Factors associated with students' intentions to engage in science learning activities: an application of the theory of reasoned action.

Malcolm B. Butler

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FACTORS ASSOCIATED WITH STUDENTS' INTENTIONS TO ENGAGE IN SCIENCE LEARNING ACTIVITIES: AN APPLICATION OF THE THEORY OF REASONED ACTION

By

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August 1995

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The determinants of fourth, fifth, sixth, seventh, and eighth graders' intentions to perform science learning activities were investigated. The theoretical basis for this study was the theory of reasoned action. The sample consisted of 254 students, who were assessed on their laboratory and nonlaboratory behavioral intentions and attitude toward science. The ability of the theory of reasoned action to predict students' behavioral intentions was tested by using the two determinants included in the theory and five external variables identified by the researcher. The five external variables were gender, grade, race/ethnicity, socioeconomic status as determined by the range of the family's annual income, and attitude toward science. The two determinants were attitude toward the
behavior of performing laboratory or nonlaboratory activities and subjective norm. Two models were tested. The first model included the two determinants as predictor variables and behavioral intention as the criterion. The second model involved the analysis of the two determinants as they were considered in subgroups according to the five external variables. This model also included interaction terms. Multiple regression statistical techniques were used to test the two models. Pearson product-moment correlations were reported for both models. For laboratory learning activities, the two determinants, attitude toward behavior and subjective norm, were found to collectively contribute to the prediction of behavioral intention, accounting for almost a fourth of the variance in behavioral intention. For nonlaboratory learning activities, the two determinants accounted for over a fourth of the variance in behavioral intention. Testing of the second model revealed that for laboratory activities, no interaction terms were significant, but attitude toward science was a significant predictor of behavioral intention. Post-hoc tests were conducted on this external variable to analyze the variance accounted for by each category within the external variable, and to calculate the correlation and regression coefficients of the two determinants. In the case of nonlaboratory learning activities, the two determinants accounted for over a fourth of the variance in behavioral intention.
activities, no interaction terms were significant, but grade was a significant predictor of behavioral intention. Again, post-hoc tests were conducted on the external variable (grade), to analyze variance accounted for and to calculate the correlation and regression coefficients of the two determinants according to the categories within the external variable.
CHAPTER I
INTRODUCTION

No knowledgeable person would argue against the assertion that science education has a long and important history. However, as a field of scholarly endeavor, science education is relatively young. In fact, the bulk of early research studies in the field were conducted by educational psychologists. During the first half of this century, these educational psychologists assumed their findings were to be used for the improvement of teaching and learning, without regard for specific subject matter or disciplines (Shymansky & Kyle, 1992). As a result, most of the educational psychologists' writings were limited to textbooks and instructional materials.

Currently, more than 500 published articles and papers are written annually that deal with science education research (Shymansky & Kyle, 1992). These manuscripts contain a considerable amount of information regarding affective variables, especially the concept of attitudes (Koballa, 1988a). For example, Schibeci (1984) and Blosser (1984) each reported on more than 200 studies conducted between 1976 and 1983 that examined affective variables.
The recent attention given to affective variables in science education seems to have come about as a result of the commonly held belief that these variables play as important a role as cognitive variables in determining students' learning outcomes, career choices, use of leisure time, and selection of high school elective science courses (Koballa, 1988a; Laforgia, 1988).

The "theory of reasoned action," initially developed by Ajzen and Fishbein to further attitude-behavior research in social psychology (1975), has only recently been applied to the attitude-behavior relationship in science education (Crawley & Coe, 1990; Koballa, 1988b; Krynowsky, 1988; Myeong & Crawley, 1993; Ray, 1990, 1991; Stead, 1985). This theory has been used to successfully explain and predict the behavior of participants in studies involving weight loss (Sejwacz, Ajzen, & Fishbein, 1980), women's occupational orientations (Sperber, Fishbein, & Ajzen, 1980), family planning (Fishbein, Jaccard, Davidson, Ajzen, & Loken, 1980), jogging (Riddle, 1980), consumer behavior (Fishbein & Ajzen, 1980), voting (Fishbein, Ajzen, & Hinkle, 1980), behavior of alcoholics (Fishbein, Ajzen, & McArdle, 1980), blood donating (Pomazal & Jaccard, 1976), and marijuana use (Bearden & Woodside, 1978).

The wide variety of studies that have successfully applied the theory of reasoned action have resulted in differences in the contributions of the identified variables
in the attitude-behavior relationship. In Figure 1, the theory of reasoned action model indicates the role beliefs, attitudes, and social norms play in predicting behavioral intentions.
Factors Determining a Person's Behavior

Note: Arrows indicate the direction of influence.

Source: Ajzen and Fishbein (1980)
Statement of the Research Problem

There has been an increased emphasis on the study of affective variables in science education research. However, the problem of accurately and consistently defining the appropriate affective concepts used in the research remains an issue (Haladyna & Shaughnessy, 1982). Haladyna and Shaughnessy (1982) also cited the lack of appropriate and effective assessment instruments as a problem area for attitude research in science education. Even with effective instruments available, the accuracy of these instruments in assessing the attitudes of different subgroups within a targeted population (e.g., age, grade level, race/ethnicity) becomes an issue (Ray, 1991).

Both the conceptualization and instrumentation problems can be linked to the absence of a mature theory that encompasses the nature of attitudes as they relate to other constructs (White & Tisher, 1986). The theory of reasoned action, first proposed by Icek Ajzen and Martin Fishbein in 1975, has been used by several science education researchers recently in an effort to fill the theoretical void associated with attitude research in science education (Crawley & Coe, 1990; Koballa, 1988b; Krynowsky, 1988; Ray, 1990, 1991; Stead, 1985). The theory of reasoned action provides a model for the relationship between beliefs, attitudes, behavioral intentions and behavior. An assumption of the theory is that attitudes and behavior are
related. However, most science educators have neglected the attitude-behavior relationship in their research (Koballa, 1988b).

According to Ajzen and Fishbein (1980), variables external to the model of the theory of reasoned action should be included if there are research-based reasons to believe that these variables might influence the two determinants (i.e., attitude toward behavior and subjective norm). Attitude toward behavior is how a person feels about performing a particular activity. Subjective norm is characterized by the pertinent societal influences on the specified behavior. Ray (1991) supported the inclusion of pertinent external variables in science education research involving the theory of reasoned action. When these external variables are included in the theoretical model, their interactions with the two determinants, attitude toward behavior and subjective norm, must be considered (Agresti & Finlay, 1986).

Several science educators have focused on the addition of appropriate external variables to the theory of reasoned action. By including variables commonly used in science education research and testing the significance of these variables, science educators are becoming more knowledgeable of the relationship between attitude and behavior (Crawley & Coe, 1990; Koballa, 1988b; Stead, 1985).
In one of the first studies to use the theory of reasoned action for research in science education, gender and ethnicity were used as external variables (Stead, 1985), Stead studied high school students' intentions to study science in subsequent school years. The researcher found that gender differences were significant, with males indicating a more positive attitude toward science and expressing a stronger intention to continue their science studies in high school than females.

Koballa (1988b) included academic ability, science grades, and attitude toward science in his study of junior high school females' intentions to enroll in high school physical science courses. None of these exogenous variables predicted behavioral intention, nor did any of them correlate with the two determinants, attitude toward behavior and subjective norm.

In their study of middle school students' intention to enroll in high school science courses, Crawley and Coe (1990) considered the following exogenous variables: gender, ethnicity, general ability, and science ability. The researchers' findings indicated that the relative contributions of the two determinants in predicting behavioral intention varied among the students grouped according to gender, ethnicity, general ability, and science ability.
The previously-mentioned studies assume that the problem with defining affective variables has been solved. This is not necessarily the case (Koballa, 1988a). One attempt at conceptualizing affective variables has been to narrow the focus of the concepts involved. Koballa (1988a) described this conceptualization shift by discussing the commonly held three-component view of attitude (cognitive, affective and conative) and how this view has been reduced to the now popular, yet widely debated, perception that the affective component is the only characteristic of the concept of attitude.

A basis for the study of attitudes toward science has been the widely accepted assumption that there is some level of positive correlation between attitude and achievement (Rennie & Punch, 1991). However, the substantial body of literature on the attitude-achievement relationship has not adequately addressed the magnitude and direction of this particular relationship.

Shrigley, Koballa and Simpson (1988) surmised that the concept of attitude is essential in the research of student behavior in the science classroom. Since attitudes are learned (Fishbein & Ajzen, 1975), it stands to reason that if students' attitudes can be changed, then their behavior and achievement can also be positively or negatively affected. However, an adequate understanding of the
students' attitudes must be in place before behavior and achievement can be altered.

**Significance of the Study**

Research on attitudes, beliefs, social influences, behavioral intentions, and behavior in science education is extremely important because of the ramifications of results from such studies. The findings from these studies can be instrumental in understanding and predicting children's intentions to engage in science learning behaviors (Ray, 1991). Such understanding and predictive ability "might one day assist in planning ways to effectively alter young students' science learning behaviors" (Ray, 1991, p. 160).

This study furthers the use of attitude research in science education by using a theoretical approach to identify the factors associated with predicting students' intentions to perform laboratory and nonlaboratory science activities. In addition to utilizing the theory of reasoned action, this study also includes external variables that have been long associated with science education research and have shown promise in explaining group differences. The significance of these external variables is considered by testing their interactions with the two determinants, attitude toward behavior and subjective norm. Additionally, this study substantiates the use of a particular instrument
to assess attitudes toward science in terms of reliability and validity.

In essence, this study lends further justification to the importance of attitudes in science education research. This justification is achieved by adding credence to the use of the theory of reasoned action as a sound theoretical foundation for attitude research in science education. Also, an assessment instrument for evaluating students' attitudes toward science was analyzed for its' validity and reliability and was included in the two models tested as one of the external variables.

**Purpose of the Study**

The purpose of this study was to investigate the determinants of elementary and middle school students' intentions to perform science learning activities, using Ajzen and Fishbein's (1980) theory of reasoned action. The data were analyzed for all students (aggregate analysis) and for five subgroups, including gender, race/ethnicity, grade level, socioeconomic status, and attitude toward science.

The link between gender and students' attitudes has been studied by numerous science education researchers (Crawley & Coe, 1990; Koballa, 1988b; Neale, Gill, & Tismer, 1970; Simpson & Oliver, 1985; Stead, 1985; Yong, 1992). Yong (1992) also considered the significance of ethnicity on attitudes toward science by studying African
American middle school gifted students. The significance of ethnicity/race in educational research has been questioned, with the suggestion proffered that in some cases, socioeconomic status may be a better variable than ethnicity/race when studying group differences (Webb & Sherman, 1989).

While there are a reasonable number of instruments to measure attitudes toward science for junior high school students and above, there are only a few well-validated instruments that measure the attitudes of students below grade seven (Haladyna & Shaughnessy, 1982). Hence, the inclusion of grade level as a variable when studying students' attitudes has been suggested extensively (Haladyna & Shaughnessy, 1982; Ray, 1991; Yong, 1992).

Koballa (1988b) hypothesized that attitudes toward science would influence female junior high school students' intentions to enroll in high school science courses. Data analysis revealed this variable not to be significant in Koballa's study. However, the researcher did conclude that "this study raises many questions regarding the current nature of attitude research in science education and variables that may serve to improve the predictions of behaviors of interest to science educators" (p. 491).
**Research Questions**

This study was conducted to answer four research questions. First, do attitude toward behavior and subjective norm significantly predict behavioral intentions? Second, what are the relative weights of the immediate determinants (i.e., attitude toward the behavior and subjective norm) of students' intentions to engage in science learning behaviors? Third, does the prediction of behavioral intentions from attitude toward behavior and subjective norm differ when an external variable (gender, grade, race/ethnicity, SES, or attitude toward science) is added to the regression equation? Fourth, what are the relative weights of the predictors when an external variable is added to the regression equation?

Two models based on the theory of reasoned action guided the testing of the four research questions. The applicability of the theory of reasoned action to the understanding of student's intentions to engage in laboratory and nonlaboratory science behaviors was evaluated using the two models.

The first model tested research questions one and two. Students' intentions (BI) to engage in laboratory or nonlaboratory science behaviors were determined by a linear combination of attitude toward the behavior (AB) and subjective norm (SN). The following equation summarizes this hypothesized relationship:
where the w's are constants and represent the relative contribution of each variable to the prediction of intention.

The second model tested research questions three and four. Students' intentions (BI) to engage in laboratory or nonlaboratory science behavior were determined by a linear combination of attitude toward the behavior (AB), subjective norm (SN), each of the external variables (EV), and the two interactions (EV X AB and EV X SN). The following equation summarizes this hypothesized relationship:

\[ BI = w_1 AB + w_2 SN + w_3 EV + w_4 (EV \times AB) + w_5 (EV \times SN) \]

where the w's are constants and represent the relative contribution of each variable to the prediction of intention.

**Delimitations of the Study**

The delimitations of the study were as follows:

1. The participants in the study were fourth, fifth, sixth, seventh, and eighth graders at a university laboratory school in northeast Florida.

2. Two instruments were used. The Revised Science Attitude Scale for Middle School Students (Misiti, Shrigley & Hanson, 1991) was used to assess students' attitudes toward science, and the Instrument for Assessing the Behavioral Intentions of Science Students (Ray, 1991) was
used to assess students' intentions to engage in laboratory or nonlaboratory behavior. Both instruments were validated by their developers.

**Limitations of the Study**

The limitations of the proposed study were as follows:

1. The study did not include all fourth, fifth, sixth, seventh, and eighth graders in the United States.

2. The findings of the study depended on the ability of the instruments to accurately assess the beliefs, attitudes, and behavioral intentions of the students.

3. There was no follow-up assessment to document the students' actual behavior; only their behavioral intentions were assessed.

4. The students provided self-reported data on their behavioral beliefs and evaluations of behavioral outcomes, attitude, subjective norm, normative beliefs of important others, motivation to comply with the important others, and attitude toward science. The self-reported data could have been affected by normative response bias.

**Assumptions**

The following assumptions apply to the study:

1. The students who participated in the study adequately represent the population of fourth, fifth, sixth, seventh, and eighth graders in the United States.
2. The questionnaires and instruments used were adequate for data collection.

3. The students who participated in the study completed the questionnaires and instruments truthfully and to the best of their ability.

4. The students' motivation and candor were adequate for the purpose of the proposed study.

Definitions of Terms

The key terms of the study are operationally defined with regard to the theory of reasoned action.

The theory of reasoned action is a social psychological model which predicts a person's behavioral intentions from his or her beliefs, evaluations, normative beliefs, and motivations to comply (Ajzen & Fishbein, 1980).

Attitude is a bipolar evaluative judgement indicating the amount of affect for or against an object or behavior. That is, an attitude is a positive or negative feeling about a particular object or behavior.

Attitude toward the behavior "represents a person's general feeling of favorableness or unfavorableness toward some behavior" (Crawley & Coe, 1990, p. 464). Behavioral beliefs and evaluation of the outcomes of these beliefs influence the formation of attitudes (Ajzen & Fishbein, 1980). For example, a student could be asked to indicate what he or she believes to be an important behavior in
science. Then the student would be asked to indicate whether the specified behavior is good or bad. The combination of the belief and the student’s evaluation of its goodness or badness would indicate the student’s attitude toward the behavior. Operationally, attitude toward the behavior was measured by the multiplication of the students’ responses to a set of behavioral beliefs and evaluation of the outcome of these beliefs for both laboratory and nonlaboratory behavior. The specific behavioral beliefs and evaluation of the outcomes came from Ray’s (1991) instrument.

**Beliefs of behavioral outcomes** are the possible linkages between a decision for or against a particular behavior or object and the consequences. These beliefs were measured through the use of bipolar scales with the adjective endpoints "likely" and "unlikely".

**Evaluations of behavioral outcomes** are an individual’s judgement of the value of the consequences of performing a particular activity. These behavioral outcomes were measured through the use of bipolar scales with the adjective endpoints "good" and "bad".

**Subjective norm** "represents the perception one holds about the social pressures to engage or not engage in a behavior" (Crawley & Coe, 1990, p. 464). Normative beliefs and motivation to comply with particular referents shape the subjective norm (Ajzen & Fishbein, 1980).
Operationally, subjective norms were measured by the multiplication of the students’ responses to a set of normative beliefs and their motivation to comply to a set of referents for laboratory and nonlaboratory behavior. The specific normative beliefs and list of referents came from Ray’s (1991) instrument.

**Normative beliefs of important others** are an individual’s beliefs about what important others (referents) feel the individual should or should not do. These beliefs were measured on bipolar "I should--I should not" scales in which the students indicated the likelihood that each referent thinks the student should or should not perform the behavior.

**Motivations to comply with the referents** is an individual’s incentive to conform to what relevant others feel the individual should do. These motivations to comply were measured by having students rate their motivations with each referent on bipolar scales with "Yes--No" endpoints according to the stem statement "I want to do".

**Behavioral intention** can best be defined by first defining behavior. Behavior is defined as "an overt action under the volitional control and within the individual’s capability" (Crawley & Coe, 1990, p. 463). Hence, behavioral intention can be defined as an individual’s plan to act in a particular fashion. From the theory of reasoned action, behavioral intention is the weighted addition of
attitudes toward behavior and subjective norms. Since behavioral intention is a plan to act or perform a particular behavior, it can be said that behavioral intention and behavior are closely related (Ajzen & Fishbein, 1980).

Laboratory behavior and nonlaboratory behavior were considered from the perspective of students' intentions to perform them. Laboratory behavior was described as the performance of science projects and experiments directly related to school. Nonlaboratory behavior was considered as the reading and/or writing of science materials directly related to school. The instrument used to assess students' intentions to perform laboratory and nonlaboratory behaviors is based on the aforementioned definitions for laboratory and nonlaboratory behavior.

External Variables

Four external variables--gender, grade, race/ethnicity, and socioeconomic status--were gathered from demographic data reported to the school by students' parents/guardians. This information was taken from the students' school files. Socioeconomic status was considered from the perspective of the family's reported range of annual income.

The fifth external variable, attitude toward science, can be conceptualized as a person's learned favorable or unfavorable predisposition to objects, people, actions or situations involved in learning science. Operationally,
attitude toward science was determined by student scores on the Revised Attitude Scale for Children (Misiti, Shrigley, & Hanson, 1991). Students were classified as having either positive or negative attitudes toward science based on their score on the Attitude Scale.

Methodology

The setting for the proposed study was a small university laboratory school (enrollment of approximately 900 students) in northeast Florida. The school is unique in that it houses grades kindergarten through 12. Data were collected on all students in grades four, five, six, seven, and eight. Demographic information was collected from students' school files. Ray's (1991) instrument and Misiti, Shrigley and Hanson's (1991) instrument were administered to all students involved to collect data on students' intentions, attitudes and subjective norms regarding laboratory and nonlaboratory behaviors and attitude toward science.

The collected data were analyzed in two steps: testing with behavioral intention as the dependent variable and attitude toward behavior and subjective norm as the predictor variables first and then the model that included the two determinants, the external variables, and the interaction terms. The first model tested the ability of the two determinants, attitude toward the behavior, and
subjective norm, in predicting the behavioral intentions of the students to perform laboratory and nonlaboratory activities. The second model provided for the testing of the data across subgroups according to the five external variables. This model also included two interaction terms involving the external variable and attitude toward behavior and the external variable and subjective norm.

As recommended by Ajzen and Fishbein (1980), multiple regression techniques were used to test the significance of the two models. The multiple regression technique included the reporting of correlations and regression coefficients for both models.

Further details of the methodology of the study are provided in chapter three.

Summary of the Chapters

The second chapter provides a review of the pertinent literature. Included in the literature review are discussions of the evolution of attitude, attitudes toward science and related concepts, attitudes toward science and achievement in science, attitudes toward science and behavior in science, instruments and methodologies used to assess attitudes toward science and subjective norms, and a detailed explanation of Ajzen and Fishbein’s (1980) theory of reasoned action. The third chapter includes information regarding the setting, population, instrumentation, data
collection, and data analysis of the proposed study. The fourth chapter includes the outcomes of the data analyses and a discussion of these results. The fifth and final chapter contains a summary of the study and a detailed conclusion. This conclusion includes a discussion of the study's implications and recommendations for future research on the attitude-behavior relationship in science education.
CHAPTER II
REVIEW OF THE LITERATURE

This literature review is organized into eight sections. The first section provides an overview of the evolution of the definition of the concept of attitude, with emphasis on the term as it relates to science education. The second section contains an overview of the concept of attitudes toward science. Related terms are also discussed, including scientific attitudes, beliefs, opinions, and values. The comparison and contrast of these terms with the target concept, attitudes toward science, serve as the basis for analyzing and clarifying the target concept.

The third section contains an overview of research studies which involved the study of attitudes toward science and achievement in science. The review focuses on those studies which included the external variables of this study, namely, gender, grade, race/ethnicity, and socioeconomic status.

The fourth section includes a review of studies that focused on attitudes toward science and science behavior. The review focuses on those studies which included the external variables of this study, namely, gender, grade, race/ethnicity, and socioeconomic status.
The fifth section contains an in-depth discussion of Icek Ajzen and Martin Fishbein's (1980) theory of reasoned action, with an overview of its use in science education research. The sixth section contains an overview of methodologies used to assess attitudes. These methods include records, sociometric procedures, reports of others, and self-reports. The seventh section of this literature review includes an overview of the instruments used to assess attitudes toward science and subjective norms (i.e., social influences) in science as they relate to the theory of reasoned action. A summary of the literature reviewed concludes this chapter.

The Evolution of Attitude

One of the most difficult tasks faced by social psychologists has been defining the term, "attitude" (Laforgia, 1988). Hence, educators doing research in the area of attitudes have had to contribute to the task for their own needs. In science education, the task has been no less daunting (Koballa, 1988a).

Attitude as a modern concept originated in the early part of the 20th century. Previously, attitude had been considered more a physical concept than a psychological one (Shrigley, Koballa, & Simpson, 1988). Koballa (1988a) succinctly brings the concept to its present status with his assessment that:
... one common view of attitude in the past was that it had three components: a cognitive component, consisting of the person's belief's about an object; an affective component, consisting of a person's feeling about the object; and a conative component, consisting of a person's intentions to act in a particular way toward the object. This view is now less widely accepted by attitude theorists, at least in part because it clouds some important distinctions between the concepts. As currently conceived and operationalized, the affective component of the trilogy is the sole attribute of the attitude concept. (p. 121)

As the development of the concept of attitude has evolved, so has the ability to measure it. Many theories have been proposed to serve as the basis for the development of instruments designed to measure attitudes (Eiser, 1986). Several of these theories have been applied to science education research (Mayer & Richmond, 1982). Two of those theories will be discussed.

Carl Hovland's learning theory model (Hovland, Janis, & Kelley, 1953) has been utilized by numerous science educators because of its compatibility with classroom instruction (Demers, 1990; Grabowski, 1980; Hassan & Shrigley, 1984; Koballa, 1984a; Koballa, 1984b). Hovland's model focuses on the process by which attitudes are changed or modified. Central to this model is the recipient's acceptance of a message that invokes the desired attitude change.

For all its successes in social psychology and science education research, Hovland's model was limited by its inability to indicate that attitude was indeed an antecedent to behavior and the weakening of the treatments' effects
over time (Shrigley & Koballa, 1992). The major contribution of science educators who utilized the learning theory model was the confirmation of the effectiveness of a social psychology theoretical model in the milieu of science education (Shrigley & Koballa, 1992).

Another major theory developed to explain the attitude-behavior relationship was the theory of planned behavior. First proposed by Icek Ajzen in 1985, this theory is an extension of the theory of reasoned action. In the theory of planned behavior, an additional antecedent is added to the two determinants used to predict behavioral intention in the theory of reasoned action model. This additional variable is called "perceived behavioral control", which is defined as "the person's belief as to how easy or difficult performance of the behavior is likely to be" (Ajzen & Madden, 1986, p. 457). If perceived behavioral control is irrelevant or inappropriate, then the theory of planned behavior conceptually and empirically reduces to the theory of reasoned action. The theory of planned behavior has been used to successfully predict college students' attendance of class lectures and earning an "A" in a course (Ajzen & Madden, 1986) and science teachers' intentions to use investigative teaching methods (Crawley, 1990).

Although many researchers focused on attitude changes, the work of Ajzen and Fishbein (1980) served as the catalyst for the momentum gained in persuasion research in the 1980s
(Crawley & Koballa, 1994). The theories of reasoned action and planned behavior provided cogent guidance for constructing persuasive messages according to three conditions. First, changes in attitude, subjective norm, and perceived behavioral control will come about only when a sufficient number of the behavioral, normative, and control beliefs or their evaluations are changed. Second, changes in beliefs and evaluations will affect behavioral intention only to the extent that attitude, subjective norm, and perceived behavioral control carry a significant weight in the prediction of intention. Third, the degree to which an intention change will cause a behavioral change is determined by the correspondence between intention and behavior.

However, before science education research can be effectively performed on attitudes, the definition of attitude must be established. Once attitude is appropriately defined, the findings of research on attitudes may be used to better understand and predict the science-related behaviors of students (Koballa, 1988a; Shrigley et al., 1988). Fishbein and Ajzen (1975) contend that "most investigators would probably agree that attitude can be described as a learned predisposition to respond in a consistently favorable or unfavorable manner toward an attitude object" (p. 6). They go on to say, that by allowing for multiple interpretations, this definition
serves to obscure the existing disagreements among researchers.

Attitudes toward Science and Related Concepts

Although numerous attempts have been made, the field of science education does not have a widely accepted set of objectives for what should be taught and learned by students in our elementary and secondary schools (Champagne & Newell, 1992; Linn, 1992; Shymansky & Kyle, 1992; Yager, 1992). The science goals as proposed by Project 2061 (American Association for the Advancement of Science [AAAS], 1990) give some indication of the affective domain by including the term in some of its standards. Also, the National Research Council (1992) is in the process of formulating a set of science standards that will include specific information on the affective domain.

There does seem to be some consensus as to the division of educational objectives into three components—cognitive, affective, and psychomotor (Schibeci, 1983). Of the three, the affective domain has received the least attention in science education research (Koballa, 1988a). The discrepancy in the attention afforded to each component of the educational objectives can also be observed in the science standards proposed by the authors of Project 2061 (AAAS, 1990), with the majority of the attention focused on cognitive and psychomotor skills.
One of the reasons offered for this lack of attention to the affective domain is that attitude studies in science education have been handicapped by "the absence of a mature theory encompassing the nature of attitudes and their relation to other constructs" (White & Tisher, 1985, p. 892).

The concept "attitudes toward science" has been defined numerous ways by a variety of people. Peterson and Carlson (1979) reported that as of 1977, there were over 30 different definitions of the concept. Hence, part of the solution to the problem of studying attitudes toward science is to adequately define the concept and distinguish it from related terms. A discussion of some of those related concepts follows.

Scientific Attitudes

Scientific attitudes have often been studied by researchers without regard to defining the concept. For this study, scientific attitudes were not considered. However, a definition of the term is presented below to distinguish it from the concept, attitudes toward science.

There is a large body of literature related to scientific attitudes. Since scientific attitudes were not a major focus of this research, the reader is referred to Gauld and Hukins (1982) for a detailed discussion. Koballa (1988a) defined scientific attitudes as "those behaviors associated with critical thinking and typically meant to be
characteristic of the thinking processes of scientists" (p.115). Schibeci (1983) saw scientific attitudes as "the attributes of scientists in the professional work [sic], and hence desirable as objectives for school science curricula" (p. 598). Of all the definitions of scientific attitudes, the prevailing definition emphasizes that scientific attitudes have a predominately cognitive orientation. The cognitive orientation of scientific attitudes differs from attitudes toward science in that the concept "attitudes toward science" has an affective orientation. For instance, Koballa (1988a) considers scientific attitudes as being associated with critical thinking and the thinking process of scientists. Characteristics of scientific attitudes cited in the literature include suspended judgement (Koballa, 1988a), curiosity, rationality, open-mindedness, objectivity, and intellectual honesty (Laforgia, 1988).

As Shrigley et al. (1988) explain:

Scientific attitudes are seldom evaluative; they do not express a personal like or dislike toward science or the scientific enterprise. Scientific attitudes have attributes believed to be true or false. They approach the level of fact, which places them near the cognitive pole . . . (p. 669)

Beliefs

Fishbein and Ajzen (1975) explained the distinction between attitude and belief in the following manner: "Whereas attitude refers to a person’s favorable or unfavorable evaluation of the object, beliefs represent the information he has about the object. Specifically, a belief
links an object to some attribute" (p. 12). Thus beliefs can be factual or nonfactual cognitions. They can also have different levels of strength. It is along this line of reasoning that Fishbein and Ajzen (1975) contend that beliefs form the basis of attitudes, with the attitude being negative or positive depending on the strength of the set of beliefs.

**Opinion**

Opinion is another concept that has been closely associated with attitude in research. The definition of opinion was at the center of confusion at one time (Koballa, 1988a). Its definition has been placed in the cognitive domain (Berkowitz, 1980) between attitudes and beliefs, with opinion being more affective than beliefs and more cognitive than attitude (Fleming, 1967). One commonality between the various definitions for the concept of opinion has been that an opinion is seen as a verbal expression of an attitude or attitudes (Koballa, 1988a). Rather than offer a definition of opinion, the following statement from Koballa (1988a) identifies the term’s significance in affective research in science education: "With rather distinct definitions for attitude and belief, no advantage seems to be gained by considering opinion as a research variable in science education" (p. 119). This recommendation is supported by Shrigley et al. (1988), who suggest that the term opinion be
used in casual conversation but not used when conducting science education research.

Values

Values are more general than attitudes in that they lack a specific object and are content-free (Rokeach, 1970; McGee, 1980). Rokeach (1976) further claims that while a person may have thousands of attitudes, he or she has only a few dozen values. Our values are generated from our environment, be it our culture, subculture and social class (Koballa, 1988a), or our experiences (Rokeach, 1969).

Besides a difference in quantity, another distinction between attitudes and values is that attitudes are bidirectional and values are unidirectional. Attitudes can be either positive or negative, with degrees of strength in either direction. However, values tend to be positive in nature.

Though both attitudes and values are evaluative, values are much more persistent and complex. Hence, values are more difficult to change than attitudes. However, values are important to science educators "because of the crucial role they play in mediating a multitude of attitudes" (Koballa, 1988a, p. 120). For example, if a teacher values the science discipline as an important component of a child’s education, then it may be possible for that teacher to develop a positive attitude toward hands-on instruction,
inquiry learning, the use of computers in the laboratory, and other science-related learning activities.

**Attitudes toward Science and Achievement in Science**

A common assertion is that attitudes and achievement are inextricably linked (Schibeci, 1988). Any researcher who studies achievement should in some way consider students' attitudes. Most of the science education research does not make note of the attitude-achievement relationship explicitly. In fact, most researchers do not provide an explanation for the low statistical correlations between the two concepts (Schibeci, 1984; Steinkamp & Maehr, 1983; Wilson, 1981).

Extensive research has been conducted on the role gender plays in the attitude-achievement relationship. Although researchers' initial focus was on the possibility of gender differences, most found that grade level also played an important role. In their meta-analysis of forty studies conducted in Israel, Friedler and Tamir (1990) found no gender differences in attitudes toward science for elementary school students. However, the researchers found significant gender differences by the end of junior high school, with males indicating a much more positive attitude toward science than females. Friedler and Tamir (1990) found the attitude differences to be subject specific in the high school sample of students.
Simpson and Oliver (1985) found that attitudes toward science and motivation to achieve decreased for both male and female students in grades six to ten. However, males were found to exhibit significantly more positive attitudes toward science than females for each grade level. Female students were more highly motivated to achieve than male students for each grade level. A research summary by Steinkamp and Maehr (1984) supports these findings.

Although females may indicate a higher motivation to achieve (Simpson & Oliver, 1985), studies have found that males have more positive attitudes and achievement scores in science, especially in the middle grades (Steinkamp & Maehr, 1983). Factors often cited for these discrepancies include differential expectations from significant others (Fox & Tobin, 1988), absence of role models and mentors (Fox & Tobin, 1988; Valverde, 1984), fear of success (Horner, 1972), and cultural and gender role stereotyping (Cramer, 1989; Eccles, 1985; Jegede & Okebukola, 1992; Noble, 1989; Reis & Callahan, 1989; Sadker & Sadker, 1986; Wells, 1985).

**Attitudes toward Science and Behavior in Science**

The relationship between attitudes and behavior in science has been studied in terms of high school course selection (Crawley & Coe, 1990; Koballa, 1988b; Stead, 1985), specific features of laboratory experiences (Doran & Sellers, 1978), science learning activities (Ray, 1991,
1990), choice of a college major (Mason & Kahle, 1989; Tamir & Gardner, 1989), and pursuit of a career (Mason & Kahle, 1989; Tamir & Gardner, 1989). There is both correlational (Haladyna, Olsen, & Shaughnessy, 1983) and experimental (Mason & Kahle, 1989; Tamir, Welch, & Rakow, 1985) evidence to suggest that teacher characteristics play a role in the development of attitudes toward science.

The majority of the research on attitudes and behavior in science is related to gender issues. Since gender has not been found to completely account for the attitude-behavior relationship, other variables should be studied to see if they also play an important role.

The "Theory of Reasoned Action"

Numerous science education researchers have criticized the research done on attitudes toward science (Koballa, 1988a; Munby, 1980; Russell, 1981; Schibeci, 1984). Hence, the opportunities to effectively assess this construct have been limited. The necessity for a theoretical foundation on which to build the attitude research and concomitantly, develop assessment instruments, has been proposed by both early and current science education researchers (Koballa, 1988a; Messick, 1975; Munby, 1983; Shrigley, 1983).

One theoretical model that has been used in several recent studies regarding attitudes toward science is the theory of reasoned action. Icek Ajzen and Martin Fishbein
(1980) developed this theory to better explain the relationship between attitude and behavior. Early research using the theory of reasoned action focused on issues commonly associated with social psychology, namely weight loss (Sejwacz, Ajzen, & Fishbein, 1980), women's occupational orientations (Sperber, Fishbein, & Ajzen, 1980), family planning behaviors (Fishbein, Jaccard, Davidson, Ajzen, & Loken, 1980), consumer behavior (Fishbein & Ajzen, 1980), voting behavior (Fishbein, Ajzen, & Hinkle, 1980), and behavior of alcoholics (Fishbein, Ajzen, & McArdle, 1980). However, in the last few years, science education researchers have begun to use the theory of reasoned action as a basis for studying attitude–behavior relationships in science (Crawley & Coe, 1990; Koballa, 1988b; Krynowsky, 1988; Ray, 1990, 1991; Stead, 1985; Yeh, 1995). Although attitude research commands a large amount of attention in science education, there has been a dearth of research in using the theory of reasoned action to explain some of the weaknesses in the research. Some of the shortcomings of this research include the lack of specification of a theoretical foundation for the development of attitude assessment instruments and weaknesses in the verification and establishment of the psychometrics (i.e., reliability and overall validity) of available instruments (Krynowsky, 1988).
Ajzen and Fishbein's (1980) theory of reasoned action affords science education researchers the opportunity to better understand and thus predict the behavior of students. The theory of reasoned action as described in Figure 1 outlines a theoretical relationship between attitude and behavior. A succinct explanation of the theory has been articulated by Eiser (1986), who wrote:

According to the theory, behaviour [sic] (to the extent that it is under 'volitional control') is determined by intention, whereas intention is determined by a weighted additive function of 'attitude towards the behaviour' (often termed the 'attitudinal component' and 'subjective norm' (often termed the 'normative component'). The definition of these two components is given by considering the cognitive elements that combine to make them up. 'Attitude towards the behaviour' is defined as the sum of evaluative (behavioural) beliefs about the consequences of performing the behaviour in question. Such beliefs are specific to oneself performing the behaviour towards a defined target at a defined time and place. Any evaluative belief contains both an expectancy element (will this consequence be made more or less likely by my performance of this behaviour?) and a value element (how good or bad would such a consequence be?). The expectancy and value elements are combined multiplicatively.

'Subjective norms' are composed of qualitatively distinct beliefs about how other people will view one's performance of the behaviour. Again, these contain both an expectancy element (will this significant other be more or less likely to approve of me if I perform this behaviour?) and a value element, referred to as the 'motivation to comply' (how much do I value this significant other's approval?). Again, these elements are presumed to combine multiplicatively. (pp. 61 & 62)

Thus, the immediate determinant of behavior is behavioral intention, which is determined by two weighted variables: attitude toward the specified behavior (attitudinal component) and subjective norm (normative component).
An interpretation of the theory leads to two widely accepted and similar definitions for the concept attitudes toward science. Gardner (1975) defined attitude toward science as:

... a learned disposition to evaluate in certain ways objects, people, actions, situations or propositions involved in learning science. (p. 2)

Similarly, Krynowsky (1988) formulated the following definition for attitude toward the subject science:

... a learned predisposition of an individual to respond, in a consistently favorable or unfavorable way, to performing behaviors related to the teaching/learning of the subject. (p. 579)

According to the theory, behaviors must meet the criteria of action, target, context (i.e., place), and time. An example would be the assessment of a student’s positive or negative evaluation of performing (action) a minilab (target) at home (context) once a week during the school year (time). The more specific the behavior, the higher the probability of predicting the behavior (Ajzen & Fishbein, 1980). Also, if we can obtain information on a person’s attitudes toward the behavior, the person’s perceptions of the subjective norm, and the person’s behavioral intention, our ability to predict that person’s behavior greatly increases.
Science education researchers have used the theory of reasoned action to study the determinants of science students' intentions to engage in science learning activities (Ray, 1990; Ray, 1991), to study science (Stead, 1985), and to enroll in high school science courses (Crawley & Coe, 1990; Koballa, 1988b). Ajzen and Fishbein (1980) claim that although external factors such as gender, age, grade level, socioeconomic status, and various personality traits may well influence behavior, they do so indirectly, and only if they are related to one or more of the variables specified by their theory. Science education researchers have conducted studies both with and without including external factors in their data collection and analysis.

Ray (1991) considered the intentions of third, fourth, fifth, sixth, seventh, and eighth graders to perform laboratory and nonlaboratory activities. The instrument used to assess the students' intentions was developed by the researcher and based on the theory of reasoned action. The data analysis followed the pattern suggested by Ajzen and Fishbein (1980). Multiple regression analysis was used, with the dependent variable, behavioral intention, and the independent variables, attitude toward the behavior and subjective norm. Pearson product-moment correlations were also used to create a correlation matrix. In this study, Ray followed the guidance of Ajzen and Fishbein (1980) by analyzing his data without identifying any moderating
variables. However, Ajzen and Fishbein (1980) do suggest that external variables be considered if they are believed to contribute to the prediction of behavioral intention beyond the two determinants included in their model.

In a related study (Ray, 1990), the researcher distinguished the type of school (external variable). Distinguishing between public, private, and home schools, the researcher was able to determine if the type of school added significantly to the prediction of behavioral intention. He found that students who are home educated have a more positive attitude toward doing science laboratory activities than students in public and private schools. Additionally, the researcher found there was a significant relationship between grade level and beliefs for both laboratory and nonlaboratory science activities, with the older students generally having lower intentions to perform science learning activities. The researcher also reported a significant relationship between the students' gender and normative beliefs for laboratory science behavioral intentions, with females believing more strongly than males that significant others (referents) want them to perform the assigned science activities.

Gender differences regarding students' intentions to study science were studied by Stead (1985). As was the case with Ray (1990, 1991), the researcher developed his own assessment instrument and used the theory of reasoned action
as the theoretical basis. Stead (1985) found boys have a more positive attitude than girls and thus, expressed a stronger intention than girls to continue to study science.

Crawley and Coe (1990) considered several external factors in analyzing the determinants of middle school students’ intentions to enroll in a high school science class. The four external variables considered by Crawley and Coe (1991) were gender, ethnicity, general academic ability, and science ability. The data were analyzed by using multiple regression analysis on three different models. The Direct-Full Effects Model included the four external variables, attitude toward the behavior, and subjective norm. The Direct-Reduced Effects Model included only attitude toward the behavior and subjective norm. The Indirect Effects Model tested the effect of the disaggregated data on attitude toward the behavior and subjective norm. Crawley and Coe (1990) found that the relative contributions of attitude and subjective norm to the prediction of behavioral intention varied among the four external variables. Crawley and Coe’s study (1990) lends further credence to the inclusion of external variables in the theory of reasoned action in future attitude studies in science education.

Koballa (1988b) studied the determinants of female students in the eighth grade to enroll in an elective high school physical science course (e.g., physics, chemistry,
physical science). Using the theory of reasoned action, Koballa (1988b) considered three external variables: academic ability, science grades, and attitude toward science. Neither of these external variables predicted behavioral intentions. However, the two independent variables, attitude toward the behavior and subjective norm, were found to predict behavioral intention with a high degree of accuracy. Koballa (1988b) surmised that the significance of external variables considered in this study may have been absorbed in the two determinants in the theory of reasoned action. If Koballa's beliefs (1988a) are accurate, then they are consistent with the beliefs of Ajzen and Fishbein (1980).

Methodologies for Assessing Attitudes

There are four commonly-used methodologies for assessing the attitudes of groups or individuals (Henerson, Morris, & Fitz-Gibbon, 1987). These are records, sociometric procedures, instruments based on the reports of others, and self-report instruments. Each methodology will be discussed in general and as it pertains to science education research.

Records

Records are systematic accounts of regular occurrences (Henerson, et al., 1987). They may consist of items such as personnel files, staff reports, inventories, counselor
files, permission slips, library cards, and attendance and enrollment reports. Any of these types of records could be beneficial if they contain information relevant to the attitude or attitudes in question. While records usually have the advantage of supplying data without placing additional demands on people’s time, they could become useless if the records are incomplete or inaccurate. The records may also be difficult to decipher if the researcher did not develop the format for data collection. Ethical and legal issues may become pertinent if the records contain sensitive information about individuals.

A form of records, meta-analysis, has been used in science education research on attitudes. Meta-analyses are the results of studying numerous sets of data that have been previously collected. Meta-analyses are performed by finding and analyzing similarities among data sets. An example of a meta-analysis in science education is the work done by Friedler and Tamir (1990). The researchers located 40 studies that included research on gender comparisons on the learning of science in Israel. Included in this study was the analysis of students’ attitudes toward science across grade levels. The results indicated no difference in attitudes for Israeli elementary students. However, by eighth grade, girls exhibited more positive attitudes toward school. This trend continued through twelfth grade.
Sociometric Procedures

Sociometric procedures are used to garner information about a group's social structure. These procedures include both peer ratings and open-ended questions about group members. Sociometric instruments are relatively easy to develop and implement. The major weakness of this type of instrument is that it allows group members to make subjective choices about their peers without providing opportunities to substantiate those choices.

Researchers in science education have made little direct use of sociometric procedures to collect data on attitudes. However, studies that have used the theories of reasoned action and planned behavior have collected data on social influences that could be construed as sociometric data collection. The major difference here is that sociometric measures usually require the respondent to comment on his or her peers, whereas studies based on the theories of reasoned action and planned behavior require a person to evaluate him or herself. These types of studies were considered during the discussion of research based on the theory of reasoned action.

Instruments Based on the Reports of Others

Data collection methods based on the reports of others provide an outside person's assessment of other people's attitudes. The data collected for the reports are usually collected through interviews, questionnaires, journals, or
observations of the reporters. These types of reports are used when people are unable or unlikely to provide accurate information about their attitudes or when the behavior of people under certain conditions is investigated.

Observations of students' behavior and interactions in science classes are the most common form of the reports of others in science education (Koballa, 1986; Koballa & Crawley, 1985). The most difficult obstacle in the use of reports of others is the establishment of rater reliability.

**Self-Report Instruments**

Self-report instruments are the most commonly used form of assessments for evaluating attitudes (Henerson, et al., 1987). They provide the most direct type of attitude assessment. Self-report instruments include interviews, surveys, polls, questionnaires, rating scales, logs, journals, and diaries. The major focus in science education research has been the development of valid and reliable attitude scales (Schibeci, 1984). The instruments that will be used for the proposed study are self-report assessment instruments.

**Instruments Used to Assess Attitudes toward Science and Subjective Norms**

Although there are a plethora of instruments available to assess the concept of attitudes toward science (Gardner, 1975; Gauld & Hukins, 1980), many of these instruments are
psychometrically weak (Munby, 1980). Another major criticism has been the lack of conceptual clarity in defining the target concept (Krynowsky, 1988; Laforgia, 1988). Few instruments have a solid theoretical foundation to support them. Ajzen and Fishbein's (1980) theory of reasoned action is a strong theory that may fill this theoretical void.

Since the theory of reasoned action has only recently gained attention in the science education community, the number of instruments available to assess social influences (i.e., subjective norms) is minimal. Thus, there is great potential for using the theory of reasoned action to explain the impact of social influences on science students' behavior.

The Attitude toward the Subject Science Scale (ASSS) (Krynowsky, 1988) was developed according to the guidelines set forth by Ajzen and Fishbein (1980). The instrument, piloted and tested on tenth grade science students, was found to be psychometrically sound by the researcher. The focus of the study was on the attitude toward behavior component of the theory of reasoned action.

The concurrent validity of the instrument was established by first comparing students' scores on the instrument to their science teachers' rankings. The Spearman-rank order coefficients were 0.79 and 0.65 for the two classes evaluated. Second, the students' scores were
correlated with a reliable attitude-toward-the-subject science scale, the School Science Scale (Taylor, 1982), and was found to have a correlation coefficient of 0.70 with this scale. Third, the students' scores were correlated with their scores based on an interview. The correlation here was 0.81. Test-retest reliability was 0.82, with a four-week interval between the administration of the instrument. No replication of the study has been conducted to further verify Krynowsky's (1988) findings.

Summary of the Literature Review

As stated earlier, there is a need for a theoretical foundation to support science education research on attitudes. The relationship between attitudes toward science and behavior has been studied, but the results have been inconsistent. Ajzen and Fishbein's (1980) theory of reasoned action has been used by a few researchers in science education to develop a theoretical basis for research on attitude-behavior relationships. The determinants for predicting behavior have been identified by the theory. However, the moderating variables in predicting behavioral intentions (and thus predicting behavior) have not been adequately addressed in the research, nor has there been enough research to establish the reliability and overall validity of the assessment instruments that are available.
This research study is a timely one in that it helps to fill several major gaps in science education research regarding attitudes and behavior. First, this research study further establishes the reliability and construct validity of an attitude assessment instrument, namely, the Science Attitude Scale for Middle School Students (Revised). Although the instrument has been tested by its developers for its adequacy, this research study serves as additional proof of the instrument’s reliability and construct validity. Secondly, this research study provides additional support for the theory of reasoned action as a sound theoretical basis for science education research. Thirdly, this research study further establishes the construct validity and reliability of one of the few science education instruments available that is based on the theory of reasoned action. Finally, and most importantly, this research study helps to identify the most prominent moderating variables (and the combinations of these variables) in determining students’ intentions to engage in science learning activities. A more rigorous testing of the theory of reasoned action is conducted, where the interactions of the identified external variables and the two determinants are considered. This novel method of data analysis has not been considered in previous studies relating to science education attitude-behavior research.
CHAPTER III

METHODOLOGY

Introduction

The research study was conducted in two phases. The first phase involved the collection of data at the school site. Data were collected through: (a) the administration of the Revised Science Attitude Scale for Middle School Students (Misiti et al., 1991) and Ray's (1991) Instrument for Assessing the Behavioral Intentions of Science Students and (b) the procurement of demographic data on all students from the school's administration. The second phase was the analysis of the collected data, using the statistical techniques suggested by Ajzen and Fishbein (1980), as well as the inclusion of interaction terms in one of the regression models. The following discussion provides an overview of the school where the study took place, the characteristics of the students involved, the assessment instruments used in the data collection phase, the method used to collect the data, and the statistical techniques used to analyze the data.
Setting of the Study

The laboratory school where data were collected is located in a medium-sized city in north central Florida. The school is unique in that it houses facilities for students in grades Kindergarten through 12. Another unique aspect of the school is that it has no special education program. The total enrollment for all grade levels is approximately 925 students. Data were collected on 264 of the 310 students enrolled in grades four through eight over a three-day period. The instruments were not administered to 46 students because of their absence from school on the day the researcher administered the instruments, their involvement in school activities that prevented them from being in class, or other valid reasons. The data collected on ten students were not usable because the students did not provide the information that was necessary to match their instrument results with their demographic data. Hence, the data collected on a total of 254 students were used in the data analyses. Because of missing data, a small number of students were not included in each data analysis, resulting in sample numbers less than 254 for some of the data analyses.

Population Demographics

The population consisted of all children in grades four through eight enrolled in the school described in the
setting of the study. The demographics of the students enrolled at the school are representative of the state’s characteristics in terms of gender, race/ethnicity, and socioeconomic status. This representation is accomplished by having students on a waiting list to enter the school and selecting students from the list as slots open. These slots are filled by students whose characteristics fit the needs of the school in order to keep a representative sample of the population enrolled.

Socioeconomic status was based on the student’s family total income for the previous twelve months. Students were placed in categories based on their family’s reported and verifiable annual income (see Table 1).

Instrumentation

Two instruments were administered to the students. A copy of each can be found in Appendix A (Revised Science Attitude Scale for Middle School Students) and Appendix B (Instrument for Assessing the Behavioral Intentions of Science Students).

Revised Science Attitude Scale for Middle School Students

Misiti et al. (1991) revised and validated a Likert science attitude scale for fifth through eighth grade students (N = 206) that was first used over two decades ago. The target attitude was defined as learning classroom science in middle school and was carefully differentiated
from attitudes towards science inquiry, science careers, and the nature of science or scientists. The revised instrument consists of 23 statements categorized into five subscales: investigations, comfort/discomfort, learning science content, reading and talking about science, and viewing films on television. Coefficient alphas from the two sets of data were 0.96 and 0.92, providing evidence of reliability of the instruments. Validation procedures included inviting middle school students to assist in the selection of statements, Likert analysis, and cross-cultural testing (Mejias-Algarin, 1988).

The Attitude Scale was also used to test the belief that at many age levels, males score higher on attitude scales than females. Misiti et al. (1991) found that the mean score (72.8, S.D. = 17.5) of 55 male sixth graders was significantly higher than the mean score (65.7, S.D. = 17.8) of 54 female sixth graders (t = 2.09, p < 0.04). The Fry readability level was reported to be at third-grade level or lower.

Instrument for Assessing the Behavioral Intentions of Science Students

Using the theory of reasoned action as the basis for the study, Ray (1991) elicited sets of salient beliefs related to attitude toward laboratory and nonlaboratory behavior from 377 students in grades three through eight. These beliefs were significantly correlated with students’
attitude toward the behavior (i.e., whether to participate) and subjective norms (i.e., sources of pressure to participate). The behavioral intentions of the students were predictable based upon their attitude toward the behavior and subjective norm. For laboratory behavior, with behavioral intention the dependent variable, and attitude toward the behavior and subjective norm the independent variables, the adjusted coefficient of multiple determination \( R^2 = 0.14 \) was significant, yet relatively small. Attitude toward the behavior had a standardized regression coefficient (relative weight) of 0.35. The relative weight for subjective norm was reported as 0.11. For nonlaboratory behavior, the adjusted coefficient \( R^2 = 0.25 \) was also significant. Again, attitude toward the behavior had a larger standardized regression coefficient \( (w = 0.54) \) than subjective norm \( (w = 0.08) \). The correlations between adjacent constructs in the theoretical model (i.e., intention-attitude toward the behavior, intention-subjective norm, attitude toward the behavior-behavioral beliefs and outcome evaluations, subjective norm-normative beliefs and motivations to comply) were also significant in all cases.

Data Collection

The researcher reviewed the administration procedures with a school official to insure proper understanding of the
data collection procedures. The researcher administered the two instruments to all students. The administration of the two instruments to all the students was completed over a one-week period. The actual administration time was no longer than 30 minutes for both instruments. Each class was administered the laboratory behavioral intention and the nonlaboratory behavioral intention components of Ray’s (1991) instrument. All students also completed the Attitude Scale (Misiti et al., 1991). During the administration of the instruments, the researcher read aloud each item to the students. Also, during the administration of the instruments, the teacher was asked to leave the classroom. All of the teachers obliged. The instruments were administered to 264 students.

Demographic information regarding the students’ gender, grade level, race/ethnicity, and socioeconomic status was collected via the school’s student files. The anonymity of the students was assured by having a data collection number assigned to each student. Demographic information on each student was provided to the researcher based on each student’s assigned data collection number. The data collected on each student were then coded according to each student’s data collection number. Students’ names were not used during data analysis.
Data Analysis

The data analysis used multiple regression techniques (Ajzen & Fishbein, 1980) to answer four research questions. First, do attitude toward behavior and subjective norm significantly predict the behavioral intentions of students to perform laboratory and nonlaboratory activities? Second, what are the relative weights of the immediate determinants (i.e., attitude toward the behavior and subjective norm) of students’ intentions to engage in laboratory and nonlaboratory science learning behavior? Third, does the prediction of behavioral intentions from attitude toward behavior and subjective norm differ when an external variable (gender, grade, race/ethnicity, SES, or attitude toward science) is added to the regression equation? Fourth, what are the relative weights of the predictors of behavioral intentions when an external variable is added to the regression equation?

When significant effects were identified in the relative contributions of an external variable, post-hoc equations were constructed within the levels of the external variable to identify the specific source of the significant effects. Correlations and regression coefficients are reported for both models. Both models were used twice, with the two dependent variables being laboratory behavioral intentions and nonlaboratory behavioral intentions. In other words, the first model was used once with laboratory
intention as the dependent variable and again with nonlaboratory intention as the dependent variable. The same analyses were utilized for the interaction model.
CHAPTER IV
RESULTS

Overview of Statistical Procedures

The data were analyzed by using the PC/SAS statistical program (SAS Institute, 1987). The analyses were conducted according to the guidelines suggested by the developers of the theory of reasoned action (Ajzen & Fishbein, 1980). First, multiple regression techniques were applied to the data, with behavioral intention as the dependent variable and attitude toward behavior and subjective norm as the independent variables. Regression analysis tested the first and second research questions of whether the two determinants, attitude toward behavior and subjective norm, account for a significant amount of the variance in the behavioral intention of students for both laboratory and nonlaboratory behavior. Two regression models were tested—first using students' scores on the laboratory behavioral intention instrument and second using students' scores on the nonlaboratory behavioral intention instrument. These analyses were designed to test the ability of the two determinants, attitude toward behavior and subjective norm, to predict the specified behavioral intention for the entire sample of students. Tables 2 and 5 contain the results of
the testing of the first and second research questions for each behavioral intention.

As a result of the above analyses, the better predictor of the two determinants was identified for each of the two behavioral intentions. Tables 3 and 5 include the standardized regression coefficients (w's) of attitude toward behavior and subjective norm. These statistics indicate how strong a predictor each determinant is in predicting the behavioral intention.

The next step in the data analysis consisted of using multiple regression techniques to test for differences in the relative contributions of attitude toward behavior, subjective norm, each external variable, and the two interaction terms, in predicting behavioral intention. These regression analyses tested the third and fourth research questions—first, whether the prediction of behavioral intentions from attitude toward behavior and subjective norm differ when an external variable (gender, grade, race/ethnicity, SES, or attitude toward science) is added to the regression equation, and secondly, what are the relative weights of the predictors of behavioral intentions when an external variable is added to the regression equation? The data were disaggregated by categories for each external variable. This disaggregation resulted in two categories for gender (male and female), five for grade level (fourth, fifth, sixth, seventh, and eighth), four for
race/ethnicity (Black, White, Hispanic, and Other), seven for socioeconomic status (levels one to seven), and two for attitude toward science (positive or negative). Students were identified as having a positive attitude toward science if they had a score of 70 or higher on the Attitude toward Science Scale. Students with a score of 68 or lower were categorized as having a negative attitude toward science. Students with a score of 69 on the scale were categorized as having a neutral attitude. The scores of the five students who scored a 69 on the Attitude toward Science Scale were not included in the data analyses that involved the external variable, attitude toward science.

Because of the relatively low number of students identified as "Hispanic" or "Other" on the race/ethnicity independent variable, it was decided by the researcher not to use these two categories of race/ethnicity in analyses including this variable.

Just as with the first model, analyses involving interaction effects were conducted for data based on the laboratory behavioral intention instrument and again for the nonlaboratory behavioral intention instrument. These data analyses tested for the possibility of interaction effects between each of the five external variables and the two determinants, attitude toward behavior and subjective norm. Once the possibility of interaction effects was eliminated, the main effects of the five external variables were
considered. The standardized regression coefficients of the significant terms are reported in Tables 6 and 7.

Tables 8 and 10 contain the results of testing the theory of reasoned action based on the groupings of the two external variables that were significant in the interaction model. Pearson product-moment correlations were reported for each of the external variables that was significant in the interaction model (Tables 9 and 11).

A significance level of .0001 ($p < .0001$) was used for data testing of the first and second research questions (aggregate analysis) and a $p$-value of .03 was selected for the testing of the third and fourth research questions (interaction effects included). These levels are lower than the commonly used .05 and less than the .10 value reported in a similar study (Ray, 1991). However, the researcher felt that the use of lower $p$-values allowed for a more rigorous testing of the theory of reasoned action. As a result, one can place more confidence in the findings of this study.

**Results**

The results of the data analyses are presented based on the four research questions that served as the foundation for this study.
Research Questions One and Two

The first research question asked whether the two determinants included in the theory of reasoned action (Ajzen & Fishbein, 1980)—attitude toward behavior (AB) and subjective norm (SN)—would account for a significant amount of the variance in the dependent variable, behavioral intention. The second research question asked what are the relative contributions of each of the two determinants in predicting behavioral intentions. These two research questions were tested for both laboratory and nonlaboratory behavioral intentions, using multiple regression techniques.

For laboratory behavioral intentions, attitude toward behavior and subjective norm were found to collectively contribute to the prediction of behavioral intentions (p < .0001), accounting for almost a fourth of the variance in behavioral intention (see Table 2). Regression coefficients (Table 3) indicate attitude toward behavior to be a better predictor of laboratory behavioral intentions than subjective norm ($w_{AB} = .31$, $p < .0001$; $w_{SN} = .27$, $p < .0001$).

Post-hoc tests were conducted to determine the independent correlation of each of the two determinants with the dependent variable, behavioral intention. For laboratory behavioral intentions (Table 3), attitude toward behavior and subjective norm were found to be related to behavioral intention ($r_{AB} = .43$, $p < .0001$ and...
For nonlaboratory behavioral intentions, attitude toward behavior and subjective norm were found to collectively contribute to the prediction of behavioral intentions \((p < .0001)\), accounting for more than a fourth of the variance in behavioral intention (see Table 4). Regression coefficients (Table 5) show that attitude toward behavior was a better predictor of nonlaboratory behavioral intentions than subjective norm \((w_{AB} = .39, p < .0001; w_{SN} = .23, p < .0001)\).

For nonlaboratory behavioral intentions (Table 5), attitude toward behavior and subjective norm were significantly related to behavioral intention \((r_{ABI} = .47, p < .0001\) and \(r_{SN} = .36, p < .0001)\).

**Research Questions Three and Four**

Multiple regression analyses were also used to examine the study's third and fourth research questions. These questions were examined using the interaction model, where the contributions of each of the five external variables were examined separately. Tests were conducted to determine whether attitude toward behavior, subjective norm, the external variable, and the two interaction terms made significant contributions to the prediction of the criterion, behavioral intention. The disaggregation of the data resulted in five model equations, one each for gender, grade level, race/ethnicity, SES, and attitudes toward
science. As was the case with the first and second research questions, the third and fourth research questions were tested twice, using data collected on students' intentions of performing laboratory activities and nonlaboratory activities.

For nonlaboratory intentions (Table 7), no interaction terms were found to be significant. The only external variable found to be a significant predictor of behavioral intention was grade ($w = -.34$, $p < .02$). This significance was found in the model:

$$BI = w_1 \text{AB} + w_2 \text{SN} + w_3 \text{GR} + w_4 (\text{GR} \times \text{AB}) + w_5 (\text{GR} \times \text{SN})$$

Post-hoc tests were conducted on the external variables that were significant in the interaction model. For each of the significant external variables, the data were disaggregated according to the external variables and further analyzed. For example, the external variable attitude towards science (ATS) was significant for laboratory intentions. Therefore, the students were grouped according to their scores on the Attitude Scale (Misiti et al., 1991). This grouping resulted in two categories for ATS: "Positive" and "Negative". Multiple regression techniques were then conducted by grouping the students according to their positive or negative ATS designation. As shown in Table 8, attitude toward behavior and subjective norm predicted a significant amount of the variance in behavioral intention for students with a negative attitude.
toward science ($R^2(\text{adj}) = .28, p < .0001$). The variance accounted for was slightly higher than the variance in the aggregate sample (see Table 2).

The correlation and regression coefficients for attitude toward behavior and subjective norm were reported for ATS categories (Table 9). No coefficients were significant for positive ATS, but all coefficients were significant for negative ATS. The correlations between attitude toward behavior and subjective norm and behavioral intention were moderate ($r_{AB1} = .49, p < .0001$ and $r_{SN1} = .44, p < .0001$, respectively). Attitude toward behavior was found to be the better predictor of behavioral intention, with a regression coefficient of .36 ($p < .0001$), as compared to subjective norm ($w_{SN} = .27, p < .001$).

For laboratory intentions (Table 6), no interaction terms were significant. Attitude toward science was the only external variable found to be a significant predictor ($w = -.49, p < .01$). This significance was found in the model:

$$BI = w_{AB} + w_{SN} + w_{ATS} + w_4(ATS \times AB) + w_5(ATS \times SN)$$

Since the external variable grade (GR) was significant for nonlaboratory behavioral intentions, the students were grouped according to their grade level, resulting in five categories. Multiple regression techniques were then conducted for each grade level. Table 10 shows that for fourth and seventh grade students, attitude toward behavior
and subjective norm predicted a significant amount of the variance in behavioral intention ($R^2(adj) = .33, p < .0001$
and $R^2 = .35, p < .0001$, respectively). In the case of both grade levels, the variance accounted for was higher than the variance in the aggregate sample (see Table 4).

The correlation and regression coefficients for attitude toward behavior and subjective norm are reported for the five grade levels (Table 11). For fourth graders, the correlation coefficient for subjective norm was significant ($r_{SN,1} = .51, p < .0001$). Both regression coefficients were significant, with subjective norm slightly higher than attitude toward behavior ($w_{A,1} = .37, p < .01$ and $w_{SN} = .39, p < .001$). For seventh graders, the correlation and regression coefficients for attitude toward behavior were significant ($r_{AB,1} = .61, p < .0001$ and $w_{AB} = .54, p < .0001$).
### TABLE 1
Summary of Five External Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grade</strong></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>54</td>
</tr>
<tr>
<td>5</td>
<td>47</td>
</tr>
<tr>
<td>6</td>
<td>40</td>
</tr>
<tr>
<td>7</td>
<td>56</td>
</tr>
<tr>
<td>8</td>
<td>57</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>120</td>
</tr>
<tr>
<td>Female</td>
<td>134</td>
</tr>
<tr>
<td><strong>Race/Ethnicity</strong></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>56</td>
</tr>
<tr>
<td>White</td>
<td>182</td>
</tr>
<tr>
<td>Hispanic</td>
<td>11</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
</tr>
<tr>
<td><strong>SES</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td>41</td>
</tr>
<tr>
<td>4</td>
<td>49</td>
</tr>
<tr>
<td>5</td>
<td>60</td>
</tr>
<tr>
<td>6</td>
<td>51</td>
</tr>
<tr>
<td>7</td>
<td>27</td>
</tr>
<tr>
<td><strong>ATS</strong></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>104</td>
</tr>
<tr>
<td>Negative</td>
<td>145</td>
</tr>
</tbody>
</table>

**Note:** SES—socioeconomic status according to level of family’s reported annual income, "1" indicating income of $9,999 and under, "2" indicating income of $10,000--14,999, "3" indicating income of $15,000--24,999, "4" indicating income of $25,000--34,999, "5" indicating income of $35,000--49,999, "6" indicating income of $50,000--74,999, "7" indicating income of $75,000 and above.

ATS—attitude toward science according to score on Science Attitude Scale for Middle School Students (Revised) (Misiti, Shrigley & Hanson, 1991), a score of 70 or above indicating a "positive" attitude, a score of 68 or below indicating a "negative" attitude.
### TABLE 2

Significance Test for the Prediction of Intentions to Engage in Laboratory Activities from Attitude toward Behavior (AB) and Subjective Norm (SN)

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p</th>
<th>R²(adj.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MODEL</td>
<td>2</td>
<td>33.85</td>
<td>16.92</td>
<td>39.62</td>
<td>.0001</td>
<td>.24</td>
</tr>
<tr>
<td>ERROR</td>
<td>248</td>
<td>105.94</td>
<td>.43</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

N = 251
### TABLE 3
Correlation and Regression Coefficients from Table 2 Model

<table>
<thead>
<tr>
<th></th>
<th>Attitude toward Behavior</th>
<th>Subjective Norm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>r</td>
<td>w</td>
</tr>
<tr>
<td>Laboratory Behavioral</td>
<td>.43*</td>
<td>.31*</td>
</tr>
<tr>
<td>Intention</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: * p < .0001
w's are standardized
N = 251
### TABLE 4

Significance Test for the Prediction of Intentions to Engage in Nonlaboratory Activities from Attitude toward Behavior (AB) and Subjective Norm (SN)

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p</th>
<th>R²(adj.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MODEL</td>
<td>2</td>
<td>54.45</td>
<td>27.23</td>
<td>45.43</td>
<td>.0001</td>
<td>.26</td>
</tr>
<tr>
<td>ERROR</td>
<td>250</td>
<td>149.82</td>
<td></td>
<td>.60</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

N = 252
<table>
<thead>
<tr>
<th></th>
<th>Attitude toward Behavior</th>
<th>Subjective Norm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>r</td>
<td>w</td>
</tr>
<tr>
<td>Nonlaboratory Behavioral Intention</td>
<td>.47*</td>
<td>.39*</td>
</tr>
</tbody>
</table>

Note: * p < .0001

w’s are standardized

N = 252
TABLE 6

Significant Terms in the Prediction of Intentions to Engage in Laboratory Activities from Attitude toward Behavior (AB), Subjective Norm (SN), an External Variable (EV), an External Variable X Attitude Interaction, and an External Variable X Subjective Norm Interaction

<table>
<thead>
<tr>
<th>External Variable</th>
<th>Significant Term</th>
<th>w</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Subjective Norm</td>
<td>.44</td>
<td>.02</td>
</tr>
<tr>
<td></td>
<td>Attitude toward Behavior</td>
<td>.44</td>
<td>.02</td>
</tr>
<tr>
<td>SES</td>
<td>Attitude toward Science</td>
<td>-.49</td>
<td>.01</td>
</tr>
</tbody>
</table>

Note: Five regression equations were computed, each with a different external variable (grade level, gender, race/ethnicity, SES, or attitude toward science)

w's are standardized

N = 251 for external variables grade level, gender, race/ethnicity, and SES

N = 246 for the external variable attitude toward science
TABLE 7
Significant Terms in the Prediction of Intentions to Engage in Nonlaboratory Activities from Attitude toward Behavior (AB), Subjective Norm (SN), an External Variable (EV), an External Variable X Attitude Interaction, and an External Variable X Subjective Norm Interaction

<table>
<thead>
<tr>
<th>External Variable</th>
<th>Significant Term</th>
<th>w</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade</td>
<td>Grade</td>
<td>-.34</td>
<td>.02</td>
</tr>
<tr>
<td></td>
<td>Attitude toward Race/Ethnicity Behavior</td>
<td>.38</td>
<td>.03</td>
</tr>
<tr>
<td></td>
<td>Attitude toward SES Behavior</td>
<td>.38</td>
<td>.01</td>
</tr>
</tbody>
</table>

Note: Five regression equations were computed, each with a different external variable (grade level, gender, race/ethnicity, SES, or attitude toward science)

w's are standardized

N = 253 for external variables grade level, gender, race/ethnicity, and SES
N = 248 for the external variable attitude toward science
TABLE 8

Post-hoc Analysis of Regression Effects within Levels of the Attitude toward Science Variable

<table>
<thead>
<tr>
<th>External Variable</th>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p</th>
<th>R²(adj)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATS Positive</td>
<td>MODEL</td>
<td>2</td>
<td>2.77</td>
<td>1.38</td>
<td>4.63</td>
<td>.01</td>
<td>.07</td>
</tr>
<tr>
<td>(n=104)</td>
<td>ERROR</td>
<td>101</td>
<td>30.22</td>
<td>.30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>MODEL</td>
<td>2</td>
<td>28.76</td>
<td>14.38</td>
<td>28.74</td>
<td>.0001</td>
<td>.28</td>
</tr>
<tr>
<td>(n=142)</td>
<td>ERROR</td>
<td>139</td>
<td>69.55</td>
<td>.50</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: ATS—attitude toward science according to score on Science Attitude Scale for Middle School Students (Revised) (Misiti, Shrigley & Hanson, 1991), a score of 70 or above indicating a "positive" attitude, a score of 68 or below indicating a "negative" attitude.
TABLE 9

Correlations and Regression Coefficients of Intentions on Attitude toward Behavior (AB) and Subjective Norm (SN) Laboratory Intentions

<table>
<thead>
<tr>
<th>External Variable</th>
<th>Correlation Coefficients</th>
<th>Regression Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$r_{AB,I}$</td>
<td>$r_{SN,I}$</td>
</tr>
<tr>
<td>ATS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>.24</td>
<td>.23</td>
</tr>
<tr>
<td>Negative</td>
<td>.49*</td>
<td>.44*</td>
</tr>
</tbody>
</table>

Note: * $p < .0001$, ** $p < .001$, *** $p < .01$

w's are standardized
<table>
<thead>
<tr>
<th>External Variable</th>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p</th>
<th>R²(adj)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 4th</td>
<td>MODEL</td>
<td>2</td>
<td>7.91</td>
<td>3.96</td>
<td>14.01</td>
<td>.0001</td>
<td>.33</td>
</tr>
<tr>
<td>(n=53)</td>
<td>ERROR</td>
<td>51</td>
<td>14.40</td>
<td>.28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 5th</td>
<td>MODEL</td>
<td>2</td>
<td>3.82</td>
<td>1.91</td>
<td>5.13</td>
<td>.01</td>
<td>.15</td>
</tr>
<tr>
<td>(n=47)</td>
<td>ERROR</td>
<td>44</td>
<td>16.39</td>
<td>.37</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 6th</td>
<td>MODEL</td>
<td>2</td>
<td>3.19</td>
<td>1.59</td>
<td>5.52</td>
<td>.01</td>
<td>.19</td>
</tr>
<tr>
<td>(n=40)</td>
<td>ERROR</td>
<td>36</td>
<td>10.40</td>
<td>.29</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 7th</td>
<td>MODEL</td>
<td>2</td>
<td>28.44</td>
<td>14.22</td>
<td>15.87</td>
<td>.0001</td>
<td>.35</td>
</tr>
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<td>(n=55)</td>
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<td>52</td>
<td>47.49</td>
<td>.90</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 8th</td>
<td>MODEL</td>
<td>2</td>
<td>12.75</td>
<td>6.37</td>
<td>8.64</td>
<td>.0006</td>
<td>.21</td>
</tr>
<tr>
<td>(n=56)</td>
<td>ERROR</td>
<td>54</td>
<td>39.82</td>
<td>.74</td>
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<td></td>
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<tr>
<td>External Variable</td>
<td>Correlation Coefficients</td>
<td>Regression Coefficients</td>
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<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------------------</td>
<td>-------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$r_{AB}$</td>
<td>$r_{SN}$</td>
<td>$w_{AB}$</td>
<td>$w_{SN}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4th</td>
<td>.46</td>
<td>.51*</td>
<td>.37***</td>
<td>.39**</td>
<td></td>
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<td></td>
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<tr>
<td>5th</td>
<td>.42</td>
<td>.24</td>
<td>.39***</td>
<td>.11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6th</td>
<td>.41</td>
<td>.35</td>
<td>.34</td>
<td>.26</td>
<td></td>
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<td>7th</td>
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<td>.40</td>
<td>.44</td>
<td>.28</td>
<td>.32</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: * $p < .0001$, ** $p < .001$, *** $p < .01$

$w$'s are standardized
CHAPTER V
DISCUSSION

Summary of Research Problem and Method

Through a review of science education research, the researcher found a lack of consistency in defining the appropriate affective constructs used in conducting studies on students' attitudes toward science. This finding is supported by Haladyna and Shaughnessy (1982). Another identified problem area, a result of the lack of construct conceptualization, is the dearth of appropriate and effective instruments for measuring affective constructs (Haladyna & Shaughnessy, 1982; Ray, 1991). Both of the above research problems have been linked to the absence of a theory that effectively ties together attitudes and other appropriate constructs, namely behavior (White & Tisher, 1986).

This study was conducted to address the aforementioned research problems by using Ajzen and Fishbein's theory of reasoned action (1980) as the basis for analyzing the factors associated with students' intentions to perform science learning activities. The developers of the theory of reasoned action proposed that the two main antecedents of
a person’s behavioral intention are one’s attitude toward the behavior and subjective norm. Although this sociopsychological model has been effective in some realms of behavioral research, it has been used sparingly and with moderate levels of success in science education research.

This study used the theory of reasoned action as a backdrop for attitude toward science as a construct, along with testing the rationality of attitude toward behavior and subjective norm as predictors of behavioral intentions. Five variables were identified from the literature as possible predictors of students’ behavioral intentions of performing science learning activities: gender, grade, race/ethnicity, socioeconomic status, and attitude toward science. As a result, the theory of reasoned action was assessed on its effectiveness to predict the behavioral intentions of various subgroups common in American culture.

The instruments used in this study were identified in the research as having the possibility of serving to solidify the definition of attitude toward science and providing valid and reliable instruments to effectively study the attitude-behavior relationship in science education. Misiti et al.’s Revised Science Attitude Scale for Middle School Students (1991) was used to assess the students’ attitude toward science. Ray’s Instrument for Assessing the Behavioral Intention of Science Students (1991) was used because of its theoretical foundation in the
theory of reasoned action and its focus on assessing students' intentions to perform science learning activities.

The statistical analysis followed the pattern suggested by Ajzen and Fishbein (1980), with multiple regression techniques used to test the predictive power of the two antecedents identified by Ajzen and Fishbein (1980) and the five independent variables identified by the researcher on behavioral intention. The researcher analyzed whether the two determinants contributed significantly to the prediction of behavioral intention. The effectiveness of the theory of reasoned action for the five external variables was also tested. Additionally, the researcher considered the contribution of the interaction of the five external variables with the two determinants.

**Interpretation of Results**

While the theory of reasoned action is marginally supported by the findings of this study, the results identify possible external variables that should be considered in model testing. As the theory suggests, attitude toward behavior and subjective norm are significant predictors of behavioral intention. This was found to be true for both laboratory behavioral intentions (Table 3) and nonlaboratory behavioral intentions (Table 5). Another finding that supports previous science education research is that of the two antecedents, attitude toward
behavior is the better predictor of behavioral intentions (Crawley & Coe, 1991; Koballa, 1988b; Ray, 1990, 1991). This was true for both laboratory (Table 3) and nonlaboratory (Table 5) behavioral intentions.

The two determinants, attitude toward behavior and subjective norm, combined accounted for slightly more variance in nonlaboratory behavioral intentions than laboratory intentions (Tables 2 and 4). Over a fourth of the overall variance in nonlaboratory behavioral intention was accounted for, as opposed to less than one fourth of the variance being accounted for in the case of laboratory behavioral intentions. Possible reasons for this discrepancy could be:

(1) the students in this study were more familiar with and comfortable engaging in nonlaboratory activities (e.g., science reading and writing) than laboratory activities (e.g., science projects and experiments); and

(2) the variables identified by the researcher may not be the best group of predictors for either set of science learning activities. A consistent and effective method for identifying such variables seems appropriate.

Another finding of the study supports the commonly held belief that students' attitudes toward science tend to become more negative as students grow older, i.e., pass on to higher grades (Doran & Sellers, 1978; Koballa, 1988a; Mason & Kahle, 1989; Oliver & Simpson, 1985, 1988; Rennie &
Punch, 1991; Stead, 1985). When the five independent variables were taken into consideration, attitude toward science (ATS) was found to be a significant predictor of behavioral intention for laboratory activities. The findings of this study indicate a negative relationship between attitude toward science and behavioral intention.

Grade was a significant external variable for nonlaboratory behavioral intentions (see Table 5). However, in both laboratory and nonlaboratory activities, grade had a negative correlation with behavioral intention. This result indicates that as the grade level of the students increased, the behavioral intention of the students decreased. In other words, the higher the grade level the less the students intended to perform the science learning activities requested by their teachers.

In the cases of the two external variables race/ethnicity and SES, the results are unclear as to whether there is support for the assertion proffered by Webb and Sherman (1989) that SES is possibly a better social index than race/ethnicity. Neither race/ethnicity nor SES were significant predictors of behavioral intention for laboratory and nonlaboratory activities.

Gender was the other external variable that was not significant in the prediction of either laboratory or nonlaboratory behavioral intentions. Although previous researchers in science education have identified gender as a
significant moderating variable in the attitude-behavior relationship (Cramer, 1989; Eccles, 1985; Mason & Kahle, 1989; Ray, 1990), this study did not provide such support.

The above discussion leads to the conclusion that more work needs to be done to adequately assess the value of the variables race/ethnicity, SES, and gender in the study of attitude-behavior relationships in science education research.

Limitations of the Study

As with any research study involving humans in natural settings, there are some limitations to the interpretation of the findings. One of the limitations of this study is the use of a convenient sample of subjects. This limitation does not allow for a wide spectrum of generalizability (Borg & Gall, 1989; Shavelson, Webb, & Rowley, 1989). However, due to the demographics of the students in this study, it is believed that there is some merit to discussing the research findings in a general nature. This type of sampling issue is a common occurrence in educational settings (Borg & Gall, 1989).

Another limitation to the study is the uniqueness of the school where the study was conducted. This school is unique in several ways. First, the school enrolls students from grades kindergarten through 12. There are many students who begin and end their precollege education at
this school. Another unique aspect of the school is the elementary science program. The instructor of the high school physics courses is also the science resource teacher for the elementary division of the school. The elementary students have the opportunity to visit and perform experiments in the science lab with this teacher, in addition to the science instruction provided by their regular classroom teachers. This school also has a limited enrollment policy, where students are placed on a waiting list and selected for admission based on the needs of the school to reflect the demographics of the local community.

For all the unique aspects of this school, it must be mentioned that this school is not a "private" school in the sense that it admits only certain kinds of students. It does accept students with various learning styles and capabilities. It is required by the state's department of education to adhere to the general policies that are enforced for all public schools in the state of Florida.

Regarding the collected data, one limitation is that the sample did not include an adequate sample of Hispanic, Asian, and other race/ethnic groups of students. The ideal scenario would be to have a sample that represents the demographics of this country. At the very least, the sample needs to include a representative sample of Hispanic students, especially in a state such as Florida, where Hispanics constitute a significant portion of the state's
population. It was hoped that Hispanics would be adequately represented in the sample. However, this was not the case when the data were collected. Therefore, a crucial part of the analysis was not addressed.

In considering the external variables used in this study, uneven sample sizes were detected when the data were disaggregated (see Table 1). Although the statistical procedures used in analyzing the data accounted for uneven groups, results from data analyses of even sample sizes are more easily interpretable.

Another limitation of the study associated with one of the external variables is the selection of two categories for the external variable attitudes toward science. Although the instrument used to assess students' attitudes toward science allowed for a range of scores, the researcher categorized students into two groups, positive and negative, in accordance with similar research (Koballa, 1988b; Misiti et al., 1991). By taking students' scores on the Attitude Scale (see Appendix A), one can group them into numerous categories. For example, it is possible to categorize students as having strongly negative, moderately negative, slightly negative, neutral, slightly positive, moderately positive, and strongly positive attitudes toward science.

Since there is the possibility for more than two groups on this variable, it is proffered that research findings
involving attitudes toward science may change if more groups are included in the data analyses.

Another limitation of the study, which is associated with the instruments used in data collection, is that the instruments do not address the impact of students' feelings about their science teachers. One can see from the instruments used in this study (Appendices A and B) that the issue of students' feelings is embedded in the two instruments. However, analyzing students' feelings about their teachers was not a focus of this study.

Two limitations of this study associated with the theory of reasoned action are identified here. First, the theory has been primarily used to predict the behavioral intentions of adults. Only recently has the theory been used on younger people. Although the readability levels of the instruments using the theory have been appropriate for the age groups, the theory of reasoned has not been confirmed as an adequate theoretical basis for predicting children's behavioral intentions.

The other limitation of this study associated with the theory of reasoned action is that there was no follow-up assessment to document the students' actual behavior; only their behavioral intentions were assessed. None of the research involving the use of the theory of reasoned action in science education has considered the actual behavior of students.
Other limitations of the study include: (a) the study did not include all fourth, fifth, sixth, seventh, and eighth graders in the United States; (b) the findings of the study depended on the ability of the instruments to accurately assess the beliefs, attitudes, and behavioral intentions of the students; and (c) the students provided self-reported data on their behavioral beliefs and evaluations of behavioral outcomes, attitude, subjective norm, normative beliefs of important others, motivation to comply with the important others, and attitude toward science. The self-reported data could have been affected by normative response bias.

**Implications**

While the theory of reasoned action was moderately successful in predicting students' behavioral intentions, this study identifies possible independent variables that should be considered in model testing. In other words, this study validates and supports the use of the theory of reasoned action in science education. The inclusion of external variables that are deemed appropriate by research is supported by Ajzen and Fishbein (1980) and other science education researchers (Crawley & Coe, 1991; Koballa, 1988b; Ray, 1990, 1991). The necessity of further research to identify variables that might increase the predictability of students' behavioral intentions is also supported by this
study. In addition, there is support for conducting further research that examines attitude towards science and grade level to accurately identify when students' attitudes begin to decline.

Although none of the interaction variables in this study were significant, the need to identify external variables and consider their interactions with the two main determinants in the theory of reasoned action is warranted. Since this is one of the first studies in science education research that includes interaction effects in model testing (Gogolin & Swartz, 1992; Martinez, 1992), it is reasonable to assume that more of this type of research is necessary to validate the rigorous and parsimonious data analyses used in this study. It is possible that various combinations of external variables may have a significant impact on students' attitudes toward science.

This study also supports the need for more stringent testing of the theory of reasoned action when external variables are included in the theoretical model. The limited amount of science education research that has been conducted using the theory of reasoned action also warrants the full replication of the current study.

On a practical level, the instruments in this study can be administered by classroom teachers to assist them in focusing on the affective factors that impact student learning. Once knowledge of students' attitudes is
attained, educators can develop and implement programs and instructional strategies that will enhance students' attitudes toward science. This study provides support for the need to continue research that examines strategies in the classroom for improving all students' attitudes toward science.

A logical step in affirming the use of the theory of reasoned action in science education is to conduct studies where the students' actual behaviors are observed. It is expected that a high correlation exists between behavioral intention and behavior (Ajzen & Fishbein, 1980). However, there may be moderating variables that affect the relationship between intention and behavior. The theory of planned behavior (Ajzen, 1988) attempts to address this issue.

Another suggestion for future research involves the methods used to collect data. Henerson et al. (1978) describe several ways of collecting data on attitudes. It is possible that forms of evaluation such as teacher evaluations, peer questionnaires and parental reports, may provide insight into students' attitudes that was not identified in this study.

Another research suggestion involves gender. Most research in science education has shown that gender is a significant factor when students' attitudes are being studied (Cramer, 1989; Crawley & Coe, 1990; Eccles, 1985;
Fox & Tobin, 1988; Friedler & Tamir, 1990; Horner, 1972; Martinez, 1992; Mason & Kahle, 1989; Ray, 1990). Since the results of this study are in conflict with most research involving gender issues, it seems appropriate to replicate this study using the same data analysis procedures with a different sample.

The results of this study reveal the difficulty and complexity associated with assessing students' intention to engage in science learning activities. The results show that students value different sources of information and support. Some students appear to place more importance on personal consequences (attitude toward behavior), whereas other students indicate that the support they receive from significant others (subjective norm) is more important. There are even some students who place equal value on personal beliefs and social support. Therefore, improving the attitude, behavior, and achievement in science of female students, students of color, and students from various SES groups, may continue to be difficult, due to the significant differences in value these students place on the personal beliefs and social supports necessary to be successful in science.

Ultimately, science educators must consider the affective domain of learning to more effectively impact student learning in science. Before science educators can alter the performance of students in science, "... a better
understanding is needed of the major determinants of attitude and subjective norm as well as their relative importance in the decision-making process for different groups of students." (Crawley & Coe, 1991, p. 474).
APPENDIX A

SCIENCE ATTITUDE SCALE FOR MIDDLE SCHOOL STUDENTS (REVISED)

DIRECTIONS: Put a check in the blank that best describes your feelings about each of the following 23 statements. Only check one blank for each statement.

1. Getting science books from the library is a drag.

   Strongly Agree  Agree  Undecided  Disagree  Strongly Disagree

2. I hate to keep records of science experiments in a notebook.

   Strongly Agree  Agree  Undecided  Disagree  Strongly Disagree

3. Science films bore me to death.

   Strongly Agree  Agree  Undecided  Disagree  Strongly Disagree

4. I wish science class lasted all day.

   Strongly Agree  Agree  Undecided  Disagree  Strongly Disagree

5. I dislike watching science specials on television.

   Strongly Agree  Agree  Undecided  Disagree  Strongly Disagree
6. I hate science class.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

7. Learning science facts is a drag.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

8. Working with science equipment makes me feel important.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

9. I would like to join a science club that meets after school.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

10. Looking through a microscope is not my idea of fun.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

11. Knowing science facts makes me feel good.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

12. I don't mind doing an experiment several times to check the answer.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>
13. I feel like daydreaming during science class.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

14. Sharing science facts that I know makes me feel great.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

15. I hate to study science out of doors.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

16. It’s neat to talk to my parents about science.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

17. I like to make science drawings.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

18. I wouldn’t think of discussing science with friends outside of class.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

19. I enjoy using mathematics in science experiments.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>
20. I cannot wait until science class.

| Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree |

21. I wish we didn't have science class so often.

| Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree |

22. Doing science projects at home is dumb.

| Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree |

23. Science is one of my favorite classes.

| Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree |
### Scoring for Attitude Scale

<table>
<thead>
<tr>
<th></th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Negative</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td><strong>Statement</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Positive</strong></td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td><strong>Statement</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Negative Statements:** 1, 2, 3, 5, 6, 7, 10, 13, 15, 18, 21, 22 = 12
- **Positive Statements:** 4, 8, 9, 11, 12, 14, 16, 17, 19, 20, 23 = 11 items

<table>
<thead>
<tr>
<th>Subcomponent</th>
<th>Item #’s</th>
<th># of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Using science materials</td>
<td>2, 8, 10, 12, 15, 17, 19, 22</td>
<td>8</td>
</tr>
<tr>
<td>(investigative processes)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Comfort/discomfort related to classroom science</td>
<td>4, 6, 13, 20, 21, 23</td>
<td>6</td>
</tr>
<tr>
<td>3. Learning science content</td>
<td>7, 9, 11, 14</td>
<td>4</td>
</tr>
<tr>
<td>4. Reading or talking about science</td>
<td>1, 16, 18</td>
<td>3</td>
</tr>
<tr>
<td>5. Viewing science films or TV specials</td>
<td>3, 5</td>
<td>2</td>
</tr>
</tbody>
</table>

23 items
APPENDIX B

INSTRUMENT FOR ASSESSING THE BEHAVIORAL INTENTIONS OF SCIENCE STUDENTS

Laboratory Intentions

DIRECTIONS: Put a check in the blank that best describes your feelings about each of the following 37 statements. Only check one blank for each statement.

***INTENTION
1. I plan to do the science projects and science experiments my teacher asks me to do.

***ATTITUDE TOWARD THE BEHAVIOR
2. My doing the science projects and science experiments my teacher asks me to do is:

***BEHAVIORAL BELIEFS
3. My doing the science projects and science experiments my teacher asks me to do causes me to learn.

4. My doing the science projects and science experiments my teacher asks me to do causes me to have fun with science and enjoy science.

5. My doing the science projects and science experiments my teacher asks me to do allows me to do science activities and experiments.

6. My doing the science projects and science experiments my teacher asks me to do causes me to get good or better grades.
7. My doing the science projects and science experiments my teacher asks me to do causes me to have to work on science assignments.

likely extremely slightly neither slightly extremely unlikely

8. My doing the science projects and science experiments my teacher asks me to do causes me to be confused and not understand science.

likely extremely slightly neither slightly extremely unlikely

9. My doing the science projects and science experiments my teacher asks me to do causes me to think of how a science experiment will turn out.

likely extremely slightly neither slightly extremely unlikely

10. My doing the science projects and science experiments my teacher asks me to do causes me to be interested and not bored.

likely extremely slightly neither slightly extremely unlikely

11. My doing the science projects and science experiments my teacher asks me to do causes me to have an experiment work well.

likely extremely slightly neither slightly extremely unlikely

12. My doing the science projects and science experiments my teacher asks me to do causes me to dissect animals and touch their parts.

likely extremely slightly neither slightly extremely unlikely

13. My doing the science projects and science experiments my teacher asks me to do causes dangerous things to happen.

likely extremely slightly neither slightly extremely unlikely

***OUTCOME EVALUATION

14. Causing me to learn is

good extremely slightly neither slightly extremely bad

15. Causing me to have fun with science and enjoy science is

good extremely slightly neither slightly extremely bad

16. Allowing me to do science activities and experiments is

good extremely slightly neither slightly extremely bad

17. Causing me to get good or better grades is

good extremely slightly neither slightly extremely bad
18. Causing me to work on science assignments is
   good:________:________:________:________ bad
   extremely slightly neither slightly extremely

19. Causing me to be confused and not understand science is
   good:________:________:________:________ bad
   extremely slightly neither slightly extremely

20. Causing me to think of how a science experiment will turn out is
   good:________:________:________:________ bad
   extremely slightly neither slightly extremely

21. Causing me to be interested and not bored is
   good:________:________:________:________ bad
   extremely slightly neither slightly extremely

22. Causing me to have an experiment work well is
   good:________:________:________:________ bad
   extremely slightly neither slightly extremely

23. Causing me to dissect animals and touch their parts is
   good:________:________:________:________ bad
   extremely slightly neither slightly extremely

24. Causing dangerous things to happen is
   good:________:________:________:________ bad
   extremely slightly neither slightly extremely

***SUBJECTIVE NORM
25. Most people who are important to me think
   I should:________:________:________:________ I should not
   do the science projects and science experiments my teacher asks me to do.

***NORMATIVE BELIEFS
26. My parents think
   I should:________:________:________:________ I should not
   do the science projects and science experiments my teacher asks me to do.

27. My teacher thinks
   I should:________:________:________:________ I should not
   do the science projects and science experiments he or she asks me to do.
28. My brothers or sisters think
I should ___:____:____:____:____ I should not
do the science projects and science experiments my teacher asks me to do.

29. My grandparents think
I should ___:____:____:____:____ I should not
do the science projects and science experiments my teacher asks me to do.

30. My friends think
I should ___:____:____:____:____ I should not
do the science projects and science experiments my teacher asks me to do.

31. God thinks
I should ___:____:____:____:____ I should not
do the science projects and science experiments my teacher asks me to do.

***MOTIVATION TO COMPLY
32. Generally speaking, I want to do what my parents think I should do.
Yes ___:____:____:____:____:____ No

33. Generally speaking, I want to do what my teacher thinks I should do.
Yes ___:____:____:____:____:____ No

34. Generally speaking, I want to do what my brother or sisters think I should do.
Yes ___:____:____:____:____:____ No

35. Generally speaking, I want to do what my grandparents think I should do.
Yes ___:____:____:____:____:____ No

36. Generally speaking, I want to do what my friends think I should do.
Yes ___:____:____:____:____:____ No

37. Generally speaking, I want to do what God thinks I should do.
Yes ___:____:____:____:____:____ No
***Headings for each of the seven components (e.g., INTENTION, ATTITUDE TOWARD THE BEHAVIOR) were not on the copy of the instrument given to the students.

Instrument Scoring

<table>
<thead>
<tr>
<th>Items</th>
<th>Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-31</td>
<td>+2 (e.g., extremely likely), +1, 0, -1, -2 (e.g., extremely bad)</td>
</tr>
<tr>
<td>32-37</td>
<td>+5 (e.g., yes), +4, +3, +2, +1 (e.g., no)</td>
</tr>
</tbody>
</table>
INSTRUMENT FOR ASSESSING THE BEHAVIORAL INTENTIONS OF SCIENCE STUDENTS

Nonlaboratory Intentions

DIRECTIONS: Put a check in the blank that best describes your feelings about each of the following 33 statements. Only check one blank for each statement.

***INTENTION

1. I plan to do the science reading and science writing my teacher asks me to do.

   likely extremely slightly neither slightly extremely unlikely

***ATTITUDE TOWARD THE BEHAVIOR

2. My doing the science reading and science writing my teacher asks me to do is:

   good extremely slightly neither slightly extremely bad

***BEHAVIORAL BELIEFS

3. My doing the science reading and science writing my teacher asks me to do causes me to learn.

   likely extremely slightly neither slightly extremely unlikely

4. My doing the science reading and science writing my teacher asks me to do causes me to have fun with science and enjoy science.

   likely extremely slightly neither slightly extremely unlikely

5. My doing the science reading and science writing my teacher asks me to do causes me to become someone who uses science in their job.

   likely extremely slightly neither slightly extremely unlikely

6. My doing the science reading and science writing my teacher asks me to do causes me to get good or better grades.

   likely extremely slightly neither slightly extremely unlikely

7. My doing the science reading and science writing my teacher asks me to do causes me to think about science activities and experiments.

   likely extremely slightly neither slightly extremely unlikely

8. My doing the science reading and science writing my teacher asks me to do causes me to do questions that are difficult and hard to understand.

   likely extremely slightly neither slightly extremely unlikely
9. My doing the science reading and science writing my teacher asks me to do causes me to do more writing.

likely extremely slightly neither slightly extremely unlikely

10. My doing the science reading and science writing my teacher asks me to do causes me to have to do work on science assignments.

likely extremely slightly neither slightly extremely unlikely

***OUTCOME EVALUATION
11. Causing me to learn is good extremely slightly neither slightly extremely bad

12. Causing me to have fun with science and enjoy science is good extremely slightly neither slightly extremely bad

13. Allowing me to become someone who uses science in his/her job is good extremely slightly neither slightly extremely bad

14. Causing me to get good or better grades is good extremely slightly neither slightly extremely bad

15. Causing me to think about science activities and experiments is good extremely slightly neither slightly extremely bad

16. Causing me to do questions that are difficult and hard to understand is good extremely slightly neither slightly extremely bad

17. Causing me to do more writing is good extremely slightly neither slightly extremely bad

18. Causing me to have to do work on science assignments is good extremely slightly neither slightly extremely bad

***SUBJECTIVE NORM
19. Most people who are important to me think I should do the science reading and science writing my teacher asks me to do.
***NORMATIVE BELIEFS***

20. My parents think

I should ____:____:____:____:____ I should not
do the science reading and science writing my teacher asks me to do.

21. My teacher thinks

I should ____:____:____:____:____ I should not
do the science reading and science writing he or she asks me to do.

22. My brothers or sisters think

I should ____:____:____:____:____ I should not
do the science reading and science writing my teacher asks me to do.

23. My grandparents think

I should ____:____:____:____:____ I should not
do the science reading and science writing my teacher asks me to do.

24. My friends think

I should ____:____:____:____:____ I should not
do the science reading and science writing my teacher asks me to do.

25. God thinks

I should ____:____:____:____:____ I should not
do the science reading and science writing my teacher asks me to do.

26. My relatives think

I should ____:____:____:____:____ I should not
do the science reading and science writing my teacher asks me to do.

***MOTIVATION TO COMPLY***

27. Generally speaking, I want to do what my parents think I should do.

Yes ____:____:____:____:____:____:____:____ No

28. Generally speaking, I want to do what my teacher thinks I should do.

Yes ____:____:____:____:____:____:____:____ No

29. Generally speaking, I want to do what my brother or sisters think I should do.

Yes ____:____:____:____:____:____:____:____ No

30. Generally speaking, I want to do what my grandparents think I should do.

Yes ____:____:____:____:____:____:____:____ No
   Yes:________:________:________:________:______ No

32. Generally speaking, I want to do what God thinks I should do.
   Yes:________:________:________:________:______ No

33. Generally speaking, I want to do what my relatives think I should do.
   Yes:________:________:________:________:______ No

***Headings for each of the seven components (e.g., INTENTION, ATTITUDE TOWARD THE BEHAVIOR) were not on the copy of the instrument given to the students.

Instrument Scoring

Items
1-26 +2 (e.g., extremely likely), +1, 0, -1, -2 (e.g., extremely bad)
27-33 +5 (e.g., yes), +4, +3, +2, +1 (e.g., no)
REFERENCES


BIOGRAPHICAL SKETCH

Malcolm Blaine Butler was born in Lafayette, Louisiana, on August 22, 1965. He lived in Maringouin, Louisiana, and attended elementary and high school in Pointe Coupee Parish, where he graduated from Livonia High School in 1983. He was class president during his senior year at Livonia High School. Mr. Butler then went on to Southern University and Agricultural and Mechanical College in Baton Rouge, Louisiana, where he received his Bachelor of Science degree in physics in 1989.

Mr. Butler entered the University of Florida Department of Physics in 1989. He later earned a Master of Education in Instruction and Curriculum with an emphasis in science education in 1991. Mr. Butler has spent two years teaching mathematics and science in the public school system in Florida, one year at Newberry Junior/Senior High School in Newberry and another year at P.K. Yonge Developmental Research School in Gainesville. He has also taught courses in the University of Florida’s College of Education as a Graduate Teaching Assistant, and has spent time working as a substitute teacher both in Florida and Virginia. As of August, 1995, Mr. Butler will be an Assistant Professor of Education at Texas A&M University in Corpus Christi, Texas.
I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Simon O. Johnson, Chair
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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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Associate Professor of Instruction and Curriculum

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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Professor of Instruction and Curriculum

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Arthur Newman
Professor of Foundations of Education

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Craig L. Frisby
Associate Professor of Foundations of Education
This dissertation was submitted to the Graduate Faculty of the College of Education and to the Graduate School and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

August 1995

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