitude in students should be eliminated as one of the major goals of science education, and this certainly follows for the attitude as it has been formulated by science educators for the past 60 years. Teaching that scientists possess these characteristics is bad enough but it is abhorrent that science educators should actually attempt to mold children in the same false image. (1982:118)

Gauld has suggested that terms such as open-mindedness, objectivity, skepticism need to be clarified and the way in which they relate to scientific practice needs to be more carefully discussed so that it may be possible to develop a re-formulated and more acceptable version of what is meant by scientific attitude.

This is a large task. It is not apparent from a review of the existing literature that science educators are working on it or that they are even aware of Gauld's review and criticisms. If, and when, such a task is begun, science educators need to look at the nonempiricist philosophers of science that have been published since 1960 (Gauld, 1982:117).

Perhaps we need to remember not only the Educational Policies Commission's seven values underlying science but also some of the discussion that followed the listing of these values:

... like other sets of values, they have the defect that neither individually nor jointly do they provide a fully adequate guide to action; in many concrete human situations, various values, all cherished, are involved, and the choice of action involves an ethical compromise. The values of the spirit of science express the belief that the compromise is likely to be better if based on thoughtful choice; in this respect they differ from those value systems which hesitate to submit all problems to reason . . .

By their very nature, these values cannot be acquired through indoctrination . . . (1966:16)

Attitudes towards Science

When this broad category of attitudes is considered, the situation is no more encouraging. There is wide variation of topics considered to relate to this category. This is evident in Haladyna and Shaughnessy's categorization of studies they included in their analysis study (1982). In reviewing results for this analysis, they classified studies as relating to scientific attitudes, to attitude toward scientists, to attitudes toward a method of teaching science, to scientific interests, to attitudes toward parts of the curriculum, and attitudes toward the subject of science.

Gardner (1975) reviewed studies containing variables within the attitudes toward science category: interest, satisfaction, enjoyment. Gardner considered the relationships between attitudes to science and other personal and social variables. He separated his discussion into studies of internal or personal variables, which included other attitude variables, cognitive variables, personality and sex; and studies of external or social variables, which included such structural variables as home background, school environment variables, and curriculum and instructional variables. However, Gardner admitted that it was not always easy to classify a study into one of these two groups and that some external variables were confounded with some internal variables.

Gardner said that there was support in the literature for the idea that attitudes are not isolated personal attributes but that they form broad and coherent patterns consistent with, and outgrowths of, deeper personality structures (1975:19). It was possible to find relationships between students' attitudes to science and aspects of their personality. There was variation among studies in terms of age of students, gender, measuring instruments used, but the general picture was that "... students who are favourably inclined towards science tend to be relatively serious and achievement-oriented, realistic and independent, but conventional and conformist." (1975:22)

According to Gardner, "Sex is probably the single most important variable related to pupils' attitudes to science." (1975:22) Sex differences apparently arise relatively early in life. Gardner wrote that there was a "substantial body of evidence" involving upper primary and secondary school pupils that boys have greater interest in science than do girls, with the differences appearing to carry over into adulthood. The nature of boys' and girls' interests in science also tended to differ, with boys relatively more interested in medical science and girls more interested in biology and social science. These differences also persist into adulthood. (1975:23) When social forces and sex differences are
ment.

involves the use of some kind of instru-

et al., 1975:3-4). Most attitude research

person holds based on the behavior

socially acceptable. Another

ting to provide a truthful response or may

the person being questioned may be

ted in providing a response by the

in mind that teacher and pupil variables

and instruction, the reader needs to keep in

attitudes and instruction variables do (1975:29).

Gardner raised the question: to what extent do instruments now available ac-

This question has been studied and dis-

Page and his colleagues wrote, one method is to ask

development (1975:23). Gardner reported a

classroom climate and teacher behavior have been studied. Gardner reported a

study by Walberg in which it was found that

classroom characteristics associated

with higher achievement were differ-

tent attitudes. Teacher behavior studies need

to be reviewed with the caution that the

same teacher behavior could have differ-

ent effects on different kinds of pupils

(1975:26). Likewise, when looking at

attitude studies involving curriculum and

instruction, the reader needs to keep in

mind that teacher and pupil variables

may exert more powerful effects on atti-

tudes than the curriculum and instruc-

tion variables do (1975:29).

Gardner raised the question: to what extent do instruments now available ac-

This question has been studied and dis-

Gardner, in his 1975 review, discussed

five steps involved in constructing a valid and

able attitude instrument: definition of the attitude(s) to be measured, scale con-

duction, trial, appropriate use, and appropriate choice of research design and statistical analysis (1975:11). When one or more of these steps is ignored or inadequately carried out, problems result and the research which

results is questionable.

The person developing an attitude instrument needs to clearly specify the

oretical construct which underlies this instrument. If more than one vari-

able is to be measured, each should be

ified in advance and the instrument

should yield separate scores for each

parate variable. According to Gar-

ner, these requirements are frequently

not only are theoretical con-

structs lacking, items may be vague or

ambiguous. Or items be in the form of a

complex sentence which contains one

part with which the respondent may

gree and a second part with which he/she may disagree. Items may be in-

cluded that do not reflect the construct

the instrument purports to measure

(1975:12-14).

The attitude instrument needs to be

tried with a sample similar to the target

population to be involved in the research

study. The data collected need to be

alyzed to determine if the instrument is

ufficiently sensitive to discriminate among individuals, if it is internally con-

istent, and if it is stable. Factor analysis

y may be done to see if items have been

cently allocated to scales and whether different scales "had on differ-

ent factors (1975:14-16).

When use is considered, Gardner

ured that there needs to be some basis for

arguing that there is a connection

between the treatment and the outcome,

but says this is frequently ignored in

educational research. Subjects are fre-

quently involved in a treatment and then

asked to complete a test that is unrelated to the treatment (1975:16).

Problems such as this may be avoided if the

research design of the study is carefully

examined and if appropriate statistical

procedures are chosen, but these do not

always prevent weaknesses in studies.

That such weaknesses exist has been

amply documented by Munby.

Gardner, in his 1975 review, discussed

five steps involved in constructing a valid and

able attitude instrument: definition of the attitude(s) to be measured, scale con-

duction, trial, appropriate use, and appropriate choice of research design and statistical analysis (1975:11). When one or more of these steps is ignored or inadequately carried out, problems result and the research which

results is questionable.

The person developing an attitude instrument needs to clearly specify the

oretical construct which underlies this instrument. If more than one vari-

able is to be measured, each should be

ified in advance and the instrument

should yield separate scores for each

parate variable. According to Gar-

ner, these requirements are frequently

not only are theoretical con-

structs lacking, items may be vague or

ambiguous. Or items be in the form of a

complex sentence which contains one

part with which the respondent may

gree and a second part with which he/she may disagree. Items may be in-

cluded that do not reflect the construct

the instrument purports to measure

(1975:12-14).

The attitude instrument needs to be

tried with a sample similar to the target

population to be involved in the research

study. The data collected need to be

alyzed to determine if the instrument is

ufficiently sensitive to discriminate among individuals, if it is internally con-

istent, and if it is stable. Factor analysis

y may be done to see if items have been

cently allocated to scales and whether different scales "had on differ-

ent factors (1975:14-16).

When use is considered, Gardner

ured that there needs to be some basis for

arguing that there is a connection

between the treatment and the outcome,

but says this is frequently ignored in

educational research. Subjects are fre-

quently involved in a treatment and then

asked to complete a test that is unrelated to the treatment (1975:16).

Problems such as this may be avoided if the

research design of the study is carefully

examined and if appropriate statistical

procedures are chosen, but these do not

always prevent weaknesses in studies.

That such weaknesses exist has been

amply documented by Munby.

Gardner undertook to conduct a

thorough examination of instruments

designed to measure attitudes to

interest inventories

preference ranking

projective techniques

enrollment data

other forms: clinical and anthropo-

logical observation

Differe ntial scales, which Gardner

terms "Thurstone" identify, contain a num-

ber of opinion statements designed to

provide various positions on an attitude

tinuum. The scale is composed of a

large number of items, and respondents

are asked to select those statements

most closely resembling their own be-

iefs. Each statement has a scale value

so that the respondent's score is the

mean or median of the scale values of

the statements selected (1975:4).

Rating scales do not appear to be

ecipitely used in research on attitudes to

science, according to Gardner. In this

method, a particular concept is present-

ed and the rater places the ratee along a

numerical scale. Sometimes self-report-

ing is used (1975:5).

Summed rating scales are more

ommonly used. In this technique a set of

mean or median of the scale values of

the statements selected (1975:4).

Semantic differential scales consist of

a word or phrase representing an atti-

tude object which is followed by a list of

polar adjectives. These adjectives lie

at opposite ends of a seven-point scale,

and the respondent marks a position on

each scale for each adjective pair.

Interest inventories, which may be

either general or specific, contain items

ting careers, topics, or activities and

the respondent indicates those in which

he/she is interested (1975:7).

The preference ranking technique in-

volves having a respondent make com-

parisons between enjoyment of science

and enjoyment of other subjects. One

ect of this technique is that a student

could have a positive attitude to all

school subjects and rank science last,

while still having a more favorable atti-

tude toward science than another re-

spondent who disliked most school sub-

jects and ranked science last (1975:9).

Projective techniques are used in an

attempt to reveal attitudes the respon-

dent may have hidden. They may involve

sentence completion, word association,

or interpretations of drawings (1975:9).

Clinical observations of students as

they work or play may also be used to
determine attitudes. Anthropological

methods with the researcher as a partici-

pant observer may also be used (1975:11).

Methodological issues

Gardner, in his 1975 review, discussed

five steps involved in constructing a valid and

able attitude instrument: definition of the attitude(s) to be measured, scale con-

duction, trial, appropriate use, and appropriate choice of research design and statistical analysis (1975:11). When one or more of these steps is ignored or inadequately carried out, problems result and the research which

results is questionable.

The person developing an attitude

strument needs to clearly specify the

oretical construct which underlies this instrument. If more than one vari-

able is to be measured, each should be

ified in advance and the instrument

should yield separate scores for each

parate variable. According to Gar-

ner, these requirements are frequently

not only are theoretical con-

structs lacking, items may be vague or

ambiguous. Or items be in the form of a

complex sentence which contains one

part with which the respondent may

gree and a second part with which he/she may disagree. Items may be in-

cluded that do not reflect the construct

the instrument purports to measure

(1975:12-14).

The attitude instrument needs to be

tried with a sample similar to the target

population to be involved in the research

study. The data collected need to be

alyzed to determine if the instrument is

ufficiently sensitive to discriminate among individuals, if it is internally con-

istent, and if it is stable. Factor analysis

y may be done to see if items have been

cently allocated to scales and whether different scales "had on differ-

ent factors (1975:14-16).

When use is considered, Gardner

ured that there needs to be some basis for

arguing that there is a connection

between the treatment and the outcome,

but says this is frequently ignored in

educational research. Subjects are fre-

quently involved in a treatment and then

asked to complete a test that is unrelated to the treatment (1975:16). Problems

such as this may be avoided if the

research design of the study is carefully

examined and if appropriate statistical

procedures are chosen, but these do not

always prevent weaknesses in studies.

That such weaknesses exist has been

amply documented by Munby.

Munby undertook to conduct a

thorough examination of instruments

designed to measure attitudes to
Munby limited his analysis to instruments that used the Likert or Thurstone scales or multiple choice questionnaires. Instruments using the semantic differential or projective techniques were not analyzed.

Instruments which Munby identified and located but did not analyze were included in the appendices of his report (1983a) so these are not lost but are available for study.

Munby’s report contains 12 appendices, as follows:

A. Semantical Differential Instruments (30)
B. Projective Instruments (5)
C. Instruments Measuring Scientific Attitudes (14)
D. Instruments Measuring Science Career Preferences (6)
E. Instruments Measuring Attitudes about Science Teaching (6)
F. Instruments Measuring Attitudes to Specific Science Subjects and Subject Preferences (27)
G. Instruments Measuring Science Interests and Activities (20)
H. Instruments Measuring Attitudes to Science Courses and Science in School (24)
I. Instruments Measuring Attitudes to Specific Science Issues (1)
J. Unavailable Instruments (15)
K. Those Selected for Detailed Study (56)
L. Detailed Description and Analysis of 56 Attitude Instruments.

Munby chose to analyze attitudes to science (56 instruments) and devised what he termed a “clue structure” to use in his analysis. A detailed explanation of this clue structure and how it was derived is found in chapter two of Munby’s report (1983a).

Munby reported that 56 of the instruments purported to measure attitudes to science used the Likert format for gathering data. Twenty-one of the 56 were used in more than one research study. Munby considered this unnecessary duplication (in developing instruments) and called for better communication within the research community.

Twenty-one of the 56 instruments had no reported reliabilities (1983a:106). There was a new calculation of reliability reported for only seven instruments used in more than one study, although 21 instruments were used more than once. Munby considered that Thurstone and Likert type instruments should have a reliability coefficient of .8. Munby wrote that if the reliability coefficient was less than .7, “another reliability tryout is needed.” (1983a:111). Thirty-one of the 56 instruments had reliability coefficients of .7 or above.

Munby also examined the instruments’ validity; did the items measure what they purport to measure? For 18 of the 56 instruments, there was no evidence to indicate that validity had been established. Munby is skeptical of the determination of validity by the use of a panel of judges, citing some remarks by Lucas to the effect that the panel method rests on a myth of the majority being right (1983a:115). So, if those instruments whose validity was determined by this method were removed from the analysis, nine more instruments could be set aside. Only seven instruments had validities determined by two or more psychometric methods (1983a:115-116).

Munby also considered whether the attitude instruments included items that measured cognitive knowledge. Only 4 instruments contained no cognitive items. Cognitive items made up 50 percent or more of 17 instruments and 18 instruments had 25 percent or more items that were cognitive. Munby suggested that the inclusion of cognitive items helps explain why so many findings of no significant differences appear in attitude research in science education when attitudes are measured before and after treatment. If cognitive items are not related to the treatment (some experimental course or teaching methodology), scores are likely to be unaffected by the treatment (1983a:129). It is Munby’s opinion that having a large number of cognitive items in an attitude instrument makes the validity of this instrument questionable (1983a:132).

When Munby considered the problems of reliability, validity, and what items seemed to be testing, his pool of 56 instruments diminished. If those instruments Munby considered incomplete or not strictly measuring attitudes to science were removed, 50 instruments remained. When this group of 50 was culled to remove those whose reliability was not known, 33 were left for analysis.

From this group were removed those instruments with reliability coefficients of less than .7; 29 instruments remained. From these 29 were removed those instruments whose validity was not tested or was established by the panel of judges method. There were seven survivors and even these were considered, by Munby, to be suspect on one basis or another (1983a:132-140).

In the final chapter of Munby’s report he attempted to describe what he considered to be the situation in attitude research in science education. It is a large field of study but one which has not been well reviewed. Most of the reviews are selective and uncritical. Most reviews report what exists rather than evaluating it. It is Munby’s contention that instrument developers are not doing all they could to assure that their instruments may be used with confidence. Other users seem to take validity and reliability for granted. Of those 21 attitudes that Munby removed from one study, only 8 had a “fresh determination of reliability” (1983a:144).
110 In this same document Munby reported this number as 7, not 6]. In only two studies was there an investigation of the validity of the instrument used (1983a:144).

Munby was also concerned over the fact that instrument developers mix scientific attitude items with items of attitudes toward science and that they include a high percentage of cognitive items in instruments aimed at measuring attitudes. Munby said, "...Evidently there are conceptual problems in the construction of instruments measuring attitudes to science..." (1983a:144).

Perhaps if these conceptual problems were resolved, many of the conflicting research findings could be explained.

Munby speculated that the term science may be ambiguous and that what is needed are subscales or scales for target concepts such as "science in school" or "science careers." He also pointed out that, because science is so much a part of everyday life, it "...may be difficult to get at a person's attitudes to science if he or she is not totally aware of the extent to which science is a part of his or her intellectual and physical life..." (1983a:146).

Just as the members of the Educational Policies Commission wrote that the values of science are not taught by indoctrination, Munby was concerned about science educators' motives for cultivating positive attitudes in their students. He raised the question of whether getting students to like science or to feel positive about it should be considered an acceptable educational objective or some form of indoctrination. It is Munby's conclusion that science education experiences should foster knowledge and understanding, and from these should grow personal preferences and attitudes (1983a:149).

As Gauld called for a reconceptualization of "scientific attitude," so, too, Munby called for a reconceptualization of "attitude to science."

**Recommendations for Research**

Numerous writers have recommendations for improving attitude research. Munby included seven recommendations which he categorized as varying from mundane to significant. (1) Better written abstracts are needed. (2) Dissertations Abstracts International, as well as more complete coverage of dissertations. If necessary, guidelines for writing abstracts should be provided to doctoral candidates and their major advisors. (2) Attitude instruments should be put into the ERIC system. This would result in the assigning of an ED number to the instrument and any related papers. Then, when an instrument was reported in a journal article, the ERIC reference could be included so that readers could find and retrieve the instrument that space limitations precluded from publication as part of the article. (3) Attitude instruments used in research should first be thoroughly examined for reliability and validity. (Page et al, 1983:7, contend there are no truly adequate methods for assessing the validity of attitude scales.) (4) Proper instrument development is such an exciting task that the development of a valid and reliable instrument should be considered worthy of dissertation requirements. The usual situation is that an instrument is developed in order to use it in the dissertation study. As a result, instrument development is a secondary goal of the study, not the primary one, and, as a result, the development process is not as thorough and sound as it should be. (5) Researchers interested in attitude measurement in science education need to review the other instruments from the pool of 200 Munby identified before producing any new instruments. The items within the semantic differential format deserve further review. (6) Research needs to be done to determine influence of cognitive items, in attitude instruments, on attitude scores. (7) Research needs to be done on the effect of instrument length on attitude scores and on contradictory findings (1983a:149-154).

Haladyna and Shaughnessy (1982) provided support for Munby's first and second recommendations. Their frustration with what they termed "nonstandard" reports for their meta-analysis project led them to say that, at a minimum, a research report should include (a) a description of the sample, including numbers of males and females and grade levels involved; (b) a description of instrumentation including reliability estimates and evidence of validity as well as information about obtaining the instrument (they also suggested that instruments be put into the ERIC system); (c) appropriate analysis procedures, and data presented in a format that communicates the essence of the findings as well as the **validity (italics the authors') of the effects** of the study; (1980:558-559).

Gauld and Hukins wrote, "The survey approach adopted by many people for identifying components of the scientific attitude has turned attention away from the need to think seriously about what the scientific attitude is and how its components are related to one another at a theoretical level..." (1980:153).

They recommended that researchers needed to make explicit references to the model of science upon which their particular piece of research was based. They also stated that researchers need to be more aware of the complexity of those processes leading to the behaviors used to indicate the possession of particular scientific attitudes.

Gauld and Hukins argued for the need for coherence in research in science education and hypothesized that progress in research could be achieved through groups adopting a particular framework then spending a great deal of effort carrying out investigations within that framework, as compared to many people doing a lot of different things. They also pointed out that, if research on scientific attitudes is to be of value to the classroom teacher, more attention needs to be given to studying the effects of particular teaching strategies, teacher characteristics, and the interaction between these and pupil characteristics on the development of attitudes. They considered that innovative techniques are needed in attitude research so that respondents answer honestly rather than attempting to please the teacher or researcher (1980:154).

Schibeci (1983), in an article focused on the topic of selecting appropriate attitudinal objectives for school science, expressed some reservations about attitude research. His comments agreed with those of other writers when he said, "The poor psychometric qualities of many instruments used to assess attitudes is a major problem." (1983:599).

Schibeci was also concerned that most attitude researchers did not consider the competing influence of school and non-school variables on attitudes. Schibeci considered such studies to be important but acknowledged that they are more expensive and difficult to undertake—reasons for their not being done. Also not adequately studied, according to Schibeci, is the stability of attitudes. Researchers do not try to determine how long an exhibited change in attitude lasts. Perhaps if science education researchers were to act on Gauld and Hukin's suggestion for setting up sustained research efforts, some longitudinal studies could be done.

**What Does All This Mean?**

Writers have called for reconceptualization of the two major categories of attitude measured by science education.
Similar results with affective objectives. In the cognitive domain, we can expect helping students achieve objectives in education. Munby has called for a moratorium on attitude instrument development. Should we leave the field of attitude research and concentrate our efforts in another direction?

Such an action does not seem to be the intent of any of the authors reviewed. All want the situation to be improved so that we can put more faith in what we read when attitude research is reported. As Schibeci wrote, "A general, basic assumption of curriculum writers and researchers is that we can change attitudes in the desired direction ..." (1983:600). What we need to keep in mind is that we probably cannot change all students without resorting to techniques that could be described as indoctrination or brainwashing. We also need to thoroughly question our assumption that because we have had success in helping students achieve objectives in the cognitive domain, we can expect similar results with affective objectives.

Schibeci argued that it is dangerous for curriculum writers (and others) to assume that attitudinal objectives may be treated in the same way as cognitive objectives (1983:601). Schibeci said:

There appears to have arisen a vague assumption that attitudinal objectives are a "natural" part of a specification for a science curriculum. This assumption needs to be examined more critically by curriculum writers than has been done to date. A much clearer, explicit justification for inclusion of attitudinal objectives needs to be provided, both for curriculum and research purposes. (1983:601)

Each year the ERIC Clearinghouse for Science, Mathematics, and Environmental Education cooperates with the National Association for Research in Science Teaching to produce a review of the science education research published in the previous calendar year. Beginning in 1973 these reviews have been published as a part of the material in the journal Science Education. These annual reviews for the years 1973 through 1982 were examined to see what the authors had to say about any attitude research they reviewed. The most specific comments were found in the review for 1977 (Peterson and Carlson). These reviewers said that attitude research is chaotic because we in science education have allowed it to become so. They suggested that, to make order out of this chaos, a series of conferences on attitude research and/or a specialized journal might be useful.

It seems obvious that there is much work to be done and that there are many people and attitudes and improved communication among this group, combined with more attention to methodological issues, would appear to be some issues that should receive priority from science educators interested in attitude measurement. These individuals would do well to keep in mind Zeidler's comments in reaction to Munby's article (1983b). Zeidler said that Munby's critique of the Moore and Summan Scientific Attitude Inventory and its use brought to light a more fundamental validity problem of much of the attitudinal research in science education. Science education researchers borrow from other disciplines without giving adequate attention to the theoretical and methodological issues established by those disciplines. In social psychological studies attitude is associated with one's beliefs, intentions and behaviors with respect to a given object or experience. Zeidler agreed that conceptual analysis is needed but not until science educators have considered whether or not their instruments are developed in a manner consistent with the formal criteria and theoretical guidelines of social psychology in the validation process (1984:341).

REFERENCES CITED


RELATIONED REFERENCES


ERIJCLEARINGHOUSEFORSIENCE, MATHEMATICS,ANDENVIRONMENTALEDUCATION

Dr. Robert W. Howe
Director

Dr. Stanley L. Helgeson
Associate Director, Science Education

Dr. Marilyn N. Suydam
Associate Director, Mathematics Education

Dr. Patricia E. Blosser
Associate Director, User Services

Dr. John F. Disinger
Associate Director, Environmental Education

Dr. John A. Novak
Faculty Research Associate

ERIC® Clearinghouse for Science, Mathematics, and Environmental Education
The Ohio State University
1200 Chambers Road, 3rd Floor
Columbus, OH 43212
4230-710946

ADDRESS CORRECTION REQUESTED