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ABSTRACT

This report outlines the stages of development and validation of the Attitude Toward the Subject Science Scale (ATSSS). The instrument, developed in accordance with the Ajzen and Fishbein (1980) theory of attitude assessment, can be used by junior secondary science teachers or administrators to assess student attitudes toward the subject science or to provide feedback on how positively or negatively students view various science-related activities. The report contains: (1) an introduction; (2) a literature review in four parts: rationale for the promotion of positive attitudes toward science; research which considered student attitudes in science education; attitudes toward science compared to scientific attitudes; and methodological issues related to suggested improvements in attitude toward the subject science research; (3) an overview of the Ajzen and Fishbein theory of reasoned action; and (4) the development and testing of the ATSSS' validity and realiability, in terms of assessing students attitudes toward the subject grade 10 science. A copy of the ATSSS and scoring instructions are provided in an appendix. (Author/JN)

Report No. 85:7

THE DEVELOPMENT OF THE ATTITUDE TOWARD THE SUBJECT SCIENCE SCALE

GRANT NUMBER: DG-368

AUTHOR(S): Bernie Krynowsky

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THE DEVELOPMENT OF THE

ATTITUDE TOWARD THE SUBJECT SCIENCE SCALE

A report submitted to the Educational Research Institute of British Columbia

Bernie Krynowsky
August, 1985

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1.1 INTRODUCTION

The major purpose of the present article is to report the stages of development and validation of the Attitude Toward the Subject Science Scale, ATSSS. This scale may be of use to both teachers or administrators in the assessment of student attitudes toward the subject science. This assessment could be for the purposes of evaluating the attitudinal objectives of a science education program or to provide feedback on how students view the subject science.

In addition to the reporting of the development and validation of the ATSSS, the writer will also provide some background information about attitude assessment in science education. This background will include both a review of the literature, which will highlight some salient issues and concerns in the area of attitude assessment, and a description of how attitudes can be defined and measured.

1.2 REVIEW OF RELATED LITERATURE

1.2.1 RATIONALE FOR THE PROMOTION OF POSITIVE ATTITUDES TOWARD THE SUBJECT SCIENCE

One of the major goals or objectives for science education programs is to foster more positive attitudes toward science and the scientific enterprise. Numerous science educators and researchers note that these attitudinal goals or objectives are prevalant or very important in science education (Abraham, Renner, Grant,

& Westbrook, 1982; Ayers & Price, 1975; Birnie, 1978; Comber & Keeves, 1973; Doran, Guerin, & Cavalieri, 1974; Eggen, 1978; Fraser, 1978b; Klopfer,1971; Koballa & Crawley,1985; Lawrenz, 1975; Lowery, Bowyer, & Padilla, 1980; MacMillan & May, 1979; Johnson, Ryan, & Schroeder, 1974; Schibeci, 1984; Towse, 1983; Vitrogan, 1969; Voss, 1983; Ward, 1976; & Yager & Penick,1984) The position put forward by MacMillan and May (1979) cogently represents the importance and prevalence of attitudinal objectives for science education programs. They assert that "there has always been an interest in the development of positive pupil attitudes toward science. The objective of any science curriculum includes fostering favorable feelings toward science as well as imparting cognitive knowledge" (p. 217). Simpson, Renz, and Shrum (1976) also articulate their views on the importance of attitudinal learning outcomes in their assertion that "feelings, attitudes, and values our students take from the science courses may be of more consequence - both immediately and ultimately - than anything else the curriculum embodies" (p. 280).

The importance of student attitudes in the minds of science educators is also evident in the quantity of research done in the area. Schibeci (1984), in an update of attitude toward science research, noted that 17% of the papers presented at the National Association for Research in Science Teaching 1983 meeting were directly

related to student attitudes. Munby (1980), in a review of the quality of attitude measuring instruments, located more than 2,000 references related to the topic of attitudes in science education in a ten year period spanning from 1967-1977. Peterson and Carlson, (1979), in their review of science education literature, noted that there were about 30 published attitude studies a year for the years 1972-1976. These quantities of research might suggest that the consideration of student attitudes is important in science education and is an area worthy of investigation.

Given the significant amount of research and the expressed importance for the promotion of positive student attitudes toward the subject science, the writer believes it is important to present positions that would justify further research into the area. The following background review considers some of the arguments that are found in the science education literature as well as in his own personal experience as a science educator.

One of the major arguments for the promotion of positive attitudes involves the suggestion that there is a strong relationship between student attitudes to science and actual learning or achievement of science content (Eisenhardt, 1977; Dutton & Stephens, 1963; Hasan & Billeh, 1975; Osborne, 1976; Russell & Hollander, 1975; & Vitrogan, 1967). The general argument that can be presented is that if students have positive

attitudes toward the subject then they will learn or achieve better.

Mager (1968) extends this achievement argument to claim that attitudes affect not only present learning but also future learning. He asserts that

> the likelihood of the student putting his knowledge to use is influenced by his attitude for or against the subject. Things disliked have a way of being forgotten .... One objective toward which to strive is that of having the student leave your influence with as favorable an attitude toward your subject as possible. In this way you will help to maximize the possibility that he will remember what he has been taught, and will willingly learn more about what he has been taught. (p.311)

Some science educators also argue that student attitudes are significant in terms of the "citizens" we send out from our science classrooms (Ayers & Price, 1975; Hasan, 1975; Schock, 1973; & Wareing, 1982). Hasan (1975), Ayers and Price (1975), and Schock (1973) state that positive attitudes are important for the development of scientifically literate citizens, which they believe to be an important student learning outcome. Hasan (1975) and Gardner (1976) argue that students would be more likely to pursue science related careers if they had positive attitudes toward the

subject science. Payne (1977) pursues the issue of future benefits of positive attitudes even further in his assertions that attitudes influence a person's ability to "participate actively in a democratic society" and are "necessary for a healthy and effective life" and interacts with "occupational and vocational satisfaction" (pp. 66-67).

Student attitudes toward the subject science are also considered important because of direct implications for teachers. For example, Newton (1975) concludes that "negative attitudes in the classroom can make actual teaching complex and frustrating" (p. 370). Furthermore, if attitudes are learned dipositions, as some prominent learning and attitude theorists suggest (Ajzen & Fishbein, 1980; Fishbein, 1967; Festinger, 1957; Hovland & Rosenberg, 1960, Lewin, 1951; Krathwohl, Bloom, & Masia, 1964; Thurstone, 1931; & Osgood, Suci, & Tanebaum, 1957) and science educators (Aiken & Aiken, 1969; Koballa, 1983; Koballa & Crawley, 1985; & Shrigley, 1983) teachers may have a profound influence on their students' attitudes. MacMillan and May (1979) support the importance of the teacher's role in promoting positive attitudes toward their subject. They assert

> it is refreshing to find how much influence the teacher has on attitude development. Teacher personality, relations, and interactions with

> pupils, classroom activities, rewards, assignments, and pupil work are all directly controlled by the teacher. Thus the teacher must assume a large part of both the responsibility and challenge of developing positive attitudes of students toward science. (p.221)

The knowledge of student attitudes toward the subject is also important for teachers and administrators in terms of the evaluation of teaching and curricula. For example, Ato and Wilkinson (1982) state that student attitudes toward the subject are a form of assessment of class procedures, teaching methods, and new curricula. Furthermore, some researchers view the potential of attitudinal studies as significant for curriculum evaluations in terms of the frequently stated affective objectives (Chavez,1984; Fisher, 1969; Fraser, 1977; Leece & Mathews, 1974; Hoffstein, Yager,& Walberg 1982; & Sherwood & Herron, 1976). The basic position these researchers present is that student attitudes are important because they let us know how well our programs are achieving their stated attitudinal objectives, goals, or aims.

From a personal point of view, largely based on his experience as a science educator, the writer believes most science teachers are concerned about their students' attitudes toward their subject and regard positive student attitudes as a desirable learning

outcome. Moreover, he also believes that most science educators perceive they have a role to play in the development of positive attitudes toward the subject in their classes. The present writer, given his beliefs, will attempt to find out more about: What the student attitudes toward the subject are? What might influence these attitudes?, and What we as science educators can do in our classroom to improve them? Moreover, he believes these questions are also relevant to practising teachers.

There are some problems and concerns, however, with regard to the teaching for, evaluation of, and appropriateness of attitudinal outcomes for science education programs. In terms of teaching for improved attitudes we might consider that teachers may recognize attitudinal importance, but do little to teach systematically for improvements (Koballa & Crawley, 1985; Kozlow & Nay, 1976; Schibeci, 1980; & Wareing, 1982). Other researchers suggest that we might also ask about what learning experiences we could design to improve student attitudes (Birnie, 1978; Johnson et al., 1974; & Ward, 1976). Another concern related to the teaching for attitudinal objectives might involve the reexamination of affective objectives for their appropriateness in our science curriculums (Brown, 1976; Gauld, 1982; Gauld & Hukins, 1980; & Giesert, 1977). Schibeci (1983) cogently argues that "a much clearer,

explicit justification for inclusion of attitudinal objectives needs to be provided both for curriculum and research purposes" (p. 601). Furthermore, science educators, when planning research and teaching, might consider the conclusion of Lowery et al. (1980). who assert that "historically there has been a substantial gap between the rhetoric of science curriculum goals, the means provided to achieve them, and effective assessment of achievement" (p. 327). In summary these arguments might suggest that if teachers cannot teach for or evaluate attitudinal goals or objectives then maybe they are not appropriate for our science curriculums.

The problems a science educator might encounteer in teaching for and evaluating student attitudes toward the subject are evident if one inspects the British Columbia Junior Secondary Science Curriculum Guide (1983). Firstly, some of the attitudinal goals are not attitudinal, but rather cognitive ones. Secondly, there are no specifications of desirable behaviors to be achieved from these attitudes. Thirdly, there are no indications of how a teacher could evaluate these attitudinal goals. In the development of the ATSSS there is included a specification of what an attitude toward the subject science is, what behaviors might be desirable from these positive student attitudes, and how a science educator could assess these attitudes.

The development of the ATSSS is a step towards legitimizing the statements of attitudinal goals in science curriculums. For example, this instrument may be particularly useful to science educators in British Columbia. The Ministry of Education, via the Junior Science Curriculum Committee, suggests that teachers attempt to assess the attitudinal goals in the recently(1984) implemented Grade Ten Integrated Science Curriculum. Moreover, in the Junior Secondary Science Curiculum Guide (1983) it recommended that teachers direct 25% of their teaching time towards the promotion of positive student science attitudes. In addition to the ministries concern for attitudinal assessment, the Science Council of Canada, in their report on Science for Every Student (1984), recommend that "teachers and curriculum planners must evaluate students' progress towards all the goals of science education, not just their learning of scientific content" (p. 1). These suggestions for the need for attitude evaluation would make the attitude instrument developed for the proposed study relevant to the needs of grade ten science educators in the province of British Columbia and perhaps Canada. It would be relevant because there have been specific directives for further assessments of student attitudes toward the subject science. The Attitude Toward the Subject Science Scale developed in this project study will be one means to do these

assessments.

The writer will pesently review some of the research which outlined a few of the major concerns of how attitudes have been defined and measured in the past. Moreover, he will also suggest how the development of the ATSSS will address some of these concerns.

1.2.2 OVERVIEW OF RESEARCH WHICH CONSIDERED STUDENT ATTITUDES IN SCIENCE EDUCATION

There has been considerable research into student attitudes toward science at all education levels. Four major reviews have highlighted the methods, results and problems in the area of research concerned with student attitudes toward science. Ormerod and Duckworth (1975) have provided the most extensive review of the results and implications of over 500 studies. Gardner (1975a) examined this general general area, with evaluations of the results and instrumentations used. Munby (1980) highlighted the problems of assessment and instrumentation through an evaluation of over 50 attitude instruments. Schibeci (1984) updated attitude toward science research in an extensive review which encompassed over 200 studies. This review highlighted some of general conclusions and issues within this research area. Articles written by Schibeci (1983), Haladyna et al. (1982), Shrigley (1983), and Aiken and Aiken (1969) also provided a general overview of

research in the area.

The writer, prior to his examination of some of the findings, conclusions, and problems in science education attitudinal research, should clarify some of the major meanings which have been associated with the terms science and attitudes toward science. One reason for this clarification was because of some confusion about what these terms have represented. This confusion has caused some difficulty in the interpretation of attitudinal research in science education.

1.2.3 ATTITUDES TOWARD SCIENCE COMPARED TO SCIENTIFIC ATTITUDES

In terms of attitudinal aims and objectives for science education programs and attitudinal research done in science education, two general categories have been established (Gardner, 1975a ; Gauld & Hukins, 1980; & Schibeci, 1983, 1984). These categories included both the promotion of positive student "attitudes toward science" and "scientific attitudes". Different definitions have been given to these categories (Aiken & Aiken, 1969; Gardner, 1975a; Pearl, 1973; Fraser, 1977; Schibeci, 1984; Shrigley, 1983; & Zieldler, 1984) , however, they have also been confused or combined in assessments of student attitudes (Gauld & Hukins, 1980; & Koballa, 1983). An excellent example of this confusion was illustrated by the critical analysis of the widely

used Scientific Attitude Inventory (Moore & Sutman, 1970) by Munby (1980,1983) and Nagy (1978) which revealed inconsistencies in the attitudinal constructs supposedly being measured. The writer, will present, from the literature, the meanings associated with both scientific attitudes and attitudes toward science.

"Scientific attitudes" have generally been perceived as desired attributes of scientists in professional work and hence deemed as appropriate objectives for science curricula (Munby, 1980). Examples of these attributes were: open mindedness, curiosity, honesty, skepticism, critical thought, rationality, and objectivity. Some science educators have developed lists of desirable attitudinal attributes (Billeh & Zakhariades, 1975; Diederich, 1967; Kozlow & Nay, 1976; & Vitrogan, 1967). Doran (1980), who reviewed some attitudinal lists and other literature, concluded that there is no one standard list, however, many common attitudinal attributes were found among the lists. More recently, there has been some criticism of having the attainment of these attributes, which may not describe the characteristics of scientists at work , (Gauld, 1982; & Schibeci. 1983, 1984), as appropriate objectives for science education programs.

Specific definitions have been proposed to describe "scientific attitudes". Some examples found by the writer were : "an adherance to knowledge of the

scientific method" (Aiken & Aiken, 1969, p. 296), "the adoption of a particular approach to solving problems, to assessing ideas and information or to making decisions" (Gauld, 1982, p. 110), and "those habits of mind ... typically meant to characterize the mental processes of a scientist at work" (Munby, 1983, p. 142). In general,, "scientific attitudes" were viewed as desirable traits, characteristics, or attributes of scientists at work. An excellent review of research in the area of scientific attitudes has been provided by Gauld and Hukins (1980). In this significant review, the nature of scientific attitudes, findings of previous studies, and viewpoints about the appropriateness of these attitudes as objectives were presented.

The concept of an "attitude toward science" has not had as clear a meaning in science education research as scientific attitudes. This concept has had different meanings and uses in attitudinal research. Some of the meanings have involved, for example, "feelings, opinions, beliefs in and about, and appreciations which individuals have formed as a result of interacting directly and indirectly with the various aspects of the scientific enterprise" (Hasan & Billeh, 1975, p. 247). Gardner (1975a) viewed the meaning as "emotional reactions of students toward science" (p. 2). Dutton and Stephens (1963) viewed these attitudes as "how an individual feels about science" (p. 43). Munby (1980) in

an extensive review of attitude instruments found most attitude assessments involved an individual's "feelings, beliefs, likes" (p. 268) toward an attitudinal object in the field of science.

The unclear meaning of what an attitude toward science represented has created problems in terms of coordinating and comparing attitude toward science research. This research has been plagued with inconsistent and contradictory findings (Aiken & Aiken, 1969; Gardner, 1975a; Mallinson, 1977, Munby, 1980; Peterson & Carlson, 1979 ; & Schibeci, 1984). Reviews of the meaning of the attitude concept by Schibeci (1983), who provided an excellent perspective for the meanings associated with attitudes, and Shrigley (1983), who examined possible alternatives for clarifying the attitude concept in science education research, have made significant contributions in terms of suggestions for future research. Some of these suggestions were incorporated into the development of the ATSSS.

The writer, in the development of the ATSSS considered the need for the establishment of a clear meaning and theoretical foundation for attitudes toward science. This foundation, based on the work of Ajzen and Fishbein (1980) is described in Section 1.3.

1.2.4 METHODOLOGICAL ISSUES RELATED TO SUGGESTED IMPROVEMENTS IN ATTITUDE TOWARD THE SUBJECT SCIENCE RESEARCH

Based on the lack of integrative findings and conflicting results, critical comments have been made about the state of science education attitudinal research (Haladyna et al., 1982; Lowery, 1980; Mallinson, 1977; Manley,1977; Peterson & Carlson, 1979; Ramsey & Howe, 1969; Russell, 1981; & Schibeci, 1984). Assertions by Mallinson (1977) who stated that "frustration comes from the inconclusive, and in many cases contradictory findings of the studies" (p. 167) and Peterson and Carlson (1979) who concluded "attitude research is chaotic" (p. 500), and Schibeci (1984) who found it "disappointing that the set of conclusions which can be drawn from such a large body of literature is so limited" (p. 46), typified some of the general criticisms of the research results. There have been both general and specific problems or concerns identified in the realm of attitude to science research. Moreover, suggestions for improving the research have also been presented. Some of the methodological problems and suggestions for improvements will presently be reviewed.

A majority of the problems noted or suggested needs presented, for attitude toward science research, were concerned with the shortcomings of instruments used to collect data (Anderson & Herrera, 1976; Champlin, 1970;

Comber & Keeves, 1973; Gabel et al., 1978; Gardner, 1975a,b; Pearl, 1973 ; Peterson & Carlson, 1979; Schibeci, 1983, 1984; Ost & White, 1976; & Wilson, 1981). Munby (1980), in an analysis of 50 attitude to science instruments, asserted "there are grounds for viewing the affective outcomes of science education with misgiving simply because there seems little to be said of the instruments to enlist our confidence in their use" (p. 273). Pearl (1973) supported Munby's assertion in his comment that "the literature reveals one consistent theme - the total inadequacy of science attitude measurement" (p. 378). Many of the specific shortcomings of instrumentation noted and elaborated on by others, have been summarized by Gardner (1975a); Haladyna et al. (1982) and Schibeci (1984). Some of these instrumentation shortcomings were concerned with:

(1) The need for the specification of a theoretical construct to underlie the instrument (Messick, 1975; Munby, 1983; Munby et al., 1976; Nagy, 1978; Shrigley, 1983 ; & Zeidler , 1984) and the clear definition of the construct to be measured (Aiken & Aiken, 1969; Butts, 1983; Haladyna & Shaughnessy, 1982; Koballa, 1983; Munby, 1980; & Schibeci, 1984).

(2) The need for the verification or establishment of reliability and validity instruments (Butts, 1983; Champlin, 1970; Gabel et al., 1978; Hofstein et al., 1979; Munby, 1979, 1980; Pearl, 1973 ; & Schibeci, 1983,

1984). Specific suggestions given for the improvement of reliability and validity were: the use of test-retest reliabilities (Munby, 1980), the use of factor and cluster analysis to empirically validate subscales (Munby, 1980; & Nagy, 1978), separate scores for conceptually distinct aims (Fraser, 1978a; & Pearl, 1973), more careful wording and testing of items (Butts, 1983; & Shrigley, 1983), and the preliminary trial of the instrument on the population for whom the use is intended (Butts, 1983). It should be noted that these suggestions were considered in the design of the proposed study.

The message has been clear, that in general the results of attitudinal studies have been found to be lacking in certain respects. These criticisms were in two general streams, the questionable quality of the instrumentation and the lack of a theoretical foundation as a basis for the research (Munby et al., 1976). However, the importance of the promotion of positive attitudes and the support for continued attitude research has also been evident (Leece & Mathews, 1974; Moyer, 1975; Peterson & Carlson, 1979; Shrigley, 1983; & Simpson et al., 1976).

1.3 OVERVIEW OF THE AJZEN AND FISHBEIN THEORY OF REASONED ACTION

The writer has previously presented an overview of attitudinal research in science education. Moreover, he has alluded to the concerns and need for the development of sound instruments to measure student attitudes toward the scientific enterprise. Given this background , the writer will presently describe how attitudes were defined and measured in the context of the Ajzen and Fishbein (1980) theory of reasoned action.

The Ajzen and Fishbein (1980) theory of reasoned action provides the theoretical foundation and frame of reference for portions of the development of the ATSSS. The writer has alluded to the importance of providing a frame of reference so that when the concept of an attitude toward science is discussed or measured it will have some meaning. In this review the writer will briefly outline the Ajzen and Fishbein theory in terms of how attitudes can be defined, measured and related to behaviors.

The ultimate goal of the theory, which Ajzen and Fishbein (1980) call the "theory of reasoned action", is to predict and understand an individual's behavior. Within the theory, an individual's attitude toward the behavior, ultimately is one of the underlying variables which may determine the actual behavior exhibited. The theory is based on the assumption that human beings are usually quite rational and make systematic use of information available to

them when a behavior is considered.

In terms of predicting and understanding human behavior, the first step is to identify the behavior of interest. For example, a person, after taking a grade ten science course, may or may not take a grade eleven science course. For this specific behavior, an individual may or may not, at any given time, intend to take a grade eleven course. The theory views intention to perform or not perform a behavior as an immediate determinant of the action. The theory assumes that, barring unforseen events, a person usually acts in accordance with their intentions.

In order to further understand the behavior, the next step is to identify the determinants of the intention. The theory of reasoned action proposes that there are two basic determinants of a person's intention, one personal and the other reflecting social influence. One determinant, the personal factor is the individual's positive or negative evaluation of performing the behavior. This positive or negative (favorable or unfavorable) evaluation is considered to be the individual's attitude toward performing the behavior. In our example of the intention to take or not to take a grade eleven science course, an individual evaluates whether or not this behavior was good or bad or they were favorable or unfavorable toward the behavior. If the attitude toward the behavior is positive, the intention to perform the behavior is stronger.

The second determinant of intention is the individual's perception of the social pressures put on him to perform or not perform the behavior. This social factor is termed the subjective norm. In our example, if an individual perceives his friends as being very positive or favorable to them taking a grade eleven science course, then the individual's subjective norm is likely positive and their intention to take the course stronger. It should be noted that the strength of attitudinal and normative factors may vary for both the specific intention and the individual involved. These factors interact to determine the intention. For example, if an individual has a negative attitude toward taking a grade eleven science course, they may still intend to take it because of the individual's perception that others (subjective norm) view the behavior positively.

The theory also attempts to explain how and why attitudes and subjective norms are formed. According to the theory, attitudes and subjectives norms are a function of an individual's beliefs. The individual's evaluation of the perceived outcomes of the behavior, if positive, would likely result in a positive attitude toward the behavior. These personal beliefs that underlie an individual's attitude toward the perceived outcome of the behavior are termed behavioral beliefs. The other determinant factor, related to the individual's subjective norm, are termed normative beliefs. These beliefs entail the individual's perception of what their friends or important others believe

the potential outcomes of the behavior are. This perception of what others believe provides the social pressure or motivation to comply with the beliefs of important others. If a person perceives that their friends believe negative outcomes would result because of the behavior, then the motivation to comply with those negative beliefs would likely result in that individual having a negative normative belief.

In our example of the decision to take a grade eleven science course, if the individual believes, after evaluation of the perceived potential outcomes, that taking the course would lead to positive outcomes such as improved career opportunities or more educational options, then the individual's attitude toward taking a senior science course would likely be positive. Furthermore, if the individual perceives their friends as believing that the taking of a senior science class would likely result in positive potential outcomes such as better career options or being put into a better class, then the individual's normative belief would also likely be positive. The behavioral and normative beliefs in turn, determine the attitude toward the behavior and subjective norm respectively. The relative importance of the subjective norm and attitudinal considerations determines the intention to perform the behavior. This intention is assumed to determine the behavior of an individual.

Figure 1.3 summarizes the overview of the theory to this point. The theory attempts to explain how behavior could be explained in terms of a limited number of concepts. Each successive step from beliefs to behavior provides a more comprehensive account of the causes underlying the potential behavior. The purpose behind the present study is develop a valid reliable instrument in order to be able to assess one important dimension of the schema, student attitudes toward specific behaviors.

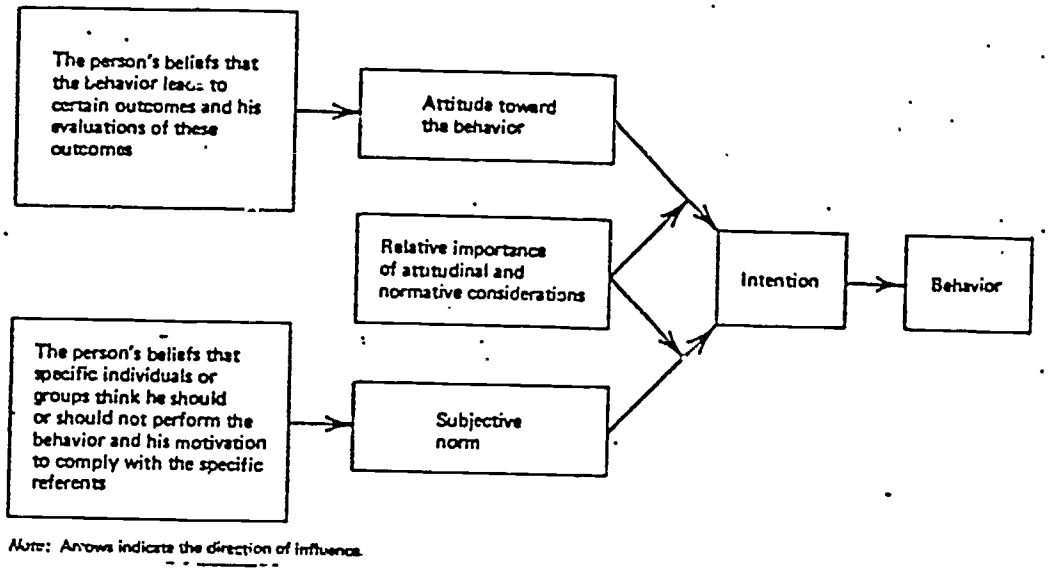

Figure 1.3 Overview of the Ajzen and Fishbein Theory of Reasoned Action

Given the background of how attitudes were viewed in the development of the ATSSS, the writer will presently provide a description of the terms attitude and attitude

toward the subject science.

1. Attitude the learned predisposition of an individual to respond in a consistently favorable or unfavorable way, to their performing of a specific stated behavior (Ajzen & Fishbein, 1980; Fishbein, 1967; & Fishbein & Ajzen,1975).
2. Attitude Toward the Subject Science the learned predisposition of an individual to respond, in a consistently favorable or unfavorable way, to their performing a specific behavior related to the activities of their science class. Operationally, these student attitudes will be measured by the ATSSS.

1.4 VALIDATION OF THE ATTITUDE TOWARD THE SUBJECT SCIENCE SCALE

The Attitude Toward the Subject Science Scale, ATSSS, was developed by the writer in order to assess student attitudes toward the subject science. This scale was developed in accordance with the Ajzen and Fishbein (1980) theory of attitude assessment previously described in the preceeding section of this article.

The ATSSS underwent development and testing for both its reliability and validity, in terms of assessing student attitudes toward the subject grade ten science. The development and testing loosely followed guidelines for attitude scale construction proposed by Koballa (1984) and Nyberg and Clarke (1982) . These stages will presently be

described.

Firstly, a pool of 21 items for the instrument was drafted in accordance with the guidelines provided by Ajzen and Fishbein (1980). It was important that this instrument is consistent with these guidelines. Two researchers familiar with the theory guidelines, examined this draft for that consistency. The items on the ATSSS were concerned with various behaviors to which science educators may desire positive student attitudes. Four teachers of grade ten science reviewed these behaviors and items and provided other more desirable behaviors. Moreover, based on these reviews of the items, the scale was revised.

Ajzen and Fishbein (1980) specified that attitudes were an evaluative or affective response to performing a specific behavior. Moreover, since they recommended the use of semantic differential type scales to evaluate behaviors, it was important to use empirically validated evaluative scales in the attitude instrument.

Nyberg and Clarke (1982) conducted a study in Alberta, Canada in order to develop an instrument to assess student attitudes toward various school subjects. They also used a semantic differential technique (Osgood et al., 1957). In their process of instrument development they found 11 adjective pairs which loaded highly on the evaluation factor for grades 5,8,and 11. The researcher initially selected three suitable pairs from the list and used them in all the ATSSS items. These pairs were slected on the basis that they

had to make sense in the item. The pairs selected were : nice-awful; interesting-boring; and pleasant-unpleasant.

After the preparation and evaluation of the second draft, the researcher piloted the instrument in a grade ten science classroom . Based on student feedback and an analysis of the internal consistency of the items the instrument was revised. Items with item-total correlations corrected for overlap below 0.40 were eliminated from the pool. Moreover, items with which students had difficulty were rewritten or eliminated. This third version of the ATSSS was then be subjected to tests of validity and reliability.

The researcher used this third version of the instrument in a pilot study in the Kamloops School District. In this pilot the researcher administerd the instrument to two science classes in the district and readminister the same instrument , three to four weeks later , to the same classes. Based on these administrations, the researcher obtained reliability coefficents, item-total correlations corrected for overlap; and an overall estimate of test reliabilty. These data are located in Table 1.4.

Item no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Item-tot.corr.	.77	.75	.68	.59	.67	.75	.72	.79	.72	.74	.79	.73	.82	.77	.79
Estimate(rel.) (Hoyt-r)	.92	.90	.96	.85	.98	.97	.99	.98	.91	.84	.96	.94	.97	.90	.99

Cronbach alpha for composite (n=42) was 0.77

Table 1.4 Reliability Data for Items on the ATSSS

In addition to tests of reliability , the researcher attempted to establish the validity of the ATSSS using three approaches. Firstly, the researcher asked teachers of the two participating classes to rank order the students in the class in terms of most positive attitude toward the subject science. The teacher's rank order of students were correlated to the student's rank order on the ATSSS scores. Spearman-rank order coefficients were computed for each of the two classes involved. These coefficents were 0.79 (n=25) and 0.65 (n=19).

The second approach, in the establishment of the validity of the ATSSS, involved the reassessment of student attitudes toward the subject science during the personal interview with the researcher. The Classroom Factors that Influence Student Attitudes interview schedule included six items that assessed student attitudes toward the subject science. Student total scores on these items were compared their scores on the ATSSS. The comparison were in the form of Pearson correlation. This coefficent was 0.81 (n=16).

The third approach, entailed a comparison between the student ATSSS score to a reliable attitude toward the subject science attitude scale,the School Science scale. This scale was developed in British Columbia as part of the British Columbia Science Assessment (1978). A Pearson correlation coefficent was computed for students in two classes from the sample. This coefficent was 0..70 (n=76).

In terms of the overall validity assessment of the ATSSS , the researcher weighted the correlation coefficents. The School Science coefficent , because it was based on a previously validated instrument , were given a 0.5 weighting. The teacher comparison and student interview coefficents were given a 0.25 weighting . The researcher selected the teacher comparison method because he believed, based on his experience in classrooms , that teachers should be able to recognize students with positive and negative attitudes. Moreover, he choose the interview comparison because he believed that the students verbalized attitude should represent an accurate indication of their attitude toward the subject. Finally , the researcher also believed that using a variety of approaches provided a more complete analysis of instrument valididty . The overall weighted coefficent of correlation, which should provide some indication of the instruments validity, was 0.73.

The ATSSS was further tested for its reliability over time. This test entailed another retest of the final version in two classes from the sample. The test retest reliability coefficent was 0.82 (n=44).

The ATSSS and its directions for scoring are located in the Appendix. Moreover, the developer of this instrument will allow for its use for any educational purpose.

1.4.1 CONCLUSION

In conclusion the preceeding article involved both the presentation of some of the issues and concerns for attitude assessment in science education as well as a review of the stages of development of the Attitude Toward the Subject Science Scale. Hopefully this review provided some insights into the realm of attitudes in terms of their importance in education, the problems involved in their assessment, and the means by which they can be defined and measured in the context of a classroom situation. Moreover, the writer hopes that this instrument will be of use to both science teachers and administrators who are concerned about improving student attitudes toward the subject science.

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APPENDIX - Attitude Toward the Subject Science Scale (ATSSS)

- Directions for Scoring ATSSS

ATTITUDE TOWARD THE SUBJECT SCIENCE SCALE

Please do not turn the page until you are asked to do so.

SCHOOL _____ SCALE NUMBER _____

PURPOSE

The purpose of this scale is to find out your overall thoughts or feelings toward the topics and activities within the science course you are taking this school year. You will be asked to respond to some statements about activities related to this science course. Please respond to all of the statements honestly and to the best of your ability. This is not a test. Your answers are confidential.

INSTRUCTIONS AND EXAMPLE

Instructions

1. Read the statement carefully.
2. Note the words at the opposite ends of the scales given to you. Pick the word from the end of each scale that best describes how you think or feel about the activity in the statement.
3. Put an X in one of the labelled spaces at the end of the scale that you picked. This X shows how strongly you think or feel about the activity in the statement.

Example

Here is an example of a statement and one scale which has been responded to:

MY READING A SCIENCE RELATED MAGAZINE ARTICLE IS

BORING	:	:	:	:	:	:	:	INTERESTING
	extremely	quite	slightly	undecided	slightly	X quite	extremely	

In this example, the X placed in the quite space on the INTERESTING end of the scale shows that the person responding to this statement thinks or feels that the reading of a science related magazine article is quite interesting.

4. Work rapidly, and give your first thought or feeling about the activity in the statement. Please remain quiet until everyone is finished.

REMEMBER

*THERE ARE 3 SCALES PER STATEMENT. RESPOND TO ALL OF THE STATEMENTS AND SCALES.

*ANSWER HONESTLY AND TO THE BEST OF YOUR ABILITY.

*THIS IS NOT A TEST. YOUR ANSWERS ARE CONFIDENTIAL.

ARE THERE ANY QUESTIONS? .....YOU MAY BEGIN

1. ALL OF THE FOLLOWING STATEMENTS ARE RELATED TO YOUR SCIENCE COURSE THIS SCHOOL YEAR.

Please respond to all three scales for each statement.

1. MY READING THE SCIENCE TEXT AT LEAST ONCE A WEEK IS

INTERESTING	_____	_____	_____	_____	_____	_____	_____	BORING
	extremely	quite	slightly	undecided	slightly	quite	extremely	
PLEASANT	_____	_____	_____	_____	_____	_____	_____	UNPLEASANT
	extremely	quite	slightly	undecided	slightly	quite	extremely	
AWFUL	_____	_____	_____	_____	_____	_____	_____	NICE
	extremely	quite	slightly	undecided	slightly	quite	extremely	

2. MY ACTIVELY PARTICIPATING IN MOST OF THE LAB ACTIVITIES IS

INTERESTING	_____	_____	_____	_____	_____	_____	_____	BORING
	extremely	quite	slightly	undecided	slightly	quite	extremely	
PLEASANT	_____	_____	_____	_____	_____	_____	_____	UNPLEASANT
	extremely	quite	slightly	undecided	slightly	quite	extremely	
NICE	_____	_____	_____	_____	_____	_____	_____	AWFUL
	extremely	quite	slightly	undecided	slightly	quite	extremely	

3. MY WATCHING A T.V. PROGRAM ABOUT SCIENCE AT LEAST ONCE A MONTH IS

INTERESTING	_____	_____	_____	_____	_____	_____	_____	BORING
	extremely	quite	slightly	undecided	slightly	quite	extremely	
UNPLEASANT	_____	_____	_____	_____	_____	_____	_____	PLEASANT
	extremely	quite	slightly	undecided	slightly	quite	extremely	
AWFUL	_____	_____	_____	_____	_____	_____	_____	NICE
	extremely	quite	slightly	undecided	slightly	quite	extremely	

4. MY TRYING MY BEST TO KEEP A GOOD SCIENCE NOTEBOOK IS

INTERESTING	_____	_____	_____	_____	_____	_____	_____	BORING
	extremely	quite	slightly	undecided	slightly	quite	extremely	
PLEASANT	_____	_____	_____	_____	_____	_____	_____	UNPLEASANT
	extremely	quite	slightly	undecided	slightly	quite	extremely	
AWFUL	_____	_____	_____	_____	_____	_____	_____	NICE
	extremely	quite	slightly	undecided	slightly	quite	extremely	

ALL OF THE FOLLOWING STATEMENTS ARE RELATED TO YOUR SCIENCE COURSE THIS SCHOOL YEAR.

5. MY READING A SCIENCE RELATED MAGAZINE ARTICLE AT LEAST ONCE A MONTH IS

INTERESTING	extremely	quite	slightly	undecided	slightly	quite	extremely	BORING
UNPLEASANT	extremely	quite	slightly	undecided	slightly	quite	extremely	PLEASANT
NICE	extremely	quite	slightly	undecided	slightly	quite	extremely	AWFUL

6. MY ASKING THE SCIENCE TEACHER QUESTIONS ABOUT SCIENCE IS

INTERESTING	extremely	quite	slightly	undecided	slightly	quite	extremely	BORING
UNPLEASANT	extremely	quite	slightly	undecided	slightly	quite	extremely	PLEASANT
AWFUL	extremely	quite	slightly	undecided	slightly	quite	extremely	NICE

7. MY TRYING TO FIND OUT MORE ABOUT SCIENCE THAN WHAT WE LEARN IN CLASS IS

BORING	extremely	quite	slightly	undecided	slightly	quite	extremely	INTERESTING
UNPLEASANT	extremely	quite	slightly	undecided	slightly	quite	extremely	PLEASANT
NICE	extremely	quite	slightly	undecided	slightly	quite	extremely	AWFUL

8. MY TRYING MY BEST TO SOLVE SCIENCE PROBLEMS WE ARE GIVEN IS

INTERESTING	extremely	quite	slightly	undecided	slightly	quite	extremely	BORING
PLEASANT	extremely	quite	slightly	undecided	slightly	quite	extremely	UNPLEASANT
NICE	extremely	quite	slightly	undecided	slightly	quite	extremely	AWFUL

ALL OF THE FOLLOWING STATEMENTS ARE RELATED TO YOUR SCIENCE COURSE THIS SCHOOL YEAR.

9. MY TAKING SCIENCE AS A SCHOOL SUBJECT IS

	extremely	quite	slightly	undecided	slightly	quite	extremely	
BORING	:	:	:	:	:	:	:	INTERESTING
UNPLEASANT	:	:	:	:	:	:	:	PLEASANT
AWFUL	:	:	:	:	:	:	:	NICE

10. MY TRYING MY BEST TO GET A GOOD SCIENCE MARK IS

	extremely	quite	slightly	undecided	slightly	quite	extremely	
INTERESTING	:	:	:	:	:	:	:	BORING
UNPLEASANT	:	:	:	:	:	:	:	PLEASANT
AWFUL	:	:	:	:	:	:	:	NICE

11. MY LISTENING CLOSELY TO THE TEACHER TALKING ABOUT SCIENCE IS

	extremely	quite	slightly	undecided	slightly	quite	extremely	
INTERESTING	:	:	:	:	:	:	:	BORING
UNPLEASANT	:	:	:	:	:	:	:	PLEASANT
AWFUL	:	:	:	:	:	:	:	NICE

12. MY TRYING TO DO SCIENCE ASSIGNMENTS TO THE BEST OF MY ABILITY IS

	extremely	quite	slightly	undecided	slightly	quite	extremely	
BORING	:	:	:	:	:	:	:	INTERESTING
UNPLEASANT	:	:	:	:	:	:	:	PLEASANT
NICE	:	:	:	:	:	:	:	AWFUL

13. MY TRYING TO APPLY THE SCIENCE WE LEARN OUTSIDE OF CLASS IS

INTERESTING	extremely	quite	slightly	undecided	slightly	quite	extremely	BORING
PLEASANT	extremely	quite	slightly	undecided	slightly	quite	extremely	UNPLEASANT
AWFUL	extremely	quite	slightly	undecided	slightly	quite	extremely	NICE

14. MY TAKING UP OF MOST OF THE SCIENCE TOPICS IS

BORING	extremely	quite	slightly	undecided	slightly	quite	extremely	INTERESTING
PLEASANT	extremely	quite	slightly	undecided	slightly	quite	extremely	UNPLEASANT
AWFUL	extremely	quite	slightly	undecided	slightly	quite	extremely	NICE

15. MY TRYING TO DO SCIENCE EXPERIMENTS OUTSIDE OF CLASS IS

INTERESTING	extremely	quite	slightly	undecided	slightly	quite	extremely	BORING
UNPLEASANT	extremely	quite	slightly	undecided	slightly	quite	extremely	PLEASANT
AWFUL	extremely	quite	slightly	undecided	slightly	quite	extremely	NICE

16. From the following list of grade 10 subjects, could you please rate the classes from most to least liked. The most liked subject is written by you into space #1, the second most liked into space #2 . . . and the least liked goes into space #5.

Grade 10 Subjects	Your Rating
1. English	1. _____ most liked
2. Math	2. _____
3. Science	3. _____
4. Social Studies	4. _____
5. Physical Ed.	5. _____ least liked

THANK YOU FOR YOUR ASSISTANCE AND COOPERATION!

SCORING THE ATTITUDE TOWARD THE SUBJECT SCIENCE SCALE (ATSSS)

The ATSSS was designed to measure student attitudes toward speoific behaviors or activities which were typical in the learning of scienoe at the junior high school level. An individuals attitude toward each of the activities can be determined by summing the student responses for each of the 3 scales for each activity. For example, for the first activity, doing the science labs, there are 3 scales which ask for the student's attitude toward performing that activity (BORING-INTERESTING, PLEASANT-UNPLEASANT, and NICE-AWFUL). Each of these scales is given a soore from 1-7. An X placed in the extremely space , next to INTERESTING ,PLEASANT, and NICE would be scored as 7. Conversely, an X placed in the extremely space next to BORING ,UNPLEASANT , and AWFUL would be scored as 1. An X in the spaoes between these extremes is scored acoording to the number of spaces they are away from the ends. An X in the UNDECIDED space is scored as a 4. Missing data is also scored as a 4. The students attitude toward performing any of the 15 activities in the ATSSS is determined by summing the 3 scale scores together. Scores can range from 3-21. Roughly the meaning of these scores can be translated as follows:

3.0 to 5.6 (extremely negative) ; 5.6 to 8.2 (quite negative) ;
8.2 to 10.7(slightly negative) ; 10.7 to 13.3 (undecided or a mixed review)
13.3 to 15.8 (slightly positive) ;15.8 to 18.4 (quite positive) ;
and 18.6 to 21.0 (extremely positive).

What may be more useful is to rank order the mean scores for each of the activities from highest class mean to lowest class mean. This ranking will give the relative favorableness for each of the activities. The higher the mean score, the more favorable are the student attitudes toward the activity .

It is also possible to get an overall individual or class attitude toward the subject science by totalling the scores for all of the activities together. Scores can range form 45-315 Roughly , the total scores would mean the following:

45-85 (extremely negative) ; 85-125 (quite negative) ;
125-165 (slightly negative) ; 165-205 (undecided or mixed reaction)
205-245 (slightly positive) ; 245-285 (quite positive) ; and
285-315 (quite positive).

The ATSSS can be used to assess class attitudes toward activities related to the learning of science; individual student attitudes toward the subject science; or to measure changes of student attitude toward specific activities during the course of the school year. Moreover, on question 16. students are asked to compare their science class to others they take. This comparison gives teachers some general feedback as to how students view the class.

In general, use of the ATSSS can give some information to the classroom science teacher on both what their student attitudes toward the subjeot are and an indication of what factors in their class are important in terms of why the class is viewed negatively or positively. This information may help the teacher alter slightly some of their methods in order to promote even more positive attitudes toward the subject science.