The purpose was to gain information about the determinants of student behavior with respect to laboratory (lab) and non-laboratory (non-lab) science learning activities. Fishbein and Ajzen's (1975) theory of reasoned action was used to investigate students' salient beliefs, correlations between determinants of intention, and the relative weights of determinants of intention. Analogous correlations for the lab and non-lab were compared, and gender and grade level were tested for effects upon the determinants of intention.

Multistage cluster sampling was used to select 377 grades 3 to 8 public school students in 18 classes in 3 Oregon school districts. Salient beliefs were elicited from 72 of these students. Cores of salient beliefs related to attitude toward lab and non-lab behaviors and
cores of salient beliefs related to subjective norm (significant others) for lab and non-lab behaviors were identified. These beliefs were used to construct two instruments (lab and non-lab). A pilot study was conducted involving 102 other students. Finally, half of the original 377 sample responded to the lab instrument and half to the non-lab instrument.

Multiple regression showed that attitude toward behavior and subjective norm explained significant ($p < .01$) amounts of variance in behavioral intention for both lab ($R^2 = .14$) and non-lab ($R^2 = .25$). The $R$s for lab and non-lab were not significantly different ($p > .10$). Attitude toward behavior had a greater relative weight than subjective norm for both lab and non-lab.

The correlations between adjacent constructs in the theory of reasoned action were significant ($p < .08$) for both lab and non-lab. Some significant differences between analogous lab and non-lab correlations were found. ANOVA revealed that gender had a significant effect on precursors of attitude toward behavior and subjective norm in one of four cases; it was of low practical significance. ANOVA showed that grade level had a significant effect on precursors of attitude toward behavior and subjective norm for both lab and non-lab behavioral intentions. The data with the theory showed that, in general, the intention to engage in lab and non-lab activities would be lowest for those in grade 8. A
subjective analysis revealed that both gender and grade level affected the relative weights of attitude toward behavior and subjective norm for lab and non-lab.

A psychological theory of social behavior was used to gain baseline information relevant to the intentions of science learners. This information might be used to plan strategies for affecting science student behavior so that they will become more scientifically literate.
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Dean of Graduate School

Date thesis is presented April 25, 1988

Typed by Brian Daniel Ray for Brian Daniel Ray
DEDICATION

To Betsy, my wife and so very much more.
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I would like to acknowledge God (who is Christ Jesus) who has sustained me and given me blessings untold throughout my academic endeavors. My complete and bounteous thanks also go to my wife, Betsy, and my children, Hallie, Rachel, and Hannah, who have been a continual source of support and joy during my studies.

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The aim of science education is to effect changes in learners such that they exhibit evidence of increasing scientific literacy. Various constructs that can be evaluated via observation of specific behaviors (which a student should exhibit after instruction) are targeted by science educators (Collette & Chiapetta, 1984). Examples are process skills, knowledge of science concepts, attitudes toward science, understanding of science/technology-related social issues, and decision making skills (National Science Teachers Association [NSTA], 1982). It would seem that science educators might value and use a theory that would allow accurate prediction of science learning behavior. With such a theoretical model in hand, they might then be able to gather information germane to a better understanding of the determinants of science learning behavior. The availability of such information could then be used to design research which could lead to more productive educational tactics, and to more significantly effect
changes in the science learning of youth. Thus, the information generated via use of the model might be used to enhance the scientific literacy of this nation's citizenry.

Problem and Need for the Study

The public has recently favored a move back to the "basics" (Shymansky, Kyle, & Alport, 1983), a category which generally does not include science. Simultaneously, there has been a renewed and expanding interest in science education in the United States (Sigda, 1983). This interest includes attention to both science achievement and attitude toward science (Berkheimer & Lott, 1984; NSTA, 1982). That is to say, science educators want to enhance both the cognitive and affective components of science learning. In spite of the aforementioned interest, "we have not succeeded in building a nation of informed citizens confident of making reasoned decisions about the myriad scientific issues that affect our lives" (Linn, 1987, p. 191). Likewise, in 1982 the NSTA said that there was a "crisis" in science education, and in 1984 Collette and Chiapetta reported that "our schools are not succeeding in producing scientifically literate individuals . . . " (p. 4). Yager and Penick echoed the thought in 1987 that a crisis in science education existed. The scientific literacy status of U.S. citizens apparently
has not changed much during the past decade.

It often appears that there is lacking a coherent overall approach to effecting change in science learners' behavior. In one phase of education, practitioners attempt to alter various factors that are thought to affect learning behavior (e.g., program changes, curriculum reform, amount of homework, longer school days and years, increased choices in education, access to education, and parental involvement). In another phase of education, researchers attempt various approaches to understanding how to affect learning behavior (e.g., experimental studies with theoretical frameworks of varying persuasiveness, qualitative studies to generate grounded theory, and studies which seek to develop and test theoretical paradigms). Practitioners' and researchers' approaches are not well articulated; this should be of great concern to science educators in an era when on one hand scientific literacy is deemed so very important while on the other hand science is not considered a "basic."

Science educators need a more effective approach to achieving the goal of scientific literacy for children who are our future citizenry. Generating valid and reliable baseline information about and developing an understanding of the determinants of children's intentions to engage in science learning behavior may
prove to be a profitable strategy in this area. Along this line, Talton and Simpson (1986) pointed out that "As more is understood concerning how adolescent students form attitudes toward science, policy changes can be made that will affect curriculum and instruction in science in American schools" (p. 366). Science educators need information that would be useful in changing science learners' ideas (Linn, 1987). For example, the procured knowledge and understanding related to science learning behavior could then be used to develop and execute more rigorously controlled experimental research. Results of such research might then be used to inform a behavioral change method such as Hovland's persuasive communication approach (Martin, 1985; Shrigley, 1983) or Lewin's group dynamics approach (Shrigley). For, as Shrigley noted, "... science educators interested in modifying attitudes can expect an accompanying change in behavior" (p. 431). At this time, it is apparent that science educators do not have a clear idea of or sufficient information regarding the determinants of children's intentions to engage in science learning behavior. Therefore, potentially effective approaches to attitude and behavior change in science education are not adequately informed. Science educators need to know what determines a youth's intentions and behavior with regard to engaging in science learning activities. Knowledge of
the determinants would inform science educators as to how they might better ensure that young people will participate in science activities. More relevant and controlled experiments could then be conducted.

It appears that science educators could benefit from the use of a dependable, multivariate model that accurately predicts and helps to explain the learning behavior of young science learners. Knowledge and understanding of young students is particularly important because many lose interest in science during grades four to eight (Linn, 1987). Such a model, and the information and understanding that it generates, might lend coherency to certain aspects of science education research. The information and understanding might also provide logical reasons for executing particular research plans to change science learner behavior.

Purpose

The purpose of this study is to gain information about the determinants of student behavior with respect to laboratory and non-laboratory science learning activities. More specifically, the purpose of the study is to answer the following questions by using Fishbein and Ajzen's (1975) theory of reasoned action:

1. What are the salient beliefs of students with respect to engaging in laboratory and non-laboratory activities?
2. What are the correlations between adjacent components in the theory of reasoned action?

3. What are the relative weights of the immediate determinants (i.e., attitude toward the behavior and subjective norm) of student intention to engage in laboratory and non-laboratory science learning behaviors?

4. Do the relative weights of the immediate determinants (i.e., attitude toward the behavior and subjective norm) differ with respect to laboratory versus non-laboratory intentions?

5. Do the analogous correlations for the two behavioral intentions (laboratory and non-laboratory) differ?

6. What is the relationship between gender of student and attitude toward the behavior, subjective norm, and the relative weights of attitude toward behavior and subjective norm?

7. What is the relationship between grade level of student and attitude toward the behavior, subjective norm, and the relative weights of attitude toward behavior and subjective norm?

Theoretical Framework and Rationale

Various authors (Haladyna, Olsen, & Shaughnessy, 1983; Koballa & Crawley, 1985; Linn, 1987; Zeidler, 1984) have called for sound, theoretical approaches to science education research. Researchers must develop a logical,
and eventually empirical, basis and argument for the research they perform if they want it to make a significant and positive impact on learner behavior.

It is reasonable to assume that an understanding of the determinants of science learning behavior is needed in order to develop an effective plan for changing the target behaviors. Fortunately, there is substantial evidence to suggest that the construct most closely associated with behavior is behavioral intention (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975). In addition, the theory of reasoned action (Fishbein & Ajzen) has proven useful in understanding the precursors of intention. The model is founded on

... the assumption that most actions of social relevance are under volitional control and, consistent with this assumption, our theory views a person's intention to perform (or to not perform) a behavior as the immediate determinant of the action (Ajzen & Fishbein, p. 5).

The paradigm's main use is the prediction and understanding of behavior and its determinants (see Figure 1 and Figure 2).

It is theorized "... that people use the information available to them in a reasonable manner to arrive at their decisions" (Ajzen & Fishbein, 1980, p. 244) regarding particular behaviors. The information a person has serves as the basis of his or her beliefs. The beliefs are linked to attitude toward a behavior (the
Possible explanations for observed relations between external variables and behavior

Stable theoretical relations linking beliefs to behavior

Feedback

Figure 1. Effects of variables on behavior, according to the theory of reasoned action. (After Ajzen & Fishbein, 1980, and Fishbein & Ajzen, 1975)
Figure 2. The theory of reasoned action model will be used with respect to two student behaviors in this study: laboratory and non-laboratory.
personal component) and subjective norm (the social component), then to intention, and finally to behavior. Using the theory of reasoned action, it is supposed that the intention (BI) to perform a particular behavior (B) (e.g., doing science experiments) is a function of the weighted (w₁) attitude toward performing a behavior (Aᵣ) and the weighted (w₂) subjective norm (SN). Ergo, a behavioral intention consists of a personal and a social component.

Use of the theory of reasoned action might generate information about the determinants of science learning behavior. The first step would be to identify the behaviors of interest. The two behaviors will be "doing science projects and science experiments" and "doing science reading and science writing." It is essential to note that there are several reasons to expect the determinants of science learning behavior to be unique. First, if the determinants and their weights were the same for a person with respect to all learning behavior, then one would expect that person to perform equally in all content areas in school; this is not the case. Second, the content and processes under study in science are clearly different from those under study in other subject areas. Third, the theory of reasoned action argues that it is highly probable that an individual's intentions in the milieu of science will be unique to
that school subject. The preceding three reasons for expecting the determinants of science learning behavior in general to be unique can likewise be applied as an argument for expecting the determinants of laboratory and non-laboratory behavior to be dissimilar.

Furthermore, the literature presented in Chapter II indicates that there may be reason to expect salient beliefs of science learners to vary with respect to their gender and grade level. These two external variables should be investigated so that more complete information might be gleaned from this study.

After identifying the behaviors of interest, the next step would be to identify the salient beliefs of a group of science learners. Then the relative weights of the attitude toward the behavior and subjective norm could be determined. Analysis of the generated information might provide understanding necessary for future research aimed at effecting science learner behavior. That is, which beliefs are salient to this group with respect to doing laboratory or non-laboratory science activities? Which determinant of intention holds more weight, the personal or social component? Is there a difference in beliefs with respect to gender or grade level of the science student? Answers to the foregoing questions might provide direction to future researchers. For example, experimental designs could be utilized in
order to ascertain the effects on behavioral intention of attempts to differentially influence salient beliefs in the context of science learning. Thus, a careful exploration of behavioral determinants and selected external variables that are related to young science learners might guide future researchers, and eventually educational practitioners, in developing plans for altering science students' learning.

Discussion of the theoretical framework for this study will be greatly expanded in Chapter II.

**Definition of Terms**

The following definitions will be employed in the study. Other terms or phrases used have been previously defined or are assumed to be self-explanatory.

1. **Science Learner** is a student in grades 3 to 8 in the public schools in the mid-Willamette Valley region of the State of Oregon. The student is not categorized as having visual, hearing, or emotional handicaps that would interfere with participation in the study.

2. The science **laboratory** is a student-centered learning environment in which students are provided the opportunity to physically and in an active, hands-on manner manipulate materials, collect data, and draw conclusions.

3. **Laboratory behavior** is operationally defined as that which is included in the behavioral intention
item(s) of the final instrument.

4. **Non-laboratory** refers to the science learning environment that does not focus on the activities/processes previously mentioned with respect to the laboratory. The non-laboratory environment is generally more teacher-centered with students (a) listening to the teacher (or some audio device), (b) reading science-related literature, (c) writing literature-based reports or completing worksheets, (d) watching the teacher (or person on a visual medium) do demonstrations, or (e) giving oral reports to the teacher or classmates.

5. **Non-laboratory behavior** is operationally defined as that which is included in the behavioral intention item(s) of the final instrument.

**Assumptions**

1. The theory of reasoned action is a valid model for use in the understanding and prediction of behavioral intention.

2. The constructs in the theory of reasoned action and the selected external variables are measurable.

3. The subjects respond honestly to the instruments.

**Limitations**

1. The study is limited by the extent to which subjects respond honestly to the items on the instruments.
2. The study is limited to public school students in grades 3 to 8 in the mid-Willamette Valley region of the State of Oregon, and the students are not categorized as having visual, hearing, or emotional handicaps that would interfere with participation in the study.

3. Only two external variables are measured and analyzed.

4. The theory of reasoned action is the theoretical model used.

Organization of the Remainder of the Study

Literature which is related to the study will be reviewed in Chapter II. The methodology that was employed will be described in Chapter III. Briefly, the study is exploratory in nature and baseline information regarding the determinants of intention is to be generated. The data are to be analyzed using correlational techniques. The findings will be presented in Chapter IV. A summary, conclusions, and recommendations will be presented in Chapter V.
Chapter II
Review of Related Literature

Organization of the Chapter

This chapter is meant to examine the literature which is closely related to the purpose of this study. First, literature dealing with the theory of reasoned action will be reviewed. Second, literature related to the intentions that were studied will be examined. Third, literature pertaining to the external variables of gender and grade level will be reviewed. A detailed theoretical framework and rationale for the study will be woven throughout the review of literature.

Theory of Reasoned Action

Calls for sound, theoretical approaches to science education research have come from various sources (e.g., Haladyna, Olsen, & Shaughnessy, 1983, on attitude toward science; Koballa & Crawley, 1985, on determinants of behavior; Linn, 1987, on a more integrated approach among science education researchers; Zeidler, 1984, on giving adequate attention to theoretical guidelines in attitudinal research). The point they made was that science education researchers must develop a logical, and eventually empirical, basis and argument for expecting research to provide what they hope for and treatments to cause what they desire. This thought should be kept in
mind as science educators strive to affect science
learners’ behavior.

One needs an understanding of the determinants of
behavior in order to have a rational and effective
approach to developing relevant research, and in order to
change the target behavior. Under this assumption, it is
relevant to note that substantial evidence has suggested
that the construct most closely associated with behavior
is behavioral intention (Ajzen & Fishbein, 1980; Fishbein
& Ajzen, 1975). Furthermore, there is an extant model
which has proven helpful in understanding the precursors
of intention. The paradigm is the theory of reasoned
action.

The theory of reasoned action was proposed by
Fishbein and Ajzen (1975). The model is founded on

. . . the assumption that most actions of
social relevance are under volitional control
and, consistent with this assumption, our
theory views a person’s intention to perform
(or to not perform) a behavior as the
immediate determinant of the action. (Ajzen &
Fishbein, 1980, p. 5)

The main interest of the model is the prediction and
understanding of behavior and its determinants (see
Figure 1).

The theory holds the view " . . . that people use
the information available to them in a reasonable manner
to arrive at their decisions" (Ajzen & Fishbein, 1980, p.
These decisions may not always be carefully thought out, reasonable, or appropriate from an objective point of view, Ajzen and Fishbein added. Nevertheless, one's beliefs are based on the information that is at his or her disposal. The two types of beliefs are behavioral beliefs and normative beliefs. These beliefs are, in turn, systematically linked to attitude toward behavior and subjective norm, intention, and finally behavior. The theory posits that there is a sequence in which each stage follows reasonably from the preceding stage. It is reasonable for people to weigh their personal feelings (attitude toward the behavior) and perceived social pressure (subjective norm) in arriving at and carrying out their intentions. Together, the processes in this sequence comprise a theory of reasoned action (Ajzen & Fishbein).

The model can be algebraically represented by three equations (Fishbein & Ajzen, 1975):

(1) \[ B - BI = w_1(A_b) + w_2(SN) \]

(2) \[ A_b = \sum_{i=1}^{n} b_i \cdot e_i \]
Using the model, it is supposed that the intention (BI) to perform a certain behavior (B) is a function of the weighted \( w_1 \) attitude toward performing a behavior \( (A_B) \) and the weighted \( w_2 \) subjective norm (SN) (equation 1). Ergo, a behavioral intention consists of a personal and a social component.

The "attitude toward the behavior" is the individual's feelings about performing (or not performing) the behavior. It is a function of the expected consequences or outcomes of behavior (beliefs = \( b_i \)) and the evaluations of these expected consequences or outcomes (evaluations = \( e_i \)) (equation 2). This personal component, attitude, can be measured directly by asking the person to rate the performance of the behavior on a scale. Or, attitude toward the behavior \( (A_B) \) can be measured indirectly by summing salient attitudinal belief scores, \( \sum b_i \cdot e_i \). It should be noted that attitude toward the behavior (e.g., do science projects and science experiments) is not synonymous with attitude toward an object (e.g., science).

Subjective norm is the term for the social
component. It is the person's perception of the pressures by important others, or referents, to perform (or to not perform) the specific behavior. In the model, it is a function of normative beliefs regarding the performance of the behavior ($nb_j$) and the motivation to comply with these beliefs ($mc_j$) (equation 3). As for the personal component, subjective norm can be measured directly; or it can be measured indirectly by summing salient normative belief scores, $\Sigma nb_j * mc_j$.

In summary, "... a person's behavioral intention is viewed as a function of two factors: his attitude toward the behavior and his subjective norm" (Fishbein & Ajzen, 1975, p. 16). Any other variables are thought to affect intention only as mediated by attitude toward the behavior and subjective norm.

The theory of reasoned action should prove helpful in planning future science education experimental research, since it is likely that its use will generate information on the determinants of science learning behavior. There are a multitude of examples of how the theory has been successfully used to explain behavioral intentions and behaviors.

For illustrative purposes, some studies that employed the theory of reasoned action will now be described. Hom and Hulin (1981) used the theory of reasoned action to predict Army Guardsmen's reenlistment
intentions and behavior. They also used three other models for prediction and compared the four models in terms of competitiveness with respect to predictive strength. Hom and Hulin followed the protocol of the theory of reasoned action's authors in constructing the instrument items related to the theory of reasoned action. Validity of the items was apparently insured by following the protocol of Ajzen and Fishbein (1980). Reliability was not addressed in the report. In terms of analytic method,

Each reenlistment criterion was separately regressed on each model. To maximize sample size, subjects were eliminated from a regression analysis if they missed data on the variables involved in that regression, but they were not necessarily eliminated from another regression analysis involving different variables .... ... sample size varied with different regression analyses. (Hom & Hulin, p. 27)

The sample size varied from 202 to 1,046. The analysis resulted in the correlations depicted in Figure 3. The correlation between intention and behavior was .70. The authors did not specify whether they used the point-biserial correlation, which would have been the appropriate technique since a true dichotomy was involved in the behavior variable. However, if they in fact used the product-moment correlation then the point-biserial would have yielded an even higher correlation value. The authors concluded that the theory of reasoned action and
Figure 3. Reported findings of Hom and Hulin (1981) study.
one other model were effective in predicting behavior, and were superior to the other two models studied. Hom and Hulin also discussed how the information generated by the theory of reasoned action might be used to affect the behavior of people. Hom and Hulin mentioned the use of a decisional balance sheet, which requires that an individual contemplating an important decision anticipate for each alternative course of action the utilitarian gains or losses for the self and significant others, the reactions to a particular choice by the referent others, and that alternative’s effects on personal moral standards and ego ideals. (p. 36)

Hom and Hulin suggested that this might be a way to help employees become more aware of their own ideas and make more systematic decisions about career choices. Hom and Hulin’s discussion suggests one way that the understanding of behavioral determinants might be put to practical use.

In a second study, Bowman and Fishbein (1978) utilized the theory of reasoned action to understand voter decision making on an energy ballot proposal. They basically followed the protocol outlined by Ajzen and Fishbein (1980) to develop the instrument; this apparently ensured validity of the instrument. This author could not find that Bowman and Fishbein addressed the reliability of their instrument. Regression analysis was used to analyze data from 89 subjects. The significant (p < .01) correlations are depicted in Figure
4. The correlation between intention and behavior was .89 (df = 71, p < .01). The authors did not specify whether they used the point-biserial correlation, which would have been the appropriate technique since a true dichotomy was involved in the behavior variable. However, if they in fact used the product-moment correlation then the point-biserial would have yielded an even higher correlation value. The theory of reasoned action model's predictions were strongly supported by the data.

Lin (1987) used the theory of reasoned action to investigate factors that influence industrial education instructors to use computers for instruction. Lin randomly selected 210 secondary teachers of industrial arts and/or trade and industrial education in Oregon; usable instruments were received from 165 subjects. "The construction of the instrument was based on guidelines given by Ajzen and Fishbein (1980)" (Lin, p. 36), and this procedure theoretically ensures the instrument's validity. Although Lin apparently did not elicit salient beliefs from a subsample to begin with, he did do a pilot study in order to revise the instrument. Using Cronbach's alpha, the internal consistency coefficients were .92 for attitude toward the behavior, .91 for normative beliefs and motivations to comply scores, and .82 for behavioral beliefs and outcome evaluations
Figure 4. Reported findings of Bowman and Fishbein (1978) study.
scores. Internal consistencies for subjective norm and behavioral intention could not be estimated because the measures included only one or two items. Validity of the items was apparently insured by following Ajzen and Fishbein’s protocol and making sure that the items corresponded closely with the behavioral criterion. Multiple regression and partial correlations were used to analyze the data. Figure 5 represents some of the reported results. Lin concluded that teachers’ attitudes toward using computers for instruction "and their perceptions of the opinions of other were relatively good predictors of their intentions to use computers (65 percent of the total variance)" (p. 56). Finally, the researcher discussed how information from his study might be used to change the behavior of teachers in terms of using computers. For example, the opinions of significant others is one of the three most fundamental means of influencing these teachers. The most influential significant others were educational experts, and therefore they should be encouraged to be the ones to communicate to industrial education teachers the importance of computers in instruction.

Riddle (1980) used the theory of reasoned action to study the beliefs, attitudes, and behavioral intentions of men and women toward regular jogging. Riddle followed the protocol of the theory’s authors to construct the
Behavioral Beliefs and Outcome Evaluations  $r = .53$

Normative Beliefs and Motivations to Comply  $r = .63$

Attitude toward Behavior  $r = .80$

Behavioral Intention  $R = .81$

Subjective Norm  $r = .71$

**Figure 5.** Reported findings of Lin (1987) study.
survey instrument. By readministering (at least two weeks later) the instrument to 63 of the 296 subjects, the correlation coefficients representing consistency of the instrument were .867 for behavioral beliefs and outcome evaluations scores, .775 for normative beliefs and motivations to comply scores, and .718 for attitude toward the behavior. Multiple correlations and regression statistical procedures were used to produce the (apparently) significant values reported in Figure 6. The correlation between intention and behavior was .820. The author did not specify whether she used the point-biserial correlation, which would have been the appropriate technique since a true dichotomy was involved in the behavior variable. However, if Riddle in fact used the product-moment correlation then the point-biserial would have yielded an even higher correlation value. "The theoretical tenets underlying Fishbein’s behavioral intention model were supported in this study" (Riddle, p. 671). In terms of practical use, health educators should be able to apply the findings generated via the theory of reasoned action in "their attempts to motivate volitional behavior change" (Riddle, p. 673).

Koballa (1986) used the theory of reasoned action in the realm of science education to investigate the relationship between prospective elementary teachers' attitudes, subjective norms, and intentions to teach science using hands-on
Figure 6. Reported findings of Riddle (1987) study.
activities at least twice a week during their first year of employment. (p. 493)

The sample was comprised of 5 male and 71 female preservice teachers enrolled in several sections of an elementary science methods course. They had received instruction on how to teach science using hands-on activities. Measures of attitude toward the behavior, subjective norm, and behavioral intention were constructed as prescribed by Ajzen and Fishbein (1980). The "coefficient alphas for the [attitude toward behavior] scales were reported at 0.91 and 0.93" (p. 497). Item-total correlation coefficients for the scales ranged from .43 to .63. Koballa stated that the content validity for the three scales was evidenced by their correspondence with the behavioral criterion. A correlational design was employed; product-moment correlation coefficients and multiple correlation coefficients were calculated. There was a significant correlation between attitude toward the behavior and behavioral intention ($r = .67, p < .01$), and Koballa reported that the data generally supported the theory of reasoned action.

Stead (1985) also utilized the theory of reasoned action to do a study in the area of science education. The model was used to explore students' intentions, including gender differences, to study or not to study
science. The subjects were 71 males and 81 females in several New Zealand high schools. Stead followed the Ajzen and Fishbein (1980) pattern for developing their instrument. Reliability and validity of the instrument were not stated. However, it appears that the researcher did follow the protocol prescribed by Ajzen and Fishbein. Contrasts between males and females were preformed using t-tests, while simple and multiple correlations were used to determine the strength of relationships among the theory's constructs. Four t-tests found males and females to differ significantly ($p < .05$) in terms of behavioral intention and normative beliefs and to differ significantly ($p < .01$) in terms of attitude toward the behavior and beliefs about the behavior. The results of regression analyses are presented in Figure 7. (The $p$ values for the regression analysis were not reported.)

Stead reported that the theory of reasoned action was useful in terms of developing an instrument with a sound theoretical rationale and in terms of providing "... an explicit rationale for allowing for the analysis, description, prediction and application of the findings s [sic] generated" (p. 85).

A consideration of the preceding studies, and the multitude of others that have tested or used the theory of reasoned action (e.g., Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975), substantiates its strong
Figure 7. Reported findings of Stead (1985) study.
theoretical foundation and its potential for practical applications. As Fredricks and Dossett (1983) stated, "the practical significance of identifying those variables that ultimately affect . . . behavior . . . is obvious" (p. 512).

Intentions to be Studied

A principal concern of science educators is the science learning behavior, and the subsequent scientifically literate behavior, of students. These educators strive to engage students in activities that are designed to improve their performance or affect in various areas (NSTA, 1982). Namely, science educators desire students to (a) improve in their process skills, such as observing, classifying, and hypothesizing, (b) gain knowledge of science concepts and facts, such as evolution and that DNA is genetic material in organisms, (c) have positive attitudes toward science, such as the evaluation that biology can improve the standard of living of people worldwide, (d) be better able to address and examine social issues that meld the effects of science and technology, such as "What are the costs and benefits to society of in vitro fertilization of human eggs?," and (e) be prepared to make decisions, in a rational manner, about problems and issues that society faces in the realm of science and technology. Science educators plan to achieve the preceding goals by
providing time and activities to students during which they can essentially experience or practice all of the things/processes previously listed. It is assumed that the learners must in fact engage in the provided activities in order to become scientifically literate. Under the theory of reasoned action, then, it is possible to know what the immediate determinants of behavior are for particular behaviors.

**Uniqueness of science learning.**

The determinants of science learning behavior are expected to be unique to science for several reasons. First and from a logical point of view, if the determinants of behavior and their relative weights for a given person (or class of people) were the same with respect to all subject content areas, then one would expect that person to perform equally in all content areas of schooling. Contrariwise, it is evident that the learner who is always on task and receives high marks in mathematics does not necessarily do the same in reading and physical education. The performance or non-performance of behaviors by an individual differs with respect to the behavior under examination.

Second, it is quite clear that the school subject of science is different from other school subjects in many ways. That is to say, the content under study in science, such as photosynthesis, is substantively
different from the content under study in reading/language, such as a novel about life on the North American prairies in the late 1800s. Likewise, the processes frequently used in science instruction, such as controlling variables, are not commonly used in other areas such as reading/language. An observer might intuitively or logically expect children to have different intentions to behave depending on whether they were involved in science or reading/language learning activities. The expectation that intentions to behave will differ with respect to the behavior under study is fulfilled if one considers the various intentionality studies previously discussed herein. Further discussion about the uniqueness of the school subject science will follow later in this section with respect to the science laboratory.

Third, the theoretical considerations of the theory of reasoned action argue that it is highly probable that an individual's intentions and behavior in the milieu of science will be unique to that school subject. Ajzen and Fishbein (1980) stated that "... the substantive explanation of behavior ... varies from one content area to another ..." (p. 245). Or, as Koballa and Crawley (1985) worded it, the attitude-behavior link is content dependent. Furthermore, and from a more general approach, Linn (1987) stated that
the new consensus about the learner reflected in recent research extends the ... view ... that learners build conceptual frameworks that are complex, highly organized, and strongly tied to specific subject matter. (p. 196)

The theory of reasoned action has been previously explained and an examination of its constructs makes manifest how it is that the determinants of intention and behavior are unique to the behavior that is under consideration. To begin, the expected consequences or outcomes of a behavior that an individual expresses are specific to that behavior. For example, a student's expectation that doing his science book reading could make him a better doctor some day is perhaps unlikely to be an expectation that he would have with respect to history book reading. In like manner, the evaluation of the outcome of a behavior is specific to that outcome of that behavior. Namely, the student's evaluation that being a doctor would be a very good thing is not necessarily the evaluation that he would have with respect to becoming an author. These expected consequences and evaluations that are unique to performing a school science behavior are the determinants of the personal attitude toward the behavior. Therefore, the attitude toward the science learning behavior is unique to that science learning behavior.

Likewise within the theory of reasoned action, the
normative beliefs that an individual expresses with respect to a behavior are considered specific to that behavior. For example, a student's belief that his grandparents want him to do his science book reading is not necessarily a belief that would apply to his history book reading. In like manner, the motivation to comply with his grandparents' desires with respect to a behavior are specific to that behavior. That is to say, the student's high motivation to comply with his grandparents' desires for him with respect to reading science is not necessarily the same as his motivation to comply with his grandparents' desire for him to reading history. These normative beliefs and motivations to comply are the determinants of the subjective norm with respect to a behavior. Ergo, the subjective norm with respect to science learning behavior is unique to that science learning behavior.

Following the theory of reasoned action, the personal attitude toward performing a science learning behavior and the subjective norm with respect to performing a science learning behavior are the two determinants of intention to perform that behavior. Since the attitude toward the behavior and the subjective norm are unique to this science learning behavior, it follows that the intention is unique to the science learning behavior. Finally, the theory of reasoned
action predicts that a person's particular behaviors in the science learning milieu are unique to that milieu. In other words, "... the substantive explanation of behavior provided by the theory of reasoned action varies from one content area to another ..." (Ajzen & Fishbein, 1980, p. 245). Each content area is comprised of unique combinations of the action, target (object), context, and time elements.

The preceding discussion of the theory of reasoned action included three reasons that the intention to behave in the science learning environment will probably be unique to that environment.

**Laboratory and non-laboratory science.**

Within the context of the general science learning environment, there are at least two dissimilar microenvironments which students can and do experience: laboratory and non-laboratory. One would expect the determinants of behavior (and their weights) in these two contexts to vary. The following is an explanation of the two pedagogical microenvironments and of why the behavioral determinants in them are expected to vary.

The nature of the laboratory and what its role should be in science education has been discussed and debated for many years (Bates, 1978; Blosser, 1980; Hofstein & Lunetta, 1982; Shulman & Tamir, 1973; Tamir, 1976). Regardless of the many considerations and
conflicting arguments, the laboratory and its attributes have persisted in demanding attention from science educators (NSTA, 1982). There have been many discussions about the educational objectives of the laboratory and the educational outcomes of the laboratory, but the idea remains that "the laboratory is an instructional approach unique to science teaching" (Collette & Chiapetta, 1984, p. 69). Likewise, Shulman and Tamir (1973) stated, "the laboratory has always been the most distinctive feature of science instruction" (p. 1118). Shulman and Tamir explained the three major rationales for a strong emphasis on the laboratory as follows:

1. The highly complex and abstract concepts of science might not be grasped " . . . without the concrete props and opportunities for manipulation afforded in the laboratory" (p. 1118).

2. Students are allowed to enquire, to actually collect data and analyze real phenomena, and to gain an appreciation of science; the laboratory " . . . provides a real image of science" (p. 1118).

3. "Students enjoy activities and practical work . . . " (p. 1118).

The science laboratory is a student-centered learning environment in which students are provided the opportunity to physically and in an active, hands-on manner manipulate materials, collect data, and draw
conclusions. Furthermore, students in the science laboratory might engage in various other processes of science (Showalter, 1974a, 1974b) such as classifying, designing experiments, hypothesizing, measuring, and questioning.

Non-laboratory refers to the science learning environment that does not focus on the activities/processes previously mentioned with respect to the laboratory. The non-laboratory environment is generally more teacher-centered with students (a) listening to the teacher (or some audio device), (b) reading science-related literature, (c) writing literature-based reports or completing worksheets, (d) watching the teacher (or person in a visual medium) do demonstrations, or (e) giving oral reports to the teacher or classmates. These non-laboratory activities/processes are not unique to science, but are considered by many to be essential to science education. Both the laboratory and non-laboratory microenvironments have been for a long time, and will probably continue to be, vital components of science education. Therefore, it is important to know and understand the determinants of intentions to engage in both laboratory and non-laboratory learning activities or behaviors.

The preceding discussion has indicated that laboratory and non-laboratory science learning behaviors
are theoretically dissimilar from one another. It is expected that the behavioral determinants (and their weights) will differ with respect to laboratory versus non-laboratory science learning environments. The reasons for this expectation are parallel to those given for expecting the determinants between intentions to engage in science learning and intentions to engage in reading/language learning to be different.

To summarize the preceding relevant discussion, the reasons fall into three major categories. First is the logical argument that if determinants (and their relative weights) were identical for the two behaviors under study, the behaviors of an individual with respect to the two behaviors would be identical. Contrarily, it is often observed that this is not the reality of student behavior with respect to laboratory and non-laboratory situations. Second, it is evident that laboratory and non-laboratory activities and associated student behaviors are not identical. Studies previously discussed support the conclusion that the determinants (and their relative weights) of different behaviors do in fact differ. Third, various studies indicate that the two science learning microenvironments may result in diverse learner outcomes, which in turn would result from different behaviors and different behavioral determinants.
One of Hofstein and Lunetta’s (1982) summary statements relates to the learner outcomes of laboratory and non-laboratory environments:

... researchers have not comprehensively examined the effects of laboratory instruction on student learning and growth in contrast to other modes of instruction, and there is insufficient data to confirm or reject convincingly many of the statements that have been made about the importance and the effects of laboratory teaching .... The research has failed to show simplistic relationships between experiences in the laboratory and student learning. (p. 212)

The authors of comprehensive reviews of literature or research on the science laboratory (Bates, 1978; Blosser, 1980; Hofstein & Lunetta, 1982; Shulman & Tamir, 1973; Tamir, 1976) seem to make similar inferences. For example, all of the aforementioned reviewers cited the Yager, Engen, and Snider (1969) study on the effects of the laboratory and demonstration upon instructional outcomes in secondary biology. The researchers compared three groups (discussion approach only, discussion-demonstration approach, and discussion-laboratory approach) in terms of outcomes. No significant differences (p > .05) between the three groups were found in terms of (a) critical thinking, (b) understanding of science or scientists, (c) attitude toward biology, and (d) knowledge of science and achievement in biology. However,

Students who experience science by performing
demonstrations or those experiencing numerous laboratories develop more skill (0.05 level of significance) with laboratory materials and procedures than students who experience neither demonstrations nor laboratories. (Yager et al., p. 85, 86)

Simultaneously, the researchers stated emphatically, "This is not to say that all laboratories should be abandoned since it has not been shown that specific values are inherently possible with a laboratory approach" (Yager et al., p. 84, 85). The aforementioned study was cited by the reviewers of research on the science laboratory as a well designed piece of research which yielded valid results.

However, the study was not necessarily free of all the defects (e.g., use of inappropriate instruments to measure changes or results) which Blosser (1980) listed as characteristic of research on the science laboratory. Blosser suggested that if researchers would pay attention to the common defects of laboratory related research and follow certain recommendations (e.g., be familiar with and avoid errors in research design and methodology, "... make certain the instruments they use to measure outcomes are valid, reliable, and appropriate for their purposes" (p. 130), and execute long-term studies), then the benefits of the laboratory might be more clearly significant.

The previously mentioned reviewers of science
laboratory literature commonly stated that there have been few significant differences in learner outcomes between students who experienced the laboratory environment and those who did not. However, some differences were indicated. Blosser (1980) grouped together and reviewed 15 studies that spanned the years 1963 to 1979 which compared the outcomes of laboratory versus no laboratory. She stated that

In this cluster, the use of the laboratory appeared to help in the development of critical thinking ..., in learning and retention ..., and in generating more favorable attitudes toward school ..., as well as in producing student interest and enthusiasm .... It also helped students pretesting below the median to learn more material ..., as well as enabling students to apply laboratory experiences .... (Blosser, p. 66)

Likewise, Hofstein and Lunetta (1982) found evidence that the laboratory may be superior, in some respects, to non-laboratory learning in terms of the following areas: (a) student creative thinking and problem solving, (b) scientific thinking, (c) intellectual development (e.g., working with concrete objects), (d) practical skills and abilities (e.g., observation and manipulation), (e) attitudes toward and interest in science, and (f) developing interpersonal relationships. The preceding aspects are of interest to science educators, and further research which follows the recommendations of Blosser (1980) and Hofstein and Lunetta may very well provide
more significant results related to the unique contributions of the science laboratory.

In conclusion, logical arguments and opinion still strongly favor the idea that the laboratory is a unique and essential aspect of science education (Blosser, 1983; NSTA, 1982; Yager, 1983; Yager, Klein, & McCurdy, 1981). Furthermore, although research is equivocal as to the exact benefits of the laboratory, there is evidence which suggests that the science laboratory causes learner outcomes that are not the same as those resulting from non-laboratory environments. Whether laboratory is used, how it is used, and to what extent it is used appears to result in some different science learner outcomes. It is here suggested that different behavioral outcomes of laboratory and non-laboratory microenvironments result from different behaviors and dissimilar behavioral determinants.

The third reason to expect the behavioral determinants to differ between laboratory and non-laboratory learning environments is that the theoretical considerations involved in the constructs of the theory of reasoned action indicate that it is highly probable that an individual's intentions and behavior are unique to unique milieus. This point was previously elaborated upon. In summary, there are at least three significant lines of thought to support the idea that the immediate
determinants (and their relative weights) of laboratory and non-laboratory science behavior are different.

**External Variables**

The focus of this discussion has been on the immediate determinants (and their weights) of science learning behavior. The theory of reasoned action is also capable of considering external variables and their influence on intention and behavior via the constructs of attitude toward behavior and subjective norm. (See Figure 1 and previous discussion.) Several correlates of science achievement, which is a result of behavior, have been investigated. Within the framework of the theory of reasoned action, any factor which might bear directly on behavioral beliefs and outcome evaluations or normative beliefs and motivations to comply is a factor which may be of interest to science educators. Gender and grade level are two factors which consistently appear in the literature and are apparently related in some way to science achievement and attitudes related to science.

**Gender.**

Various reports have indicated differences between males and females in terms of their attitudes toward science. Schibeci (1983) reported that "sex appears to influence attitudes: boys display more favorable attitudes to science than girls" (p. 599). Cannon and Simpson (1985) studied seventh grade life science
students in North Carolina. The attitude toward science subscale, that was from an attitude questionnaire, had a Kuder-Richardson 20 (KR 20) reliability of .95 for their study. An expert panel had reviewed the overall instrument for content validity, reported the authors. The achievement test had a KR 20 reliability of .91. Content validity of the achievement test was determined by the group of staff members of the cooperating school system and the professional test writing specialist who developed the test. Post hoc comparisons were made using the Newman-Keuls multiple comparison technique. The analysis indicated that "... there are significant differences in science attitude and achievement by gender. Males had more positive attitudes toward science and achieved higher ..." (p. 134).

Hasan (1985) studied the attitudes toward science of 313 randomly selected eleventh grade science students (153 male and 160 female) in Jordan. His 32-item Attitude Toward Science scale had split-half reliabilities of either .68 or .63. (The report was ambiguous.) Content validity was achieved by constructing items that corresponded to five listed categories. Further evidence of validity was "... established through obtaining a significant difference (α = 0.05) between achievement mean scores of science and literary groups of grade eleven students
... " (p. 7). (Perhaps the author means a difference between scores on the attitude instrument.) Multiple linear regression analysis was utilized. Whether a particular variable (e.g., father's level of education, motivation of science teacher, and perception of self's science abilities) was significantly related to attitude toward science depended on gender in some of the cases.

Simpson and Oliver (1985) studied the attitude toward science of male and female science students in grades 6 through 10. Twelve schools were randomly selected from the 55 that comprised the North Carolina school system. The study included 178 science classes, 57 teachers, and about 4,000 students. With regard to the attitude toward science scale, the authors reported: "Item reliability scores and factor analytic data revealed that the final seven Likert scale items measured consistently and parsimoniously the construct of attitude toward science" (Simpson & Oliver, p. 512). Cronbach's alpha was .94. The seven items were listed (e.g., "Science is fun" and "I have good feelings toward science") and appear to have a reasonable correspondence with the construct of attitude toward science. Analysis of variance showed that "males exhibited significantly more positive attitudes toward science than females" ($F[1] = 34.55, p = .0001$) (Simpson & Oliver, p. 521) even though "female students ... were significantly more
highly motivated to achieve in science than were their male counterparts" ($F[1] = 76.52, p = .0001$) (Simpson & Oliver, p. 523).

Willson (1983) performed a meta-analysis of 43 studies involving the relationship between science achievement and science attitude (apparently attitude toward science). Studies included elementary through undergraduate (in college) students. With regard to the relationship between positive attitude toward science and high science achievement, "Sex differences occurred at elementary and senior high levels with similar pattern [sic] repeated for junior high: males exhibit a generally higher correlation than females" (Willson, p. 849). That is, among males there was a higher correlation between attitude and achievement in science than there was for females. This is not to say that one sex had higher science achievement nor to say that one sex had a more positive attitude toward science.

Welch, Walberg, and Fraser (1986)

... made use of data collected during 1981-1982 from a random sample of 1960 nine-year-old students from 124 elementary schools involved in a national assessment of educational progress in science sponsored by the National Science Foundation. (p. 699)

Achievement was measured via a 29-item instrument which covered science content, inquiry skills, and science-technology-society interactions. The validity of the
instrument was not addressed in their report. The Cronbach alpha coefficient of reliability for the instrument was .79. Multiple regression analysis was used to analyze the data. Gender was significantly $(p < .01)$ related to achievement. Gender was not significantly related to attitude (which was, apparently, attitude "toward" science).

On the other hand, there is evidence that gender of student is not significantly related to science achievement or attitude toward science. Shymansky et al. (1983) performed a meta-analysis on 105 experimental studies that examined the effects of new science curricula on the performance of more than 45,000 students, elementary through high school age. New science curricula were defined as those which

(a) were developed after 1955 . . . , (b) emphasize the nature, structure, and processes of science, (c) integrate laboratory activities as an integral part of the class routine, and (d) emphasize higher cognitive skills and appreciation of science. (Shymansky et al., p. 388)

Traditional curricula, in contrast, were defined as emphasizing knowledge of facts, laws, theories, and applications and using "laboratory activities as verification exercises or as secondary applications of concepts previously covered in class" (Shymansky et al., p. 389). Coding variables were identified and 94.8% agreement was attained between the two coders. Mean
effect sizes, minimum delta, maximum delta, and standard deviations were calculated for the 18 criterion variables. Shymansky et al. reported that

The composite performance results indicate that predominantly male and predominantly female samples perform equally well, about one-quarter standard deviation better than their traditional course comparison groups. The substantially greater composite mean effect size for the mixed samples, however, is not explained easily. Perhaps there is a social dimension to learning and liking science that must be accounted for in the classroom!

Further analysis of the data reveals three interesting features. First, the mixed group samples performed more positively than the male and female samples on four of the six criterion clusters. Such consistency possibly alludes to favorable interactions occurring in science classrooms with mixed populations and ultimately leading to increased performance outcomes. Second, although based upon a small sample size, the predominantly female groups performed more positively on achievement measures ($\Delta = 0.55$) than did predominantly male ($\Delta = 0.25$) or mixed ($\Delta = 0.45$) groups. (p. 397, 398)

Shymansky et al. also found that predominantly female groups responded more positively on affective measures (including attitude toward science) ($\Delta = .32$) than did predominantly male groups ($\Delta = -.02$), but not as well as did mixed groups ($\Delta = .51$).

In another vein, Linn, Benedictis, Delucchi, Harris, and Stage (1987) analyzed data which showed gender differences, and they provided a logical explanation for why the differences might exist. The data they used came from the 1976-1977 assessment of 17-year-olds done by the
National Assessment of Educational Progress (NAEP). Linn et al. constructed a "test" out of the cognitive items in each of the three NAEP booklets. They reported that

A total "I don't know" score was constructed by counting the number of "I don't know" responses for each student. To assess whether there were gender differences on items requiring spatial visualization, the items in booklet 4 were categorized by presence or absence of spatial visualization content. The authors judged each item as either requiring spatial visualization or not. Interrater agreement was very high. Disagreements arose for less than 10% of the items. (Linn et al., p. 269)

The researchers reported that their constructed tests were reliable. "Split-half correlations averaged 0.83 for total [cognitive items] score and 0.89 for 'I don't know' responses" (Linn et al., p. 270). The validity of their instrument was partially established via the logical argument for why and how it was constructed. In addition, they apparently assumed that the NAEP test items were valid measures of science achievement and attitude toward science. The authors reported that the large sample size made most results across subjects statistically significant.

Linn et al. (1987) reported that "Males had higher [cognitive items] total scores than did females . . . " with an average effect size of .27 of a standard deviation (p. 270, 271). They also reported that

... performance on spatial visualization items did not explain gender differences.
A considerable body of research suggests that there are no differences on spatial visualization if this dimension is taken to mean analytic reasoning about figurally presented information. (Linn et al., p. 271)

Linn et al. further reported that attitudes toward science in four categories (i.e., liking of science, attitudes toward science teachers, usefulness of science, and participation in informal science activities) did not differentiate between the sexes. One particularly interesting finding was that "Of those who never used the 'I don't know' response, there were more males than females. Also, females answered 'I don't know' more frequently than did males. . . ." (Linn et al., p. 273).

Linn et al. suggested that perhaps "I don't know" is used by females more than males due to cultural and psychological factors (e.g., willingness to take risks), as well as the knowledge factor. "Males and females differ in their knowledge of science content but not in science inquiry skills" (Linn et al., p. 277). Linn et al. apparently suggested that the gender difference in knowledge is not necessarily the result of inherent male-female differences, but rather it may be a result of social, psychological, instructional, and test item patterns. The researchers suggested that changes can be made which might eliminate gender differences in science content scores.
In conclusion, various studies (including those previously mentioned) have indicated that there may be significant differences between males and females in terms of the variables of attitudes toward science and science achievement. The research is ambivalent, however.

At this point it is important to stress that attitude toward science is attitude toward an object. This is not synonymous with attitude toward a science learning behavior. In fact, Ajzen and Fishbein (1980) emphasized that "... research has usually found no relation between attitudes toward targets [or objects] and specific behaviors ..." (p. 89). On the other hand, attitude toward the object (science), when considered as an external variable, may have a general and significant influence on attitude toward a particular science learning behavior. Therefore, the idea arises that since males and females may have different attitudes toward science in general, it would be wise to control for this external variable in the study of determinants of behavior.

In the same vein, studies have indicated that there may be differences between males and females in terms of science achievement. Differences in achievement are likely to be a result of differences in learning behavior. Since there may be a difference between males
and females in terms of science learning behavior, use of the theory of reasoned action suggests that the determinants of science learning behavior may in part depend on gender of the learner as an external variable. Again, the idea exists that since the determinants of science learning behavior may be influenced by a student’s gender, it would be wise to control for this external variable.

Grade level.

Many studies have indicated that attitude toward the object science may be grade-dependent. Talton and Simpson (1986) studied the relationships of several variables to attitude toward science of grades 6 to 12 students from 12 schools that were selected via a stratified random sampling of a 55-school system. The attitudes toward science subscale of their instrument had a Cronbach alpha reliability of .91. The authors did not explain the instrument validation procedure. Multiple linear regression was used in this correlational study. Talton and Simpson found significant differences between grades in terms of which variables explained significant amounts of variance in attitude toward science. It should be noted that this was not a longitudinal study, and therefore the attitudes of the same students were not analyzed over time from the sixth to the twelfth grade.

Simpson and Oliver (1985) (previously described)
also found significant differences in attitude toward science across grades 6 to 10 ($F[4] = 22.99, p = .0001$). Generally, there was an inverse relationship between grade and attitude toward science. This was not a longitudinal study that traced the same students over time.

In a third study, Bohardt (1974) examined changes in attitude toward process-based science programs of grades 4 to 8 children. He used an "attitude opinionnaire" to collect data and item analysis, analysis of variance (ANOVA), and Pearson correlation coefficients were employed to analyze the data. There was no information given regarding the reliability or validity of the instrument. "The multiple classification analysis of variance revealed a strongly significant negativism toward process-based science as students moved upward thorough the grades" (Bohardt). This apparently was not a longitudinal study.

A fourth study that considered grade level and attitudes toward science was done by Haladyna, Olsen, and Shaughnessy (1982). Stratified random sampling was used to select schools and students from throughout the State of Oregon. Sample sizes were 649, 630, and 686 for grades 4, 7, and 9. Reliability and validity of the 4-item attitude toward science subscale (which was part of an instrument not reported on in the article) were not
reported. However, this author obtained a manual by Haladyna and Shaughnessy (1982) that provided some reliability data. The coefficient alpha for grade 7 was .67, and for grade 9 it was .80. Product-moment correlations and multiple regression were used in this correlational study. The four items constituting the subscale were reported by Haladyna, Olsen, and Shaughnessy; they are related to a student's emotive responses to involvement in science class. Concerning the amount of variance in attitudes toward science explained by predictor variables, the authors said, "... it seems that relationships are stronger in the higher grades ..." (Haladyna et al., p. 681). Again, this was not a longitudinal study that followed the same students over time.

Although the four previously mentioned studies did not provide conclusive evidence, they did indicate the strong possibility that there was a relationship between grade and attitude toward science.

Some research has also suggested that a student's interest in or intention to enroll in science courses may be stable and possibly difficult to alter by the time he or she is in the ninth grade. Olstad and Haury (1984), in their summary of science education research, were concerned "that positive attitudes [toward science] are negatively associated with grade level ...," and that
attitudes have an effect on student selection of science coursework (p. 230). The NAEP 1979 study (cited in Koballa & Crawley, 1985) indicated "that as early as Grade 3, 50 percent of the students no longer are interested in studying science" (p. 224). Yager (1983) stated, "We also know from research that students find science less exciting, less interesting, and less useful the longer they study it in school" (p. 27). Linn (1987) recently made recommendations for a research base in science education. One point made by her was that science education research should explain how students can be attracted to science. "Particular effort should be focused on students in grades 4-8, because many lose interest in math and science in these grades" (Linn, p. 202). It is evident, then, that the grade level factor is one worthy of further investigation. The interest in the present study is that since the determinants of science learning behavior may be significantly influenced by a student's grade, it would be wise to control for this external variable.

It was mentioned previously that perhaps several variables may be correlates of attitudes toward science and science achievement, and therefore influence the immediate determinants of behavior addressed in the theory of reasoned action. Why, then, is it suggested herein that only gender and grade be considered as
external variables to be studied? First, gender and grade are simple to measure and therefore can be adequately dealt with in a study of this genre. Second, a student's gender and grade are stable and science educators cannot change them. They are easily identified by science educators and therefore lend themselves to developing teaching strategies that may be able to accommodate the differences in the determinants of science learning behavior if they in fact exist. Third, external variables are not of primary concern in this study. Namely, the immediate determinants of intention are of primary concern. Fourth, and finally, controlling for these two external variables would provide more detailed and useful information than if none were considered, and perhaps less complex and confusing information than if several external variables were simultaneously considered. For example, inclusion of many external variables might lead to ambiguity (about factors influencing the constructs of the theory of reasoned action) which would arise from correlations within the domain of external variables.

In conclusion, the reviewed literature suggests that a careful study of behavioral determinants and selected external variables related to young science learners' intentions might guide future researchers, and eventually educational practitioners, in developing plans for
altering science students' intentions and behaviors.
Chapter III
Methodology

Organization of the Chapter

This chapter is organized into four sections. First, the general research approach will be described. Second, the variables and hypotheses will be stated. Next, the population and study under investigation will be described. Finally, the specific research activities will be delineated in chronological order.

General Research Design and Procedure

This study was designed to be exploratory in nature. Baseline information was generated, and correlational analysis procedures were employed to enhance understanding of the data. The study proceeded in three stages. Stage I involved the interviewing of students to elicit their beliefs and the construction of two instruments (laboratory and non-laboratory) based upon the students' beliefs. Stage II was a pilot study and resulted in the refinement of the instruments and the administration procedures. Stage III included the administration of the laboratory instrument to half of the students and the non-laboratory instrument to the other half. Stage III concluded with the analysis of data in order to understand the determinants of laboratory and non-laboratory behavioral intentions.
Variables and Hypotheses

The behavioral intentions and external variables which were used in this study were discussed in Chapter II. Figure 8 and Figure 9 provide a symbolic representation of the present study. The two intentions dealt with were (1) "I plan to do the science projects and science experiments my teacher asks me to do" and (2) "I plan to do the science reading and science writing my teacher asks me to do." In one case, the laboratory behavioral intention served as the dependent variable with the corresponding attitude toward the behavior and subjective norm as independent variables. In the second case, the non-laboratory behavioral intention served as the dependent variable with the corresponding attitude toward the behavior and subjective norm as independent variables. In another part of the analysis, the behavioral beliefs and outcome evaluations and the normative beliefs and motivations to comply were dependent variables with gender and grade level of students as independent variables.

Figure 8 and Figure 9 can be consulted for better understanding of the following null hypotheses which were to be tested:

1. Attitude toward behavior and subjective norm do not explain a significant amount of variance in the laboratory behavioral intention.
Possible explanations for observed relations between external variables and behavior

Stable theoretical relations linking beliefs to behavior

Feedback

Figure 8. Effects of variables on behavior, according to the theory of reasoned action. (After Ajzen & Fishbein, 1980, and Fishbein & Ajzen, 1975)
Figure 9. The theory of reasoned action model with respect to two student behaviors in this study: laboratory and non-laboratory.
2. Attitude toward behavior and subjective norm do not explain a significant amount of variance in the non-laboratory behavioral intention.

3. There is no difference between the relative weights of attitude toward behavior and subjective norm for the laboratory behavioral intention.

4. There is no difference between the relative weights of attitude toward behavior and subjective norm for the non-laboratory behavioral intention.

5. There is no significant relationship between the external variable of gender of student and the behavioral beliefs and outcome evaluations for the laboratory behavioral intention.

6. There is no significant relationship between the external variable of gender of student and the behavioral beliefs and outcome evaluations for the non-laboratory behavioral intention.

7. There is no significant relationship between the external variable of gender of student and the normative beliefs and motivations to comply for the laboratory behavioral intention.

8. There is no significant relationship between the external variable of gender of student and the normative beliefs and motivations to comply for the non-laboratory behavioral intention.

9. There is no significant relationship between the
external variable of grade level of student and the behavioral beliefs and outcome evaluations for the laboratory behavioral intention.

10. There is no significant relationship between the external variable of grade level of student and the behavioral beliefs and outcome evaluations for the non-laboratory behavioral intention.

11. There is no significant relationship between the external variable of grade level of student and the normative beliefs and motivations to comply for the laboratory behavioral intention.

12. There is no significant relationship between the external variable of grade level of student and the normative beliefs and motivations to comply for the non-laboratory behavioral intention.

13. There is no significant interaction effect between gender and grade level of student with respect to the behavioral beliefs and outcome evaluations for the laboratory behavioral intention.

14. There is no significant interaction effect between gender and grade level of student with respect to the behavioral beliefs and outcome evaluations for the non-laboratory behavioral intention.

15. There is no significant interaction effect between gender and grade level of student with respect to the normative beliefs and motivations to comply for the
laboratory behavioral intention.

16. There is no significant interaction effect between gender and grade level of student with respect to the normative beliefs and motivations to comply for the non-laboratory behavioral intention.

17. There is no pattern of relationship between the external variable of gender of student and the relative weights of attitude toward behavior and subjective norm for the laboratory behavioral intention.

18. There is no pattern of relationship between the external variable of gender of student and the relative weights of attitude toward behavior and subjective norm for the non-laboratory behavioral intention.

19. There is no pattern of relationship between the external variable of grade level of student and the relative weights of attitude toward behavior and subjective norm for the laboratory behavioral intention.

20. There is no pattern of relationship between the external variable of grade level of student and the relative weights of attitude toward behavior and subjective norm for the non-laboratory behavioral intention.

21. The amount of variance in behavioral intention which is explained by attitude toward behavior and subjective norm is not different with respect to laboratory versus non-laboratory.
22. The relative weights of attitude toward behavior and subjective norm are not different with respect to laboratory versus non-laboratory.

23. There is no significant difference between the analogous correlations for the two behavioral intentions (laboratory versus non-laboratory).

The alpha level for decision making was .10 for the preceding hypotheses 1, 2, 5 through 16, 21, and 23. Subjective decision making was used for the preceding hypotheses 3, 4, 17 through 20, and 22. The math model used and choice of alpha level will be explained later in this chapter.

Population and Sample

The population consisted of grades 3 to 8 public school children in the mid-Willamette Valley region of the State of Oregon. Three school districts were chosen to represent a variety of students in terms of demographic characteristics. School district A contained two cities each with populations near 5,000 and a small state college. School district B consisted of a city with a population of about 28,000 and contained a community college. School district C consisted of a city with a population of about 42,000 and contained a large state land grant university. These were the first three districts selected in which to do the research, and personnel in all three school districts readily accepted
the research proposal.

Administrative personnel in district A assigned the elementary school to be used and only one middle school existed. Administrative personnel in district B assigned the elementary and middle schools to be used. Personnel in district C allowed the random selection of the elementary and middle schools. Random selection via multistage cluster sampling (Borg & Gall, 1983) was used to select the classes of students that were used in the study. Regression analysis, correlations, and ANOVA were to be employed for statistical analysis. A rule of thumb in regression analysis is that a minimum of ten subjects per independent variable should be used. Since a maximum of two independent variables existed for any one regression equation in this study, a minimum of 20 students would be used for the laboratory group and a minimum of 20 students would be used for the non-laboratory group. Sampling was executed such that 187 subjects (n = 187) were used for the laboratory behavioral intention and 190 subjects (n = 190) were used for the non-laboratory behavioral intention so that 377 was the total sample size (N = 377) for the main part of the study (i.e., Stage III). (The three stages will be discussed later in this chapter.) About 20% (n = 72) of the students used in Stage III were randomly selected and interviewed in Stage I in order to elicit their salient
attitudinal and normative beliefs. A completely separate group of six classes (and their constituent students, N = 102) were randomly selected from the involved schools for the pilot study (Stage II).

**Sequence of Activities**

The research was conducted in three stages. The stages will be described in detail later in this chapter. Briefly, they were as follows:

1. Stage I was an exploratory phase. Information was gathered so that the initial instrument could be constructed.

2. Stage II was a pilot study. The initial instrument was administered to a representative group of students so that information would be gained and used to improve the instrument and its accompanying administration procedures. The final instrument and administration procedures were constructed.

3. Stage III was the administration of the final instrument to the student sample and the analysis of the resultant data.

**Stage I: Elicitation Sessions and Instrument Construction.**

The behavioral intention items for laboratory and non-laboratory were carefully worded, with special attention given to the elements of action, target, context, and time (Fishbein & Ajzen, 1975). The
behavioral intention item for laboratory was stated as follows:

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

The behavioral intention item for non-laboratory was stated as follows:

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

Based upon Appendix A of Ajzen and Fishbein (1980) (see Appendix A), a protocol was designed for elicitation sessions (see Appendix B) with a subsample of the students. The sessions and questions (e.g., What do you think are the advantages or good things that might come from you doing the science projects and science experiments your teacher asks you to do? Are there any groups or people or a god who would like you to do the science projects and science experiments your teacher asks you to do?) were designed to elicit salient beliefs with respect to attitude toward the behaviors and subjective norm.

Twelve groups of students were considered during the study. The 12 groups were a product of the two intentions under study and the six grade levels considered (2 x 6). The resultant 12 groups were referred to as "intention groups." The 12 intention groups and their constituent students came from 18
classes in three school districts (as previously described). Each teacher was asked whether any of the students were so visually handicapped that they could not read a questionnaire, so hearing handicapped that they could not hear in an interview or group situation, or so emotionally handicapped that they could not effectively participate in an interview or group instrument administration. If there were any, the students were noted and not included in the interview sessions, nor were their responses included in the analysis of data (Stage III).

Each of the 18 class lists was divided into male and female. A table of random numbers was used to assign half of the males to the laboratory group and half to the non-laboratory group; the same was done for the females. A table of random numbers was used to select one laboratory group male and one non-laboratory group male to participate in the elicitation sessions; the same was done for the females. Thus, two males and two females from each class participated in the elicitation sessions. Of the 377 students used in Stage III, 19.1% (n = 72) were interviewed in the Stage I elicitation sessions. The protocol for the elicitation sessions is delineated in Appendix B.

The resultant responses were used to identify the modal salient beliefs. Ajzen and Fishbein (1980)
explained that the

*modal salient beliefs* can be ascertained by eliciting beliefs from a representative sample of the population; the beliefs most frequently elicited by [sic] this sample constitute the modal set for the population in question. (p. 68)

**Salient outcomes and salient referents** (viz., beliefs that were relevant to the previously defined intentions) were elicited from a representative sample of students by basically following the protocol given in Appendix A, by Ajzen and Fishbein. The subsample students were asked to verbalize a list of positive outcomes or consequences and negative outcomes or consequences of engaging in laboratory or non-laboratory activities. The same subjects were asked to verbalize a list of people, groups of people, or a god who might have expectations about whether or not they should engage in the learning behaviors. The researcher wrote down all responses of the interviewees. An audiotape was made of all elicitation sessions in case it would be needed later to clarify student responses.

The salient beliefs of the students were codified and made into a frequency listing (Ajzen & Fishbein, 1980). The first step was analogous to "a content analysis of the various beliefs emitted by different individuals" (Ajzen & Fishbein, p. 68). The responses were organized by grouping together beliefs that referred
to similar outcomes and counting the frequency with which each outcome in a group was elicited. The researcher followed Ajzen and Fishbein's guidelines which were that common sense should be used to make decisions whether to consider the outcomes in a given group as a single belief or as separate beliefs. . . . a useful rule of thumb is to ask yourself whether the two outcomes in question could have been reasonably emitted by the same person. (p. 68, 69)

If more than a couple of subjects did list two outcomes separately, then they were considered to be related to separate beliefs and were coded separately.

A final decision was made concerning which beliefs to include in the modal salient set by using guidelines suggested by Ajzen and Fishbein (1980). That is, "Perhaps the least arbitrary decision rule is to choose as many beliefs as necessary to account for a certain percentage (e.g., 75%) of all beliefs emitted" (Ajzen & Fishbein, p. 70). Fredricks and Dossett (1983) and Ajzen and Madden (1986) used the 75% criterion and developed instruments with relatively high reliabilities. This method would have prevented a limited number of verbose subjects from dominating which beliefs were incorporated into the instrument. The criterion of 75% was used for this study.

The behavioral beliefs, outcome evaluations, normative beliefs, and motivation to comply items for the
instrument were defined. They were based upon the results of the codification and frequency listing that was done. The item construction protocol that was delineated by Ajzen and Fishbein (1980) was followed (see Appendix A).

The predictive items were measured on a five-point adjective scale (e.g., good-bad). Except for the motivation to comply scales, which were scored from +1 (no) to +5 (yes), all scales were scored from -2 (e.g., bad) to +2 (e.g., good). Five response options, rather than seven as in Ajzen and Fishbein, were used so that there would be fewer vague options for the young students.

Validity was assured via careful adherence to the theory of reasoned action model and the instrument construction procedures proposed by the theory's authors. The measures were valid measures of the constructs that enable prediction of behavior (Fishbein & Ajzen, 1975). The content validity of the item scales was also evidenced by their correspondence with the behavioral criteria (Koballa, 1986). In addition, a person at Oregon State University who was familiar with Ajzen and Fishbein's (1980) guidelines (see Appendix A) verified that the items and instrument were constructed according to Ajzen and Fishbein's protocol. Although such a check was not reported in related literature, it contributed to
the validity of the instrument. The completed instruments are presented in Appendix C.

The readability of the instrument was ascertained via the Fry method (Minnesota Educational Computing Consortium [MECC], 1982). Fry's method "has been validated on both primary and secondary materials, and the scores derived from it correlate highly with those from several well-known formulas" (Klare, 1974-1975, p. 77). The readability check provided a gauge as to the usability of the instrument for grades 3 to 8 children. It is important to note that a student really has a range of reading ability (Herber, 1978), and within a group of grades 3 to 8 students there will probably be a wide range of reading abilities. The instrument probably could not have been written at the individual level of every student in the study. Therefore, the relatively arbitrary grade level of 5 was used for the pilot study. If the readability were rated above grade 5 for the initial instrument, an attempt would be made to alter it accordingly to assure that the vast majority of students could read it.

The instrument was analyzed according to the procedure explained by MECC (1982). The instruments were altered and simplified until the laboratory instrument was rated at the Fry grade level of 6 and the non-laboratory instrument was rated at the Fry grade level of
4. The higher reading level of the laboratory instrument was due to the nature of the words in that instrument. It was judged that the instrument could not be further simplified in terms of readability without straying too far from the protocol prescribed by the authors of the theory of reasoned action (Ajzen & Fishbein, 1980).

A reading specialist at Oregon State University examined the instruments and made suggestions concerning how to eliminate vague phrasing of the items. Her suggestions were followed if the researcher thought it was appropriate to do so. Items which were designed to identify each student's gender, grade level, and age were included at the end of the two instruments. The completed instruments were copied and used in the pilot study (Stage II).

**Stage II: Pilot Study and Instrument Development.**

Stage II was a pilot study. Procedures for administration of the instrument were developed and are shown in Appendix D. The researcher and a research assistant reviewed the procedures until they were confident that they had the same understanding of them and would follow them in a consistent manner.

From all of the classes available (i.e., except for those selected for Stage I and Stage III) in the schools being used for the study, one class from each of grades 3 to 8 was randomly selected for the pilot study. This
involved 102 students (55 in the laboratory group and 47 in the non-laboratory group). All teachers were asked whether any of the students were so visually handicapped that they could not read a questionnaire, so hearing handicapped that they could not hear in an interview or group situation, or so emotionally handicapped that they could not effectively participate in an interview group instrument administration. If there were any, the students were noted and allowed to participate in responding to the instruments, but their instruments were discreetly marked and not included in the data analysis.

Each class list was divided into males and females, then a table of random numbers was used to assign half of the males and half of the females to the laboratory instrument and the other half to the non-laboratory instrument. The researcher and the research assistant were each randomly assigned to administer the laboratory instrument half of the time and the non-laboratory instrument half of the time. The researcher and assistant were each randomly assigned to administer instruments half of the time in the class' regular classroom and half of the time in another place in the school building.

Usually the classroom teacher told the students ahead of time that someone was coming to ask them questions about their ideas about science. The
researcher and assistant entered the room and the researcher briefly and generally explained to the students what they would be doing for the research. One instrument administrator (researcher or assistant) took half of the students to another place in the school, while the second administrator remained in the classroom with the other half. Sometimes the teachers remained in the classroom and sometimes they did not. The administrators followed the preplanned administration procedures (Appendix D). The researcher asked students what they thought of the questions, whether they understood them, and what they thought of the instrument administration. He noted their responses. The assistant gathered similar information. The administrator and students who were out of the classroom returned, the researcher thanked the teacher and students, and then the researcher and assistant left.

After each instrument administration, the researcher and assistant discussed how well things had transpired and discussed the feedback received from students after the administration. As a result of this interaction/discussion, a number of modifications were made to the administration procedures in order to simplify and further standardize the procedures for administration of the instruments. One especially important finding was that the instrument administrators
needed to act very serious, but friendly, while working with the students in order to reduce distracting verbal behavior on the part of students. The administrators found it important to emphasize that there would be no talking by students unless they were recognized to do so by the administrators. The administration procedures were reviewed, revised, and formed for use in Stage III. The finalized procedures are shown in Appendix E.

The results of the pilot study were also used to decide whether to alter the instruments. After responding to the instruments, the students at all grade levels consistently said that they understood the instrument items. They had few questions about what to do. Reading the instruments aloud to the students apparently overcame the potential problem of low reading abilities. It also became clear that the instruments could not be further simplified in terms of reading level without jeopardizing the validity of the instruments. That is, further alteration would make the instruments stray from the guidelines set forth by Ajzen and Fishbein (1980). It was decided that there was no need to alter the instruments. The instruments were described in the preceding section "Stage I," and are presented in Appendix C. As explained previously, validity of the instruments was assured via careful adherence to the theory of reasoned action model and the instrument
construction procedures explained by the theory's authors. The measures obtained from use of the instruments were valid measures of the constructs that enable the prediction of behavior (Fishbein & Ajzen, 1975). The content validity of the item scales were also evidenced by their correspondence with the behavioral criteria (Koballa, 1986) explained in the preceding section "Stage I." In addition, a person who was familiar with Ajzen and Fishbein's (1980) Appendix A (see Appendix A) confirmed that the items, and instruments in general, were constructed according to Ajzen and Fishbein's protocol.

One of the assumptions stated in Chapter I was that the subjects responded honestly to the instruments. In this study, the subjects reported on themselves (i.e., it was a self-report instrument). Gronlund (1981) explained that

The effective use of self-report inventories assumes that the individual is both willing and able to report accurately. . . . One of the areas in which self-report inventories are very useful in the classroom is that of attitude measurement. (p. 468)

Fishbein and Ajzen (1975) emphasized,

Clearly, it is possible to locate subjects on evaluative and probabilistic dimensions with a high degree of reliability. The question of reliability, therefore, does not pose a major problem for the measurement of beliefs, attitudes, and intentions when appropriate instruments are employed. (p. 108)
These authors established (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975) that they did develop methods for constructing and employing "appropriate instruments." Such instruments were likewise constructed and employed in this study. Familiar and standard methods of calculating instrument reliability (e.g., test-retest, split-half, and Cronbach's alpha) were not appropriate for use in this study. In summary, the instruments used were appropriate for the study, it was assumed that the students' responses were honest and reliable, and the results obtained with the instruments were reliable.

To begin the study, it was not certain whether all of grades 3 to 8 would be included beyond the pilot study (Stage II). There was some concern that the younger students would not be able to understand and reliably respond to the elicitation sessions and the instruments. The experiences of the researcher and his assistant and the responses of the students made it clear that students in all grade levels, 3 to 8, could and should be included in the study.

**Stage III: Instrument Administration and Analysis of Data.**

The researcher and the assistant reviewed the instrument administration procedures (Appendix E) until they were confident that they had the same understanding of them and would follow them in a consistent manner.
The assignment of students to the laboratory and non-laboratory groups was explained in the preceding section on Stage I. Those students who participated in the elicitation sessions also participated in Stage III. A table of random numbers was then used to assign the researcher to administer the instruments to half of the laboratory groups and to half of the non-laboratory groups; the assistant was assigned to the other half of the groups. A table of random numbers was also used to determine which half of the groups the researcher would work with in the regular classroom and which half he would work with elsewhere in the school; the assistant was given the complementary assignment.

Usually the teacher told the students ahead of time that someone was coming to ask them questions about their ideas about science. The researcher and assistant (administrators) entered the room and the researcher briefly explained to the students what they would be doing. One administrator took half of the students to another place in the school, while the second administrator remained in the classroom with the other half. The teacher was asked to go somewhere away from either half of the students; all teachers readily cooperated. The administrators followed the preplanned administration procedures (Appendix E). The administrator and students who were out of the classroom
returned and entered the classroom after those inside were finished responding to the instrument. The researcher thanked the teacher and students after the teacher returned, and then the researcher and assistant left. The instruments were administered to 377 students during the period of November 2 through 5, 1987.

After each instrument administration, the researcher and assistant discussed their experiences to determine whether any problems had arisen during the administration. It appeared that no problems arose which would significantly affect the outcomes of the study.

Data Analysis

The student response data were entered into Lotus 1-2-3, version 2.01 (Lotus Development Corporation, 1986) spreadsheet software format. The files were later converted to Statgraphics, version 2.1 (Statistical Graphics Corporation, 1986) files for statistical analysis. Multiple regression was used with behavioral intention as the dependent variable and attitude toward behavior and subjective norm as the independent variables. Standardized regression coefficients were calculated (Neter, Wasserman, & Kutner, 1983) to represent the relative weights of attitude toward behavior and subjective norm under various conditions. Pearson product-moment correlation coefficients were used to develop a correlation matrix including the variables
of behavioral intention, attitude toward behavior, subjective norm, behavioral beliefs and outcome evaluations, and normative beliefs and motivations to comply. Two-way ANOVA was used to determine the effects of gender and grade level on behavioral beliefs and outcome evaluations and on normative beliefs and motivations to comply, and a least significant differences (LSD) multiple range test was performed to determine which means were homogeneous. Means were also calculated for the groups used in the various ANOVA cases. Analogous correlation coefficients derived from the laboratory and non-laboratory groups were compared by testing the "hypothesis that two sample values of r are drawn at random from the same population" procedure explained by Snedecor and Cochran (1967, p. 186). An alpha level of .10 was used for the statistical tests. This level of significance was used since the nature of this study is exploratory, and use of such an alpha level made it more likely that a potentially important difference or relationship was not overlooked (Borg & Gall, 1983).

Summary

The study progressed in three stages. Stage I involved (1) the selection of 377 students in grades 3 to 8 in 18 classes in three school districts in Oregon, (2) elicitation session interviews, using Ajzen and
Fishbein's (1980) theory of reasoned action, with 72 of the students, and (3) the construction of the laboratory and non-laboratory instruments based upon the beliefs elicited from the 72 students, using Ajzen and Fishbein's theory of reasoned action. Stage II was a pilot study involving (1) the development of procedures for administering the instruments, (2) selection of 102 students in grades 3 to 8 in 6 classes in three school districts in Oregon, (3) administration of the instruments to the students, (4) examination of the instrument administration procedure and pilot study data, and (5) further refinement of procedures to be followed in the last stage. Stage III involved the administration of the instruments to the students selected in the first stage and the analysis of the resultant data.
Chapter IV
Findings

The purpose of this study was to gain information about selected determinants of student behavior with respect to laboratory and non-laboratory science learning activities. More specifically, the purpose of the study is to answer the following questions by using Fishbein and Ajzen's (1975) theory of reasoned action (see Figure 10 and Figure 11):

1. What are the salient beliefs of students with respect to engaging in laboratory and non-laboratory activities?

2. What are the correlations between adjacent components in the theory of reasoned action?

3. What are the relative weights of the immediate determinants (i.e., attitude toward the behavior and subjective norm) of student intention to engage in laboratory and non-laboratory science learning behaviors?

4. Do the relative weights of the immediate determinants (i.e., attitude toward the behavior and subjective norm) differ with respect to laboratory versus non-laboratory intentions?

5. Do the analogous correlations for the two behavioral intentions (laboratory and non-laboratory) differ?
Possible explanations for observed relations between external variables and behavior

Stable theoretical relations linking beliefs to behavior

Feedback

Figure 10. Effects of variables on behavior, according to the theory of reasoned action. (After Ajzen & Fishbein, 1980, and Fishbein & Ajzen, 1975)
Figure 11. The theory of reasoned action model with respect to two student behaviors in this study: laboratory and non-laboratory.
6. What is the relationship between gender of student and attitude toward the behavior, subjective norm, and the relative weights of attitude toward behavior and subjective norm?

7. What is the relationship between grade level of student and attitude toward the behavior, subjective norm, and the relative weights of attitude toward behavior and subjective norm?

Data will be presented which answer the preceding seven questions and which address the various hypotheses listed in Chapter III. Finally, a summary will be provided.

**Salient Beliefs**

Students were involved in elicitation sessions during which they were interviewed in order to find out their ideas concerning the doing of science learning activities. The questions they were asked are presented in Appendix B.

**Laboratory.**

The students were asked to state the advantages of, the disadvantages of, or anything else they thought of concerning doing science projects and science experiments. Their responses were codified and made into a frequency listing as described in Chapter III. As many beliefs as necessary to account for at least 75% of all beliefs emitted were included in the study. The modal
salient attitudinal beliefs (with respect to laboratory behavior) and their respective frequencies of emission are presented in Table 1.

Table 1 shows that beliefs numbered 1 to 11 constitute 79.7% of all the responses emitted. The first two beliefs, that doing science projects and science experiments "causes me to learn" and "causes me to have fun with science and enjoy science," alone accounted for 32.9% of all the responses emitted. Various idiosyncratic beliefs accounted for 20.2% of all responses emitted. All raw data are not shown in Table 1. (One idiosyncratic belief accounted for 3.2% of beliefs, one for 2.5%, and each of the others for 1.9% or less.)

The students were asked to state any groups or people or a god who would like them to do, not want them to do, or who they just thought about with respect to doing science projects and science experiments. The modal salient normative beliefs (with respect to laboratory behavior) and their respective frequencies of emission are presented in Table 2.

Table 2 shows that beliefs numbered 1 to 6 constitute 79.1% of all the responses emitted. Parents and teachers alone accounted for 53.6% of the normative beliefs emitted regarding who the students thought about with respect to doing their science projects and science
<table>
<thead>
<tr>
<th>Number</th>
<th>BELIEF thatDoing Science Projects and Science Experiments:</th>
<th>Freq.</th>
<th>%</th>
<th>Cum.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>causes me to learn</td>
<td>11</td>
<td>19.6</td>
<td>19.6</td>
</tr>
<tr>
<td>2</td>
<td>causes me to have fun with science and enjoy science</td>
<td>21</td>
<td>32.9</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>causes me to do science activities and experiments</td>
<td>12</td>
<td>19.6</td>
<td>32.9</td>
</tr>
<tr>
<td>4</td>
<td>allows me to do science activities and experiments</td>
<td>7</td>
<td>2.3</td>
<td>19.6</td>
</tr>
<tr>
<td>5</td>
<td>causes me to get good or better grades</td>
<td>7</td>
<td>7.0</td>
<td>32.9</td>
</tr>
<tr>
<td>6</td>
<td>causes me to have to do work on science assignments</td>
<td>11</td>
<td>19.6</td>
<td>52.5</td>
</tr>
<tr>
<td>7</td>
<td>causes me to be confused and not understand science</td>
<td>8</td>
<td>5.1</td>
<td>59.5</td>
</tr>
<tr>
<td>8</td>
<td>causes me to think of how a science experiment will turn out</td>
<td>7</td>
<td>4.4</td>
<td>63.9</td>
</tr>
<tr>
<td>9</td>
<td>causes me to be interested and not bored</td>
<td>7</td>
<td>4.4</td>
<td>68.4</td>
</tr>
<tr>
<td>10</td>
<td>causes me to dissect animals and touch their parts</td>
<td>6</td>
<td>3.8</td>
<td>72.2</td>
</tr>
<tr>
<td>11</td>
<td>causes dangerous things to happen</td>
<td>6</td>
<td>3.8</td>
<td>75.9</td>
</tr>
<tr>
<td></td>
<td>various idiosyncratic beliefs</td>
<td>32</td>
<td>20.2</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>158</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 2

Modal Salient Normative Beliefs for Laboratory

<table>
<thead>
<tr>
<th>Number</th>
<th>Normative BELIEF (or Referent)</th>
<th>Freq</th>
<th>%</th>
<th>Cum. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>parents</td>
<td>41</td>
<td>37.3</td>
<td>37.3</td>
</tr>
<tr>
<td>2</td>
<td>teacher</td>
<td>18</td>
<td>16.4</td>
<td>53.6</td>
</tr>
<tr>
<td>3</td>
<td>brothers or sisters</td>
<td>8</td>
<td>7.3</td>
<td>60.9</td>
</tr>
<tr>
<td>4</td>
<td>grandparents</td>
<td>7</td>
<td>6.4</td>
<td>57.3</td>
</tr>
<tr>
<td>5</td>
<td>friends</td>
<td>7</td>
<td>6.4</td>
<td>73.6</td>
</tr>
<tr>
<td>6</td>
<td>God</td>
<td>6</td>
<td>5.4</td>
<td>79.1</td>
</tr>
<tr>
<td></td>
<td>various idiosyncratic beliefs</td>
<td>23</td>
<td>20.9</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>110</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
experiments. Various idiosyncratic beliefs accounted for 20.9% of all responses emitted. All raw data are not shown in Table 2. (One idiosyncratic belief accounted for 4.5% of beliefs, three each accounted for 2.5%, and each of the others for 1.8% or less.)

Non-laboratory.

Another group of students was asked to state the advantages of, the disadvantages of, or anything else they thought of concerning doing science reading and science writing. Their responses were codified and made into a frequency listing as described in Chapter III. As many beliefs as necessary to account for at least 75% of all beliefs emitted were included in the study. The modal salient attitudinal beliefs (with respect to non-laboratory behavior) and their respective frequencies of emission are presented in Table 3.

Table 3 shows that beliefs numbered 1 to 8 constitute 80.5% of all the responses emitted. The first three beliefs, that doing science reading and science writing "causes me to learn," "causes me to have fun with science and enjoy science," and "allows me to become someone who uses science in their job," alone accounted for 46.9% of all the responses emitted. Various idiosyncratic beliefs accounted for 19.5% of all responses emitted. All raw data are not shown in Table 3. (One idiosyncratic belief accounted for 4.4% of
<table>
<thead>
<tr>
<th>Number</th>
<th>BELIEF that Doing Science Reading and Science Writing:</th>
<th>Freq.</th>
<th>%</th>
<th>Cum.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>causes me to learn</td>
<td>22</td>
<td>19.5</td>
<td>19.5</td>
</tr>
<tr>
<td>2</td>
<td>causes me to have fun with science and enjoy science</td>
<td>17</td>
<td>15.0</td>
<td>34.5</td>
</tr>
<tr>
<td>3</td>
<td>allows me to become someone who uses science in their job</td>
<td>14</td>
<td>12.4</td>
<td>46.9</td>
</tr>
<tr>
<td>4</td>
<td>causes me to get good or better grades</td>
<td>10</td>
<td>8.8</td>
<td>55.8</td>
</tr>
<tr>
<td>5</td>
<td>causes me to think about science activities and experiments</td>
<td>9</td>
<td>8.0</td>
<td>63.7</td>
</tr>
<tr>
<td>6</td>
<td>causes me to do questions that are difficult and hard to understand</td>
<td>7</td>
<td>6.2</td>
<td>69.9</td>
</tr>
<tr>
<td>7</td>
<td>causes me to do more writing</td>
<td>6</td>
<td>5.3</td>
<td>75.2</td>
</tr>
<tr>
<td>8</td>
<td>causes me to have to do work on science assignments</td>
<td>6</td>
<td>5.3</td>
<td>80.5</td>
</tr>
<tr>
<td></td>
<td>various idiosyncratic beliefs</td>
<td>22</td>
<td>19.5</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>113</strong></td>
</tr>
</tbody>
</table>
beliefs, one accounted for 2.6%, and each of the others for 1.8% or less.)

The students were asked to state any groups or people or a god who would like them to do, not want them to do, or who they just thought about with respect to doing science reading and science writing. The modal salient normative beliefs (with respect to non-laboratory behavior) and their respective frequencies of emission are presented in Table 4.

Table 4 shows that beliefs numbered 1 to 7 constitute 89.7% of all the responses emitted. Parents and teachers alone accounted for 49.5% of the normative beliefs emitted regarding who the students thought about with respect to doing their science reading and science writing. Although beliefs 1 to 5 alone would have accounted for 79.4% of all responses, the decision was made to include beliefs 6 and 7. Beliefs 6 and 7 were included because they had relatively high frequencies and they were identical to two of the beliefs included for the laboratory behavioral intention. Thus, more detailed comparison data were obtained in the study by including beliefs 6 and 7. Various idiosyncratic beliefs accounted for 10.3% of all responses emitted. All raw data are not shown in Table 4. (One idiosyncratic belief accounted for 4.1% of beliefs, one accounted for 2.1%, and each of the others for 1.0% or less.)
Table 4

Modal Salient Normative Beliefs for Non-Laboratory

<table>
<thead>
<tr>
<th>Number</th>
<th>Normative BELIEF (or Referent)</th>
<th>Freq.</th>
<th>%</th>
<th>Cum.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>parents</td>
<td>36</td>
<td>37.1</td>
<td>37.1</td>
</tr>
<tr>
<td>2</td>
<td>teacher</td>
<td>12</td>
<td>12.4</td>
<td>49.5</td>
</tr>
<tr>
<td>3</td>
<td>grandparents</td>
<td>11</td>
<td>11.3</td>
<td>60.8</td>
</tr>
<tr>
<td>4</td>
<td>relatives</td>
<td>11</td>
<td>11.3</td>
<td>72.2</td>
</tr>
<tr>
<td>5</td>
<td>brothers or sisters</td>
<td>7</td>
<td>7.2</td>
<td>79.4</td>
</tr>
<tr>
<td>6</td>
<td>friends</td>
<td>5</td>
<td>5.2</td>
<td>84.5</td>
</tr>
<tr>
<td>7</td>
<td>God</td>
<td>5</td>
<td>5.2</td>
<td>89.7</td>
</tr>
<tr>
<td></td>
<td>various idiosyncratic beliefs</td>
<td>10</td>
<td>10.3</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>97</td>
</tr>
</tbody>
</table>
Relationships Between Constructs in the Theory of Reasoned Action

The purposes, and consequently several of the hypotheses, of the study deal with relationships between constructs in the theory of reasoned action with respect to science learning behavior. Data regarding these relationships are presented for laboratory behavior and then for non-laboratory behavior.

Laboratory.

Quantitative representations of the relationships between the theory of reasoned action constructs for laboratory behavior are presented in Figure 12.

Figure 12 shows that with behavioral intention as the dependent variable and attitude toward behavior and subjective norm as independent variables, the adjusted coefficient of multiple correlation (R) is .37. The standardized regression coefficient (or relative weight, \( w_1 \)) of the attitude toward behavior is .35. The standardized regression coefficient (or relative weight, \( w_2 \)) of the subjective norm is .11. The correlation between behavioral intention and attitude toward behavior is .33 (\( r = .33, n = 154, p = .00 \)). The correlation between behavioral intention and subjective norm is .14 (\( r = .14, n = 154, p = .08 \)). The correlation between attitude toward behavior and the construct of behavioral beliefs and outcome evaluations is .57 (\( r = .57, n = 154, \)
Gender

Behavioral beliefs and outcome evaluations

Attitude toward the behavior

r = .57

r = .33

r = .43

Relative importance of attitude and subjective norm

w₁ = .35

w₂ = .11

Subjective norm

r = .14

Intention

Grade level

Normative beliefs and motivations to comply

r = .43

wl – relative weight of attitude toward behavior
w₂ – relative weight of subjective norm

Figure 12. Quantitative relationships between variables for laboratory behavior.
The correlation between subjective norm and the construct of normative beliefs and motivations to comply is .43 ($r = .43, n = 154, p = .00$).

Table 5 presents the multiple regression model values. Table 5 shows that the independent variable of attitude toward behavior is significant ($t = 9.93, n = 187, p = .00$). The independent variable of subjective norm was not significant ($t = 1.56, n = 187, p = .12$).

Table 6 presents the ANOVA table for the regression. Table 6 shows that the independent variables explained a significant amount of variance in the dependent variable $F(2, 184) = 16.78, p = .00$.

Table 7 provides the values used for calculating the aforementioned standardized regression coefficients (relative weights). Table 7 shows that the standard deviations for behavioral intention, attitude toward behavior, and subjective norm were .62, 1.79, and 1.15. The regression coefficients for attitude toward behavior and subjective norm were .12 and .06.

Non-laboratory.

Quantitative representations of the relationships between the theory of reasoned action constructs for non-laboratory behavior are presented in Figure 13.

Figure 13 shows that with behavioral intention as the dependent variable and attitude toward behavior and subjective norm as independent variables, the adjusted
Table 5

Multiple Regression for Laboratory Behavioral Intention

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-value</th>
<th>Sig. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONSTANT</td>
<td>1.094492</td>
<td>0.110217</td>
<td>9.9304</td>
<td>.0000</td>
</tr>
<tr>
<td>Attitude toward Behavior</td>
<td>0.12092</td>
<td>0.023891</td>
<td>5.0614</td>
<td>.0000</td>
</tr>
<tr>
<td>Subjective norm</td>
<td>0.059324</td>
<td>0.037923</td>
<td>1.5643</td>
<td>.1195</td>
</tr>
</tbody>
</table>

$R^2$ (Adjusted) = 0.1451  SE = 0.568782

137 observations fitted
Table 6

ANOVA for Laboratory Regression

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F-Ratio</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>10.8586</td>
<td>2</td>
<td>5.42928</td>
<td>18.7823</td>
<td>.0000</td>
</tr>
<tr>
<td>Error</td>
<td>59.5265</td>
<td>184</td>
<td>0.323513</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>70.3850</td>
<td>186</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Corrected)
Table 7

Values for Deriving Relative Weights (standardized regression coefficients) of Attitude toward Behavior and Subjective Norm for Laboratory

<table>
<thead>
<tr>
<th>Construct</th>
<th>Standard Deviation</th>
<th>Regression Coefficient</th>
<th>Relative Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behavioral Intention</td>
<td>0.615154</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitude toward Behavior</td>
<td>1.7926</td>
<td>.12092</td>
<td>.3523689</td>
</tr>
<tr>
<td>Subjective Norm</td>
<td>1.15135</td>
<td>.059324</td>
<td>.1110334</td>
</tr>
</tbody>
</table>
$r = .58$

Gender $\rightarrow$ Behavioral beliefs and outcome evaluations $\rightarrow$ Attitude toward the behavior $\rightarrow$ Relative importance of attitude and subjective norm $\rightarrow$ Intention

Grade level $\rightarrow$ Normative beliefs and motivations to comply $\rightarrow$ Subjective norm

$w_1 = .54$

$w_2 = .08$

$R = .50$

$r = .15$

$w_1$ - relative weight of attitude toward behavior

$w_2$ - relative weight of subjective norm

**Figure 13.** Quantitative relationships between variables for non-laboratory behavior.
coefficient of multiple correlation ($R$) is .50. The standardized regression coefficient (or relative weight, $w_1$) of the attitude toward behavior is .54. The standardized regression coefficient (or relative weight, $w_2$) of the subjective norm is .08. The correlation between behavioral intention and attitude toward behavior is .51 ($r = .51$, $n = 164$, $p = .00$). The correlation between behavioral intention and subjective norm is .15 ($r = .15$, $n = 164$, $p = .06$). The correlation between attitude toward behavior and the construct of behavioral beliefs and outcome evaluations is .58 ($r = .58$, $n = 164$, $p = .00$). The correlation between subjective norm and the construct of normative beliefs and motivations to comply is .58 ($r = .58$, $n = 164$, $p = .00$).

Table 8 presents the multiple regression model values. Table 8 shows that the independent variable of attitude toward behavior is significant ($t = 7.88$, $n = 190$, $p = .00$). The independent variable of subjective norm was not significant ($t = -1.18$, $n = 190$, $p = .24$).

Table 9 presents the ANOVA table for the regression. Table 9 shows that the independent variables explained a significant amount of variance in the dependent variable $F(2, 187) = 32.90$, $p = .00$.

Table 10 provides the values used for calculating the preceding standardized regression coefficients. Table 10 shows that the standard deviations for
Table 8

**Multiple Regression for Non-Laboratory Behavioral Intention**

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Coefficient</th>
<th>std. error</th>
<th>t-value</th>
<th>sig. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONSTANT</td>
<td>1.012323</td>
<td>0.093049</td>
<td>10.8795</td>
<td>.0000</td>
</tr>
<tr>
<td>Attitude toward Behavior</td>
<td>0.177343</td>
<td>0.022511</td>
<td>7.8782</td>
<td>.0000</td>
</tr>
<tr>
<td>Subjective norm</td>
<td>-0.05479</td>
<td>0.046586</td>
<td>-1.1761</td>
<td>.2410</td>
</tr>
</tbody>
</table>

$R^2$ (Adjusted) = 0.2524  \ SE = 0.683142

190 observations fitted
Table 9
ANOVA for Non-Laboratory Regression

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F-Ratio</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>30.7092</td>
<td>2</td>
<td>15.3546</td>
<td>32.9016</td>
<td>.0000</td>
</tr>
<tr>
<td>Error</td>
<td>87.2697</td>
<td>187</td>
<td>0.466683</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>117.979</td>
<td>189</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
(Corrected)
Table 10

Values for Deriving Relative Weights (standardized regression coefficients) of Attitude toward Behavior and Subjective Norm for Non-Laboratory

<table>
<thead>
<tr>
<th>Construct</th>
<th>Standard Deviation</th>
<th>Regression Coefficient</th>
<th>Relative Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behavioral Intention</td>
<td>0.789152</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitude toward Behavior</td>
<td>2.3829</td>
<td>.177343</td>
<td>.5354996</td>
</tr>
<tr>
<td>Subjective Norm</td>
<td>1.15142</td>
<td>-.05479</td>
<td>.0799418</td>
</tr>
</tbody>
</table>
behavioral intention, attitude toward behavior, and subjective norm were .79, 2.38, and 1.15. The regression coefficients for attitude toward behavior and subjective norm were .18 and -.05.

Comparison of Laboratory and Non-laboratory Relationships

Various relationships between constructs in the laboratory model are compared to analogous relationships in the non-laboratory model. The relationships compared are the coefficients of multiple correlation ($R$), the relative weights ($w_1$ and $w_2$) of attitude toward behavior and subjective norm, and the various correlations ($r$). As explained in Chapter III, alpha is set at .10.

Table 11 presents the values used for testing the significance of difference between laboratory and non-laboratory coefficients of multiple correlation. Table 11 shows that the adjusted coefficients of multiple correlation ($R$) for laboratory (.37) and non-laboratory (.50) are not significantly different.

Table 12 presents the values used for testing the significance of difference between laboratory and non-laboratory attitude toward behavior-behavioral intention correlations. Table 12 shows that the correlations ($r$) between attitude toward behavior and behavioral intention for laboratory (.33) and non-laboratory (.51) are significantly different.

Table 13 presents the values used for testing the
<table>
<thead>
<tr>
<th>Type of Science</th>
<th>Number of Students</th>
<th>$\tau$</th>
<th>$z'$</th>
<th>$\frac{1}{(n-4)}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory</td>
<td>187</td>
<td>.37</td>
<td>.3884</td>
<td>.0054645</td>
</tr>
<tr>
<td>Non-Laboratory</td>
<td>190</td>
<td>.50</td>
<td>.5493</td>
<td>.0053763</td>
</tr>
</tbody>
</table>

Difference = .1609  $\tau$ = .0108408  
$p = .122$
Table 12

Test of the Significance of Difference Between Laboratory and Non-Laboratory Attitude toward Behavior-Behavioral Intention Correlations

<table>
<thead>
<tr>
<th>Type of Science</th>
<th>Number of Students</th>
<th>$r$</th>
<th>$z'$</th>
<th>$1/(n-4)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory</td>
<td>154</td>
<td>.33</td>
<td>.3428</td>
<td>.0066225</td>
</tr>
<tr>
<td>Non-Laboratory</td>
<td>164</td>
<td>.51</td>
<td>.5627</td>
<td>.006211</td>
</tr>
</tbody>
</table>

Difference = .2199  $z = .0128336$

$z = .052$
Table 13

Test of the Significance of Difference Between Laboratory and Non-Laboratory Subjective Norm-Behavioral Intention Correlations

<table>
<thead>
<tr>
<th>Type of Science</th>
<th>Number of Students</th>
<th>( r )</th>
<th>( z' )</th>
<th>( 1/(n-4) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory</td>
<td>154</td>
<td>.14</td>
<td>.1409</td>
<td>.0066225</td>
</tr>
<tr>
<td>Non-Laboratory</td>
<td>164</td>
<td>.15</td>
<td>.1511</td>
<td>.0062111</td>
</tr>
</tbody>
</table>

\[
\text{Difference} = .0102 \quad z = .0128336 \\
\rho = .928
\]
significance of difference between laboratory and non-laboratory subjective norm-behavioral intention correlations. Table 13 shows that the correlations ($r$) between subjective norm and behavioral intention for laboratory (.14) and non-laboratory (.15) are not significantly different.

Table 14 presents the values used for testing the significance of difference between laboratory and non-laboratory behavioral beliefs and outcome evaluations-attitude toward behavior correlations. Table 14 shows that the correlations ($r$) between the construct of behavioral beliefs and outcome evaluations and attitude toward behavior for laboratory (.57) and non-laboratory (.58) are not significantly different.

Table 15 presents the values used for testing the significance of difference between laboratory and non-laboratory normative beliefs and motivations to comply-subjective norm correlations. Table 15 shows that the correlations ($r$) between the construct of normative beliefs and motivations to comply and subjective norm for laboratory (.43) and non-laboratory (.58) are significantly different.

Table 16 presents for comparison the relative weights of attitude toward behavior and subjective norm for laboratory and non-laboratory. Table 16 shows that the relative weights ($w_1$) of attitude toward behavior for
Table 14
Test of the Significance of Difference Between Laboratory and Non-Laboratory Behavioral Beliefs and Outcome Evaluations—Attitude toward Behavior Correlations

<table>
<thead>
<tr>
<th>Type of Science</th>
<th>Number of Students</th>
<th>r</th>
<th>z'</th>
<th>1/(n-1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory</td>
<td>154</td>
<td>.57</td>
<td>.6475</td>
<td>.0066225</td>
</tr>
<tr>
<td>Non-Laboratory</td>
<td>164</td>
<td>.58</td>
<td>.6625</td>
<td>.0062111</td>
</tr>
</tbody>
</table>

Difference = .015 \(\cdot .01 = .0128336\)
\[ q = .887\]
Table 15

Test of the Significance of Difference Between Laboratory and Non-Laboratory Normative Beliefs and Motivations to Comply—Subjective Norm Correlations

<table>
<thead>
<tr>
<th>Type of Science</th>
<th>Number of Students</th>
<th>r</th>
<th>z'</th>
<th>1/(n-4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory</td>
<td>154</td>
<td>.43</td>
<td>.4599</td>
<td>.0066225</td>
</tr>
<tr>
<td>Non-Laboratory</td>
<td>164</td>
<td>.58</td>
<td>.6625</td>
<td>.0062111</td>
</tr>
</tbody>
</table>

Difference = .2026 $\frac{1}{2} = .0128336

\[ p = .074 \]
Table 16
Comparison of Relative Weights of Attitude toward Behavior and Subjective Norm for Laboratory and Non-Laboratory

<table>
<thead>
<tr>
<th>Type of Science</th>
<th>Relative Weights</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Attitude toward Behavior</td>
<td>Subjective Norm</td>
</tr>
<tr>
<td>Laboratory</td>
<td>.35</td>
<td>.11</td>
</tr>
<tr>
<td>Non-Laboratory</td>
<td>.54</td>
<td>.08</td>
</tr>
</tbody>
</table>
laboratory and non-laboratory vary; it is larger for non-
laboratory. Table 16 also shows that the relative
weights ($w_2$) of subjective norm for laboratory and non-
laboratory vary; it is larger for laboratory. The
preceding relative weights are not statistically
contrasted.

External Variables

The relationships between the external variables of
gender and grade level for laboratory science are
summarized in Figure 14.

Figure 14 shows that gender has a significant effect
only on normative beliefs and motivations to comply. The
relative importance of attitude toward behavior and
subjective norm appear to be influenced by gender and
grade level of student. Grade level has a significant
effect on behavioral beliefs and outcome evaluations and
on normative beliefs and motivations to comply.

Table 17 presents the ANOVA table with the construct
of behavioral beliefs and outcome evaluations for
laboratory as the dependent variable and gender and grade
level as the independent variables. Table 17 shows that
gender has no significant effect on the construct of
behavioral beliefs and outcome evaluations for
laboratory, $F (1, 171) = .044$, $p = .84$. Grade level has
a significant effect on the construct of behavioral
beliefs and outcome evaluations for laboratory, $F (5,$
External Variables

Gender

Behavioral beliefs and outcome evaluations

Attitude toward the behavior

Relative importance of attitude and subjective norm

Intention

Grade level

Normative beliefs and motivations to comply

Subjective norm

yes - significant effect
no - no significant effect
I - gender x grade level interaction

Figure 14. Effects of external variables for laboratory behavior.
Table 17

ANOVA Table for Effects of Gender and Grade Level on Behavioral Beliefs and Outcome Evaluations for Laboratory

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F-Ratio</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAIN EFFECTS:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>5.2208</td>
<td>1</td>
<td>5.22084</td>
<td>.044</td>
<td>.8372</td>
</tr>
<tr>
<td>Grade</td>
<td>4581.7370</td>
<td>5</td>
<td>916.34740</td>
<td>7.640</td>
<td>.0000</td>
</tr>
<tr>
<td>2-FACTOR INTERACTIONS</td>
<td>239.73052</td>
<td>5</td>
<td>47.946104</td>
<td>.400</td>
<td>.8485</td>
</tr>
<tr>
<td>RESIDUAL</td>
<td>20510.680</td>
<td>171</td>
<td>119.94550</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Total                | 25428.339      | 182| (Corrected) |         |         |
interaction effect between gender and grade level on the construct of behavioral beliefs and outcome evaluations for laboratory, $F(5, 171) = .40$, $p = .85$.

Table 18 presents the LSD multiple range analysis of means table for grade level as the independent variable and behavioral beliefs and outcome evaluations as the dependent variable for laboratory. Table 18 shows that grade 8 is significantly lower than grades 7, 4, 6, and 3 which are all significantly lower than grade 5.

The relationships between the external variables of gender and grade level for non-laboratory science are summarized in Figure 15.

Figure 15 shows that gender only appears to influence the relative importance of attitude toward behavior and subjective norm. Grade level has a significant effect on behavioral beliefs and outcome evaluations and on normative beliefs and motivations to comply. Grade level of student also appeared to influence the relative importance of attitude toward behavior and subjective norm.

Figure 16 presents a graph of the relationships between the external variables of gender and grade level and the construct of behavioral beliefs and outcome evaluations for laboratory.

Figure 16 shows that for both males and females the
Table 18

LSD Multiple Range Analysis for the Effect of Grade Level on Behavioral Beliefs and Outcome Evaluations for Laboratory Science

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>N</th>
<th>Mean</th>
<th>Homogeneous Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>35</td>
<td>11.17</td>
<td>*</td>
</tr>
<tr>
<td>7</td>
<td>25</td>
<td>17.92</td>
<td>*</td>
</tr>
<tr>
<td>4</td>
<td>30</td>
<td>18.40</td>
<td>*</td>
</tr>
<tr>
<td>6</td>
<td>34</td>
<td>18.79</td>
<td>*</td>
</tr>
<tr>
<td>3</td>
<td>28</td>
<td>21.46</td>
<td>*</td>
</tr>
<tr>
<td>5</td>
<td>31</td>
<td>27.64</td>
<td>*</td>
</tr>
</tbody>
</table>
Figure 15. Effects of external variables for non-laboratory behavior.
Figure 16. Behavioral beliefs and outcome evaluations means by gender and grade level for laboratory behavior.
behavioral beliefs and outcome evaluations means are moderate in grades 3 and 4, rise in grade 5, then drop to moderate to low in grades 6, 7, and 8.

Table 19 presents the ANOVA table with the construct of normative beliefs and motivations to comply for laboratory as the dependent variable and gender and grade level as the independent variables. Table 19 shows that gender has a significant effect on the construct of normative beliefs and motivations to comply for laboratory, $F (1, 146) = 5.85$, $p = .02$; male scores are lower than female scores. Grade level has a significant effect on the construct of normative beliefs and motivations to comply for laboratory, $F (5, 146) = 3.63$, $p = .00$. There is a significant interaction effect between gender and grade level on the construct of normative beliefs and motivations to comply for laboratory, $F (5, 146) = 1.96$, $p = .09$.

Table 20 presents the LSD multiple range analysis of means table for grade level as the independent variable and normative beliefs and motivations to comply as the dependent variable for laboratory. Table 20 shows that grade 8 is significantly lower than grades 3, 6, 4, and 7. Grades 3, 6, and 4 are significantly lower than grade 5.

Figure 17 presents a graph of the relationships between the external variables of gender and grade level
Table 19
ANOVA Table for Effects of Gender and Grade Level on Normative Beliefs and Motivations to Comply for Laboratory

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F-Ratio</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAIN EFFECTS:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>1700.5854</td>
<td>1</td>
<td>1700.5854</td>
<td>5.853</td>
<td>.0168</td>
</tr>
<tr>
<td>Grade</td>
<td>5275.0634</td>
<td>5</td>
<td>1055.0127</td>
<td>3.631</td>
<td>.0040</td>
</tr>
<tr>
<td>2-FACTOR INTERACTIONS</td>
<td>2843.1524</td>
<td>5</td>
<td>568.63048</td>
<td>1.957</td>
<td>.0884</td>
</tr>
<tr>
<td>RESIDUAL</td>
<td>42418.432</td>
<td>146</td>
<td>290.5372</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (Corrected)</td>
<td>52768.842</td>
<td>157</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 20

LSD Multiple Range Analysis for the Effect of Grade Level on Normative Beliefs and Motivations to Comply for Laboratory Science

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>N</th>
<th>Mean</th>
<th>Homogeneous Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>31</td>
<td>17.16</td>
<td>*</td>
</tr>
<tr>
<td>3</td>
<td>25</td>
<td>26.12</td>
<td>*</td>
</tr>
<tr>
<td>6</td>
<td>29</td>
<td>27.10</td>
<td>*</td>
</tr>
<tr>
<td>4</td>
<td>27</td>
<td>27.37</td>
<td>*</td>
</tr>
<tr>
<td>7</td>
<td>19</td>
<td>29.74</td>
<td>**</td>
</tr>
<tr>
<td>5</td>
<td>27</td>
<td>36.89</td>
<td>*</td>
</tr>
</tbody>
</table>
Figure 17. Normative beliefs and motivations to comply means by gender and grade level for laboratory behavior.
and the construct of normative beliefs and motivations to comply for laboratory.

Figure 17 shows that for both males and females the behavioral beliefs and outcome evaluations means are moderate in grades 3 and 4 and rise in grade 5. For males, the means are also high in grades 6 and 7, then the mean drops low in grade 8. For females, the mean drops low in grade 6, is moderate in grade 7, then drops low in grade 8.

Table 21 presents the ANOVA table with the construct of behavioral beliefs and outcome evaluations for non-laboratory as the dependent variable and gender and grade level as the independent variables. Table 21 shows that gender has no significant effect on the construct of behavioral beliefs and outcome evaluations for non-laboratory, $F(1, 173) = 1.83, p = .18$. Grade level has a significant effect on the construct of behavioral beliefs and outcome evaluations for non-laboratory, $F(5, 173) = 3.68, p = .00$. There is no significant interaction effect between gender and grade level on the construct of behavioral beliefs and outcome evaluations for non-laboratory, $F(5, 173) = 1.22, p = .30$.

Table 22 presents the LSD multiple range analysis of means table for grade level as the independent variable and behavioral beliefs and outcome evaluations as the dependent variable for non-laboratory. Table 22 shows
Table 21
ANOVA Table for Effects of Gender and Grade Level on Behavioral Beliefs and Outcome Evaluations for Non-Laboratory

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F-Ratio</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAIN EFFECTS:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>153.2602</td>
<td>1</td>
<td>153.2602</td>
<td>1.826</td>
<td>.1784</td>
</tr>
<tr>
<td>Grade</td>
<td>1546.7011</td>
<td>5</td>
<td>309.34022</td>
<td>3.685</td>
<td>.0034</td>
</tr>
<tr>
<td>2-FACTOR INTERACTIONS</td>
<td>511.36800</td>
<td>5</td>
<td>102.27360</td>
<td>1.218</td>
<td>.3026</td>
</tr>
<tr>
<td>RESIDUAL</td>
<td>14524.013</td>
<td>173</td>
<td>83.953834</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (Corrected)</td>
<td>16666.238</td>
<td>184</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 22

LSD Multiple Range Analysis for the Effect of Grade Level on Behavioral Beliefs and Outcome Evaluations for Non-Laboratory Science

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>N</th>
<th>Mean</th>
<th>Homogeneous Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>32</td>
<td>10.50</td>
<td>*</td>
</tr>
<tr>
<td>7</td>
<td>23</td>
<td>11.30</td>
<td>*</td>
</tr>
<tr>
<td>4</td>
<td>32</td>
<td>12.34</td>
<td>*</td>
</tr>
<tr>
<td>5</td>
<td>34</td>
<td>13.50</td>
<td>*</td>
</tr>
<tr>
<td>6</td>
<td>35</td>
<td>15.08</td>
<td>*</td>
</tr>
<tr>
<td>3</td>
<td>29</td>
<td>19.24</td>
<td>*</td>
</tr>
</tbody>
</table>
that grade 8 is lower than grades 6 and 3. Grades 7, 4, and 5 are lower than grade 3. Grade 6 is lower than grade 3.

Figure 18 presents a graph of the relationships between the external variables of gender and grade level and the construct of behavioral beliefs and outcome evaluations for non-laboratory.

Figure 18 shows that for males the means are moderate in grades 3 to 6, then drop in grades 7 and 8. For females, the mean is high in grade 3, the means drop to moderate in grades 4 to 7, then the mean drops low in grade 8.

Table 23 presents the ANOVA table with the construct of normative beliefs and motivations to comply for non-laboratory as the dependent variable and gender and grade level as the independent variables. Table 23 shows that gender has no significant effect on the construct of normative beliefs and motivations to comply for non-laboratory, $F (1, 159) = .30, p = .59$. Grade level has a significant effect on the construct of normative beliefs and motivations to comply for non-laboratory, $F (5, 159) = 2.28, p = .05$. There is a significant interaction effect between gender and grade level on the construct of normative beliefs and motivations to comply for non-laboratory, $F (5, 159) = 2.02, p = .08$.

Table 24 presents the LSD multiple range analysis of
Figure 18. Behavioral beliefs and outcome evaluations means by gender and grade level for non-laboratory behavior.
Table 23

ANOVA Table for Effects of Gender and Grade Level on Normative Beliefs and Motivations to Comply for Non-Laboratory

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F-Ratio</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAIN EFFECTS:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>131.5659</td>
<td>1</td>
<td>131.5659</td>
<td>.296</td>
<td>.5928</td>
</tr>
<tr>
<td>Grade</td>
<td>5055.6261</td>
<td>5</td>
<td>1011.1252</td>
<td>2.277</td>
<td>.0494</td>
</tr>
<tr>
<td>2-FACTOR</td>
<td>4480.4928</td>
<td>5</td>
<td>896.09855</td>
<td>2.018</td>
<td>.0789</td>
</tr>
<tr>
<td>INTERACTIONS</td>
<td>70600.080</td>
<td>159</td>
<td>444.02566</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RESIDUAL</td>
<td></td>
<td>170</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total 80326.421 (Corrected)
Table 24
LSD Multiple Range Analysis for the Effect of Grade Level on 
Normative Beliefs and Motivations to Comply for Non-Laboratory 
Science

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>N</th>
<th>Mean</th>
<th>Homogeneous Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>30</td>
<td>26.43</td>
<td>*</td>
</tr>
<tr>
<td>7</td>
<td>21</td>
<td>27.90</td>
<td>*</td>
</tr>
<tr>
<td>4</td>
<td>31</td>
<td>33.29</td>
<td>**</td>
</tr>
<tr>
<td>5</td>
<td>31</td>
<td>34.35</td>
<td>**</td>
</tr>
<tr>
<td>3</td>
<td>28</td>
<td>40.11</td>
<td>*</td>
</tr>
<tr>
<td>6</td>
<td>30</td>
<td>41.20</td>
<td>*</td>
</tr>
</tbody>
</table>
means table for grade level as the independent variable and normative beliefs and motivations to comply as the dependent variable for non-laboratory. Table 24 shows that grades 8 and 7 are lower than grades 3 and 6.

Figure 19 presents a graph of the relationships between the external variables of gender and grade level and the construct of normative beliefs and motivations to comply for non-laboratory.

Figure 19 shows that the means for males are moderate in grades 3 to 5, the mean rises in grade 6, then the means drop to lower levels in grades 7 and 8 than in grades 3 to 5. For females, the mean is high in grade 3, the means drop to moderate in grades 4 to 7, then the mean drops low in grade 8.

Table 25 provides a comparison of the relative weights of attitude toward behavior and subjective norm with respect to the laboratory behavioral intention while considering the external variable of gender. Table 25 shows that the relative weights of attitude toward behavior and subjective norm for males are .34 and .20; for females they are .34 and .02. There is a change in the relative weights with respect to gender of student.

Table 26 provides a comparison of the relative weights of attitude toward behavior and subjective norm with respect to the non-laboratory behavioral intention while considering the external variable of gender. Table
Figure 19. Normative beliefs and motivations to comply means by gender and grade level for non-laboratory behavior.
Table 25

Comparison of Relative Weights of Attitude toward Behavior and Subjective Norm for Laboratory with Respect to Gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>Correlation Coefficients</th>
<th>Relative Weights</th>
<th>Multiple Correlation (R)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AB</td>
<td>SN</td>
<td>AB</td>
</tr>
<tr>
<td>Male</td>
<td>.39</td>
<td>.27</td>
<td>.34</td>
</tr>
<tr>
<td>Female</td>
<td>.35</td>
<td>.08</td>
<td>.34</td>
</tr>
</tbody>
</table>
Table 26

Comparison of Relative Weights of Attitude toward Behavior and Subjective Norm for Non-Laboratory with Respect to Gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>Correlation Coefficients</th>
<th>Relative Weights</th>
<th>Multiple Correlation (R)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AB</td>
<td>SN</td>
<td>AB</td>
</tr>
<tr>
<td>Male</td>
<td>.55</td>
<td>.07</td>
<td>.59</td>
</tr>
<tr>
<td>Female</td>
<td>.44</td>
<td>.19</td>
<td>.43</td>
</tr>
</tbody>
</table>
26 shows that the relative weights of attitude toward behavior and subjective norm for males are .59 and .13; for females they are .43 and .00. There is a change in the relative weights with respect to gender of student.

Table 27 provides a comparison of the relative weights of attitude toward behavior and subjective norm with respect to the laboratory behavioral intention while considering the external variable of grade level. Table 27 shows that the relative weights of attitude toward behavior and subjective norm for grade 3 are .56 and -.19; for grade 4 they are .16 and .11; for grade 5 they are .34 and -.14; for grade 6 they are .23 and .44; for grade 7 they are .35 and .30; for grade 8 they are .43 and -.06. There is change in the relative weights with respect to grade level of student for laboratory.

Figure 20 provides a graphic depiction of the relative weights of attitude toward behavior and subjective norm for laboratory with respect to grade level of student.

Figure 20 shows, in graphic form, the values given in Table 27. The relative weights do vary, but it is difficult to infer a pattern from the graph.

Table 28 provides a comparison of the relative weights of attitude toward behavior and subjective norm with respect to the non-laboratory behavioral intention while considering the external variable of grade level.
Table 27

Comparison of Relative Weights of Attitude toward Behavior and Subjective Norm for Laboratory with Respect to Grade Level

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Correlation Coefficients</th>
<th>Relative Weights</th>
<th>Multiple Correlation (R)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AB</td>
<td>SN</td>
<td>AB</td>
</tr>
<tr>
<td>3</td>
<td>.53</td>
<td>-.11</td>
<td>.56</td>
</tr>
<tr>
<td>4</td>
<td>.18</td>
<td>.15</td>
<td>.16</td>
</tr>
<tr>
<td>5</td>
<td>.32</td>
<td>-.08</td>
<td>.34</td>
</tr>
<tr>
<td>6</td>
<td>.36</td>
<td>.50</td>
<td>.23</td>
</tr>
<tr>
<td>7</td>
<td>.50</td>
<td>.48</td>
<td>.35</td>
</tr>
<tr>
<td>8</td>
<td>.42</td>
<td>.06</td>
<td>.43</td>
</tr>
</tbody>
</table>
Figure 20. Relative weights of attitude toward behavior and subjective norm for laboratory behavior with respect to grade level.
Table 28

Comparison of Relative Weights of Attitude toward Behavior and Subjective Norm for Non-Laboratory with Respect to Grade Level

| Grade Level | Correlation Coefficients | | Relative Weights | | Multiple Correlation (R) |
|-------------|--------------------------|---------------------|-----------------|------------------|
|             | AB | SN | AB | SN |                  |
| 3           | .12 | .16 | .04 | .14 | .00 |
| 4           | .60 | -.03 | .64 | .16 | .58 |
| 5           | .12 | .22 | .05 | .20 | .00 |
| 6           | .39 | .02 | .43 | .12 | .33 |
| 7           | .41 | .08 | .47 | .13 | .33 |
| 8           | .77 | .21 | .79 | .06 | .75 |
Table 28 shows that the relative weights of attitude toward behavior and subjective norm for grade 3 are .04 and .14; for grade 4 they are .64 and .16; for grade 5 they are .05 and .20; for grade 6 they are .43 and .12; for grade 7 they are .47 and .13; for grade 8 they are .79 and .06. There is a change in the relative weights with respect to grade level of student for non-laboratory.

Figure 21 provides a graphic depiction of the relative weights of attitude toward behavior and subjective norm for non-laboratory with respect to grade level of student.

Figure 21 shows, in graphic form, the values given in Table 28. The relative weight of attitude toward behavior varies widely with grade level; the relative weight of subjective norm is fairly stable and low.

Responses to Null Hypotheses and Summary

The null hypotheses were stated in Chapter III. The alpha level for decision making was .10 for hypotheses 1, 2, 5 through 16, 21, and 23. Subjective decision making was used for hypotheses 3, 4, 17 through 20, and 22. The findings (with actual p values reported) of this study indicate the following responses to the 23 null hypotheses:

1. Attitude toward behavior and subjective norm explain a significant amount of variation ($R^2 = .14$, $p =$
Figure 21. Relative weights of attitude toward behavior and subjective norm for non-laboratory behavior with respect to grade level.
.00) in the laboratory behavioral intention.

2. Attitude toward behavior and subjective norm explain a significant amount of variation \( R^2 = .25, p = .00 \) in the non-laboratory behavioral intention.

3. There is a variation in the relative weights of attitude toward behavior and subjective norm for the laboratory behavioral intention.

4. There is a variation in the relative weights of attitude toward behavior and subjective norm for the non-laboratory behavioral intention.

5. Gender of student has no significant effect on behavioral beliefs and outcome evaluations for the laboratory behavioral intention, \( F (1, 171) = .044, p = .84 \).

6. Gender of student has no significant effect on behavioral beliefs and outcome evaluations for the non-laboratory behavioral intention, \( F (1, 173) = 1.83, p = .18 \).

7. Gender of student has a significant effect on normative beliefs and motivations to comply for the laboratory behavioral intention, \( F (1, 146) = 5.85, p = .02 \).

8. Gender of student has no significant effect on normative beliefs and motivations to comply for the non-laboratory behavioral intention, \( F (1, 159) = .30, p = .59 \).
9. Grade level of student has a significant effect on behavioral beliefs and outcome evaluations for the laboratory behavioral intention, $F(5, 171) = 7.64, p = .00$.

10. Grade level of student has a significant effect on behavioral beliefs and outcome evaluations for the non-laboratory behavioral intention, $F(5, 173) = 3.68, p = .00$.

11. Grade level of student has a significant effect on normative beliefs and motivations to comply for the laboratory behavioral intention, $F(5, 146) = 3.63, p = .00$.

12. Grade level of student has a significant effect on normative beliefs and motivations to comply for the non-laboratory behavioral intention, $F(5, 159) = 2.28, p = .05$.

13. There is no significant interaction effect between gender and grade level of student with respect to behavioral beliefs and outcome evaluations for the laboratory behavioral intention, $F(5, 171) = .40, p = .85$.

14. There is no significant interaction effect between gender and grade level of student with respect to behavioral beliefs and outcome evaluations for the non-laboratory behavioral intention, $F(5, 173) = 1.22, p = .30$. 
15. There is a significant interaction effect between gender and grade level of student with respect to normative beliefs and motivations to comply for the laboratory behavioral intention, $F (5, 146) = 1.96, p = .09$.

16. There is a significant interaction effect between gender and grade level of student with respect to normative beliefs and motivations to comply for the non-laboratory behavioral intention, $F (5, 159) = 2.02, p = .08$.

17. There is a relationship between the external variable of gender of student and the relative weights of attitude toward behavior and subjective norm for the laboratory behavioral intention.

18. There is a relationship between the external variable of gender of student and the relative weights of attitude toward behavior and subjective norm for the non-laboratory behavioral intention.

19. There is a relationship between the external variable of grade level of student and the relative weights of attitude toward behavior and subjective norm for the laboratory behavioral intention.

20. There is a relationship between the external variable of grade level of student and the relative weights of attitude toward behavior and subjective norm for the non-laboratory behavioral intention.
21. There is no significant difference in the amount of variance explained in behavioral intention by attitude toward behavior and subjective norm with respect to laboratory versus non-laboratory, \( p = .12 \).

22. The relative weights of attitude toward behavior and subjective norm are different with respect to laboratory versus non-laboratory.

23. There is a significant difference between the analogous correlations for the two behavioral intentions (laboratory versus non-laboratory).

Since 27 significance test were conducted, accumulated error rate comes to bear. According to Good (1984), with alpha at .10 there is a 94% chance of obtaining one or more significant results even though all 27 null hypotheses are true. However, this research is exploratory and not involved in evaluating treatments. Therefore, the accumulated error rate associated with multiple hypothesis testing is not of major concern in this study.

Tables 1 to 4 in this chapter listed the salient beliefs of students with respect to engaging in laboratory and non-laboratory science learning behaviors. Figure 22 summarizes the relationships between the constructs considered by the theory of reasoned action for laboratory and non-laboratory behavioral intentions. Figure 22 also indicates whether selected analogous
Laboratory

R = .57
LN no

Gender

no

Behavioral beliefs and outcome evaluations

variation

Attitude toward the behavior

w_1 = .35
LN yes

Relative importance of attitude and subjective norm

w_2 = .11
LN no

Intention

Grade level

yes

Normative beliefs and motivations to comply

variation

Subjective norm

R = .33
LN yes

Non-Laboratory

R = .58
LN no

Gender

no

Behavioral beliefs and outcome evaluations

variation

Attitude toward the behavior

w_1 = .54
LN yes

Relative importance of attitude and subjective norm

w_2 = .08
LN no

Intention

Grade level

yes

Normative beliefs and motivations to comply

variation

Subjective norm

R = .51
LN no

R = .50
LN no

R = .15
LN no

R = .14
LN no

w_1 - relative weight of attitude toward behavior
w_2 - relative weight of subjective norm
yes - significant effect
no - no significant effect
l - gender X grade level interaction
LN - laboratory versus non-laboratory comparison made

Figure 22. Summary of relationships for laboratory and non-laboratory.
relationships are significantly different when comparing the laboratory and non-laboratory behavioral intentions.
Chapter V
Summary, Conclusions, and Recommendations

Science educators attempt to aid students in gaining scientific knowledge and in learning and experiencing scientific processes. To do this, science educators plan specific learning activities for students. This study is aimed at gathering and understanding information which might be used by science educators to better ensure that science students actually engage in science learning behavior.

This chapter serves as a culmination of the report on this study and is organized into four sections. The first section is a summary, the second contains conclusions, the third is a discussion not directly related to the hypotheses, and the third contains recommendations.

Summary

This section is divided into three parts. The first is a summary of the problem, purpose, and theoretical framework. The second part is a summary of the methodology, and the third part is a summary of findings.

Problem, purpose, and theoretical framework.

Different constituencies in the United States are simultaneously calling for increased scientific literacy of students and a move back to the "basics" (which
generally do not include science). Despite the debate on how resources should be used, science educators must use what resources they have to assure that students actually engage in science learning behavior when presented with the opportunity to do so. However, it appears that science educators lack important baseline information about what determines whether students will actually "do their science." Science educators need information that would be useful in changing science learners' intentions and actual behavior.

The purpose of this study was to gain information about the determinants of student behavior with respect to laboratory and non-laboratory science learning activities. More specifically, the purpose of the study was to answer the following questions by using the theory of reasoned action:

1. What are the salient beliefs of students with respect to engaging in laboratory and non-laboratory activities?
2. What are the correlations between adjacent components in the theory of reasoned action?
3. What are the relative weights of the immediate determinants (i.e., attitude toward the behavior and subjective norm) of student intention to engage in laboratory and non-laboratory science learning behaviors?
4. Do the relative weights of the immediate
determinants (i.e., attitude toward the behavior and subjective norm) differ with respect to laboratory versus non-laboratory intentions?

5. Do the analogous correlations for the two behavioral intentions (laboratory and non-laboratory) differ?

6. What is the relationship between gender of student and attitude toward the behavior, subjective norm, and the relative weights of attitude toward behavior and subjective norm?

7. What is the relationship between grade level of student and attitude toward the behavior, subjective norm, and the relative weights of attitude toward behavior and subjective norm?

The preceding questions of this study deal with the determinants of science students' intentions to behave. Answers to the questions may help science educators to eventually affect the scientific literacy of students. However, a strong theoretical approach to answering the questions is needed before useful answers can be achieved. Relevant to this need, there is substantial evidence that the construct most closely associated with behavior is behavioral intention (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975). Furthermore, the theory of reasoned action (Fishbein & Ajzen) has been successful at understanding determinants of intention and predicting
intention and behavior. Within this theory, the information a person has serves as the basis of his or her beliefs. The beliefs are linked to attitude toward a behavior (the personal component) and subjective norm (the social component), then to intention, and finally to behavior. Using the theory of reasoned action, it is supposed that the intention to perform a particular behavior (e.g., doing science experiments) is a function of the weighted attitude toward performing the behavior and the weighted subjective norm.

It was decided that use of the theory of reasoned action might generate information about the determinants of science learning behavior. The two behaviors of interest that were identified are (1) doing science projects and science experiments (laboratory) and (2) doing science reading and science writing (non-laboratory). There were several reasons to expect the determinants of science learning behavior to be unique (i.e., different from the determinants of other behavior). There were also several reasons to expect the determinants of laboratory and non-laboratory behavior to differ. The various reasons for expecting differences in determinants were explicated in Chapter I and Chapter II. Furthermore, the literature review indicated that there might be reason to expect the determinants of science learners' intentions to vary with respect to their gender
and grade level. These two external variables were included in the investigation so that more complete information might be procured.

It was thought that analysis of the generated information might provide understanding necessary for future research aimed at affecting science learner behavior. That is, a careful exploration of behavioral determinants and selected external variables might guide future researchers, and eventually educational practitioners, in developing plans for altering science students' learning.

Methodology.

This study was exploratory in nature. It generated baseline information and utilized correlational analysis procedures. Twenty-three null hypotheses were stated, and the study was designed to test them. The population of consisted of public school students in grades 3 to 8 in the mid-Willamette Valley region of the State of Oregon. Three school districts were included in order to represent a variety of students in terms of demographic characteristics. Three elementary and three middle schools were involved; some were randomly selected and some were assigned by school district personnel. Random selection via multistage cluster sampling (Borg & Gall, 1983) was used to select the classes of students. The sample size for the laboratory behavioral intention was
187 (n = 187) and for the non-laboratory behavioral intention it was 190 (n = 190). Therefore, the main part of the study involved 377 students (N = 377), while the pilot study involved 102 students (N = 102).

The research proceeded in three stages. Stage I was an exploratory phase; information was gathered so that the initial instruments could be constructed. Half of the males and half of the females from the total sample of 377 were randomly assigned to the laboratory group; the other halves were assigned to the non-laboratory group. Seventy-two (n = 72) students (50% male and 50% laboratory) were randomly selected from the 377 (which would later be used in Stage III). Half of the 72 were interviewed in order to elicit their salient attitudinal and normative beliefs regarding the doing of laboratory science; the other half were interviewed regarding the doing of non-laboratory science. The beliefs were codified and made into a frequency listing for the purpose of constructing the laboratory and non-laboratory instruments. The protocol of Appendix A was basically followed to construct the instruments. The instruments appear in Appendix C.

Stage II was a pilot study. The initial instruments were administered to a representative group of students (N = 102) from six randomly selected grades 3 to 8 classes. The information gained was to be used to
improve the instruments and their accompanying administration procedures. The final instruments and administration procedures were constructed.

Stage III was the administration of the instruments to the student sample (N = 377) during the period of November 2 through 5, 1987. Stage III also included the data analysis. Analysis procedures included (1) multiple regression, (2) Pearson product-moment correlation coefficients, (3) analysis of variance, (4) statistical comparison of coefficients of multiple determination ($R^2$) and correlation coefficients ($r$), (5) standardized regression coefficients, and (6) subjective comparison of standardized regression coefficients. An alpha level of .10 was used for decision making.

**Findings.**

Several salient beliefs were elicited from students during interviews. Eleven beliefs about the outcomes of doing laboratory science behavior were frequently elicited; seven beliefs for non-laboratory science were frequently elicited. Six of the beliefs about outcomes of doing laboratory science were identical or very similar to beliefs about outcomes of doing non-laboratory science. Six normative beliefs (referents) related to doing laboratory science behavior were frequently elicited; seven beliefs for non-laboratory were elicited. The six normative beliefs for laboratory
were included in the seven for non-laboratory.

Several findings were made regarding the relationships between constructs in the theory of reasoned action. Alpha was set at .10 for hypotheses related to the following findings numbered 1 through 5 and 7 through 9. Hypotheses related to the following findings numbered 6 and 10 were tested subjectively. These findings and their actual $p$ values are as follows:

1. A significant correlation ($R = .37$, $p = .00$) was found between the independent variables of attitude toward behavior and subjective norm and the dependent variable of laboratory behavioral intention.

2. A significant correlation ($R = .50$, $p = .00$) was found between the independent variables of attitude toward behavior and subjective norm and the dependent variable of non-laboratory behavioral intention.

3. The $R$ values for laboratory and non-laboratory are not significantly different ($p = .12$).

4. All of the correlation coefficients ($R$) (which ranged from .14 to .58) between adjacent constructs in the theory of reasoned action are significant (and for all of them, $p < .08$).

5. Of the four comparisons made between analogous correlation coefficients for laboratory and non-laboratory, two (i.e., attitude toward behavior-behavioral intention and normative beliefs and
motivations to comply-subjective norm) are significantly
different (p = .05 and p = .07).

6. Attitude toward behavior has a larger relative
weight than does subjective norm for both the laboratory
and non-laboratory behavioral intentions.

7. Gender of student has a significant effect on
normative beliefs and motivations to comply for the
laboratory behavioral intention (p = .02), but not for
the non-laboratory behavioral intention (p = .59); gender
has no significant effect on behavioral beliefs and
outcome evaluation for either the laboratory (p = .84) or
non-laboratory behavioral intention (p = .18).

8. Grade level of student has a significant effect
on behavioral beliefs and outcome evaluations (p = .00)
and on normative beliefs and motivations to comply (p = .00)
for the laboratory behavioral intention; grade level
of student has a significant effect on behavioral beliefs
and outcome evaluations (p = .00) and on normative
beliefs and motivations to comply (p = .05) for the non-
laboratory behavioral intention.

9. There is a significant interaction effect between
gender and grade level of student on the dependent
variable of normative beliefs and motivations to comply
for both the laboratory (p = .09) and non-laboratory (p = .08)
behavioral intentions; there is no significant
interaction effect on the dependent variable of
behavioral beliefs and outcome evaluations for the laboratory ($p = .85$) or the non-laboratory ($p = .30$) behavioral intentions.

10. The relative weights of attitude toward behavior and subjective norm varied with respect to both gender and grade level for both laboratory and non-laboratory behavioral intentions.

**Conclusions**

The population studied should be recalled before making conclusions. Grades 3 to 8 public school students in the mid-Willamette region of the State of Oregon were involved. This area included both rural and small urban (with one city having had a population of about 42,000) settings. Students with significant auditory, visual, or emotional handicaps were not included. There is no apparent reason to suspect that these students were notably different from others who might possess similar demographic characteristics. However, one must remember that it was a particular group in Oregon in the autumn of 1987 which was studied. With the population in mind, conclusions will be drawn.

**Salient beliefs.**

In terms of behavioral beliefs, the final study focused on 11 for laboratory and 7 for non-laboratory; 4 of the non-laboratory beliefs were identical to and 2 were very similar to the laboratory beliefs. It may be
that these six beliefs about the outcomes of doing laboratory and non-laboratory science and students' corresponding evaluations of these outcomes are essential to an understanding of their behavioral intentions. As a corollary, it may be that the beliefs unique to either laboratory or non-laboratory (and likewise less frequently mentioned by students in general) are the ones essential to an understanding of student behavioral intention. In summary, there are behavioral beliefs about doing laboratory and non-laboratory science which are frequently and consistently mentioned by public school science students in grades 3 to 8.

In terms of normative beliefs, the final study focused on six for laboratory and seven for non-laboratory; the six for laboratory were identical to six of those for non-laboratory. It appears that seven referents and motivations to comply with these referents are essential to understanding the behavioral intentions of science learners in grades 3 to 8.

Relationships between constructs and relative weights.

All of the correlations between constructs in the theory of reasoned action are statistically significant for both laboratory and non-laboratory behavioral intentions. The correlations between attitude toward behavior and subjective norm and their immediate
determinants are in the range of .43 to .58. Correlations of this magnitude can be used to achieve "crude group prediction" (Borg & Gall, 1983, p. 624). These are reasonably high correlations for research of this nature. The correlations between attitude toward behavior and behavioral intention for laboratory science and non-laboratory science are .33 and .51. These are likewise reasonably high correlations when considering the exploratory and socio-behavioral nature of this study. The correlations between subjective norm and behavioral intention for laboratory science and non-laboratory science are .14 and .15. "Correlations at this level . . . are of little value in practical prediction situations" (Borg & Gall, p. 624). However, the use of multiple regression maximizes correlations and brings the explained variance in behavioral intention up to practically significant values for both laboratory and non-laboratory. The $R^2$ for laboratory behavioral intention is .14 and for the non-laboratory behavioral intention it is .25. Such multiple correlation values are not as high as those reported in Chapter II with respect to various other studies that used the theory of reasoned action. However, only one study involved science students, and they were at the high school grade level. None of the other studies found or reviewed by the researcher involved science students, and none of
them involved people as young as grade 3 as did this study. Nevertheless, this study indicates that there are relationships of statistical and practical significance between the determinants and the behavioral intention of science learners.

The authors of the theory of reasoned action and those who have used the theory established, to a meaningful degree, its significance and practical value prior to this study. The purpose of this study was not to test the theory of reasoned action. Therefore, it is perhaps of more practical importance to examine the values of individual correlations (which was just done) and their relative weights (standardized regression coefficients). Consistent with other research that has employed the theory of reasoned action, attitude toward behavior has a greater relative weight than subjective norm in terms of predicting behavioral intention for both laboratory and non-laboratory. The values for laboratory are .35 and .11; for non-laboratory they are .54 and .08. The very small correlations (.14 and .15) between subjective norm and behavioral intention indicate that subjective norm aids little in predicting these grades 3 to 8 science students' intentions to engage in laboratory or non-laboratory science learning behavior. That is, the correlation coefficients support the idea that the standardized regression coefficients reflect the relative
weights of the independent variables, even though Neter, Wasserman, and Kutner (1983) pointed out that caution should be exercised in interpreting standardized regression coefficients in this manner. It appears that attitude toward behavior and its constituent behavioral beliefs and outcome evaluations might contribute significantly to an understanding of what determines behavioral intention with respect to both the laboratory and non-laboratory behavior of these grades 3 to 8 science learners. On the other hand, it appears that subjective norm and its constituent normative beliefs and motivations to comply might add little to an understanding of both the laboratory and non-laboratory behavioral intentions of grades 3 to 8 science learners.

Comparison of relationships and relative weights between laboratory and non-laboratory.

The coefficients of multiple correlation for laboratory and non-laboratory behavioral intention are not significantly different. Based on this information, pursuit of understanding and eventually affecting intention to engage in science learning behavior may be just as fruitful an endeavor in the context of laboratory science as in the context of non-laboratory science.

The correlation between attitude toward behavior and behavioral intention for laboratory ($r = .33$) is significantly different from the analogous correlation
for non-laboratory ($r = .51$). This may indicate that use of the theory of reasoned action to understand and eventually influence behavioral intention might be more fruitful, at this point, in the context of non-laboratory than in the context of laboratory science. The correlation between subjective norm and behavioral intention for laboratory ($r = .14$) is not significantly different from the analogous correlation for non-laboratory ($r = .15$). The low practical value of both of these correlations and the fact that they are not significantly different suggests that they are of equal and little use in explaining variance in the behavioral intentions.

The correlation between attitude toward behavior and behavioral beliefs and outcome evaluations for laboratory ($r = .57$) is not significantly different from the analogous correlation for non-laboratory ($r = .58$). Apparently, one should not expect the construct of behavioral beliefs and outcome evaluations to better predict attitude toward behavior in either the laboratory or non-laboratory science contexts. Contrariwise, the correlation between subjective norm and normative beliefs and motivations to comply for laboratory ($r = .43$) is significantly different from the analogous correlation for non-laboratory ($r = .58$). That is, the construct of normative beliefs and motivations to comply may be better
able to predict subjective norm in the non-laboratory science context than in the laboratory science context.

The preceding section included a discussion of the relative weights of attitude toward behavior and subjective norm. Attitude toward behavior has much greater relative weight than does subjective norm for both laboratory and non-laboratory science learning behavioral intention. It appears that attitude toward behavior lends much more to the understanding of the determinants of science learning behavioral intention than does subjective norm for grades 3 to 8 students.

Effects of gender.

The effects of gender of student on behavioral beliefs and outcome evaluations, normative beliefs and motivations to comply, and relative weights of attitude toward behavior and subjective norm were analyzed. Gender of student has a significant effect on normative beliefs and motivations to comply only for laboratory. That is, males generally have a lower score in the area of normative beliefs and motivations to comply in the laboratory science context. A detailed analysis was not done to determine whether the beliefs about which referents want them to do laboratory science, the motivations to comply, or a combination thereof led to lower scores for males than for females. The aforementioned significant effect of gender is reflected
in the effect of gender on relative weights of attitude toward behavior and subjective norm. Gender apparently has no effect on the relative weight of attitude toward behavior. On the other hand, for males the relative weight of subjective norm was ten times greater than for females in predicting laboratory behavior intention. The pattern is very similar with respect to effect of gender on relative weights for non-laboratory behavioral intention. However, it should be noted that subjective norm explains very little variance in laboratory and non-laboratory behavioral intention to begin with. The analyses of the effect of gender on other constructs revealed no significant effects.

In summary, gender appears to affect the normative beliefs and motivations to comply which determine subjective norm only for the laboratory science behavioral intention. However, subjective norm (which is determined by these beliefs and motivations) appears to have very little practical value in terms of predicting or understanding either laboratory or non-laboratory behavioral intention. Based on the findings while using the theory of reasoned action, the external variable of gender of student appears to have very little effect on the intention of grades 3 to 8 students to engage in laboratory and non-laboratory science learning behavior.
Effects of grade level.

Grade level of student has a significant effect on the construct of behavioral beliefs and outcome evaluations and on the construct of normative beliefs and motivations to comply for both laboratory and non-laboratory. A pattern appears to emerge for the effects of grade level on behavioral beliefs and outcome evaluations scores for laboratory. The scores are moderate in grades 3 and 4, rise in grade 5, are moderate again in grades 6 and 7, then drop low in grade 8. A pattern seems to emerge for the effects of grade level on behavioral beliefs and outcome evaluations scores for non-laboratory. Scores are high in grade 3, fairly moderate in grades 4 to 7, and drop lower in grade 8. The patterns for behavioral beliefs and outcome evaluations scores for laboratory and non-laboratory appear to be similar only in that they both generally decline or are low in grade 8.

It is much more difficult to discern patterns, if they exist at all, in the relationships between grade level and the construct of normative beliefs and motivations to comply for laboratory and non-laboratory. The patterns are complicated by the fact that there are significant interaction effects between gender and grade level on the normative beliefs and motivations to comply scores. Overall, the normative beliefs and motivations
to comply scores tend to be moderate to high for grades 3 to 7 and low for grade 8.

The relative weights of attitude toward behavior and subjective norm appear to be affected by the external variable of grade level for both laboratory and non-laboratory. However, patterns are difficult to discern. For laboratory, the relative weight of attitude toward behavior is very high in grades 3 and 8. Attitude toward behavior has lower relative weight than subjective norm in grade 6, and the relative weights are nearly equal in grade 7. For non-laboratory, the relative weight of attitude toward behavior is very high in grades 4 and 8. Attitude toward behavior has lower relative weight than subjective norm in grades 3 and 5. A close examination of the relative weights and their actual values perhaps reveals that the effects of grade level on relative weights vary from the laboratory to the non-laboratory science learning behaviors. Based on the findings while using the theory of reasoned action, the external variable of grade level of student appears to have a definite, albeit indirect, effect on the intention of grades 3 to 8 students to engage in laboratory and non-laboratory science learning behavior.

An overall examination of the data suggest that there may be a pattern for the behavioral beliefs and outcome evaluations scores and the normative beliefs and
motivations to comply scores. The scores are moderate to moderately high in grades 3 to 6 or 7, and experience a noticeable decline in grades 7 or 8. Based on the data while using the theory of reasoned action, students in grade 8 (and possibly grade 7) have a lower intention to engage in science learning behavior than do those in grades 3 to 6. Furthermore, grade 8 (and possibly grade 7) students are less likely to actually engage in assigned laboratory and non-laboratory science learning behavior. This pattern confirms the trend found in research and reported by science educators (Bohardt, 1974; Haladyna, Olsen, & Shaughnessy, 1982; Linn, 1987; Olstad & Haury, 1984; Simpson & Oliver, 1985; Talton & Simpson, 1986; Yager, 1983). That is, the older school children are the lower attitude toward science they have and the less likely they are to be interested in science learning.

Summary.

In summary, the conclusions drawn from the study are as follows:

1. There are 11 identifiable behavioral beliefs about doing laboratory science and 7 about doing non-laboratory science which are frequently and consistently mentioned by public school students in grades 3 to 8.

2. There are six normative beliefs for laboratory science and seven for non-laboratory science which are
frequently and consistently mentioned by public school students in grades 3 to 8.

3. The correlations between attitude toward behavior and subjective norm and their immediate determinants are in the range of .43 to .58.

4. The correlations between attitude toward behavior and behavioral intention for laboratory science and non-laboratory science are .33 and .51, respectively.

5. The correlations between subjective norm and behavioral intention for laboratory science and non-laboratory science are .14 and .15, respectively.

6. The $R^2$ for laboratory behavioral intention is .14 and for the non-laboratory behavioral intention it is .25.

7. Attitude toward behavior has a greater relative weight than subjective norm in terms of predicting behavioral intention for both laboratory science and non-laboratory science.

8. Attitude toward behavior contributes significantly to an understanding and prediction of the laboratory and non-laboratory science behavioral intention of students. Subjective norm explains very little variance in the laboratory and non-laboratory science behavioral intention of students.

9. Five analogous correlations were compared between the laboratory and non-laboratory models. The
correlations were significantly higher for non-laboratory in two cases (attitude toward behavior-intention and normative beliefs and motivations to comply-subjective norm); the other three comparisons revealed no significant differences.

10. The external variable of gender of student appears to have very little effect on the intention of grades 3 to 8 students to engage in laboratory and non-laboratory science learning behavior.

11. The external variable of grade level of student appears to have a definite, albeit indirect, effect on the intention of grades 3 to 8 students to engage in laboratory and non-laboratory science learning behavior.

Discussion Not Directly Related to Hypotheses

One of the basic assumptions of this study is that the theory of reasoned action is a valid model for use in the understanding and prediction of behavioral intention. However, the findings suggest that some thought should be given to the validity of the theory in general, or to the validity of it use in the present study. Five studies that utilized the theory of reasoned action and were reviewed in this thesis reported six multiple correlation coefficients (with attitude toward behavior and subjective norm as independent variables and intention as dependent variable) of .68 to .94. This author's broader study of the literature reveals similarly high multiple
correlations in many other studies which used the theory of reasoned action. On the other hand, the statistically significant multiple correlations in this study were .37 and .50.

Although differences in correlations among studies is usual, the question arises as to why they were so much lower in this study than in those previously reported. Several ideas come to mind when considering the theory of reasoned action and its ability to explain variance in behavioral intention in the present study. First, perhaps another or several other constructs should be considered as immediate determinants of behavioral intention. Human behavior is complex, and the two constructs in the theory (i.e., attitude toward behavior and subjective norm) may not be inclusive enough in terms of their ability to explain intention. In fact, Ajzen and Madden (1986) have already proposed a theory of planned behavior as an extension of the theory of reasoned action. Their proposed theory adds perceived behavioral control as a third immediate determinant of intention. Over time, it is likely that the theory will continue to be refined and expanded (or possibly even replaced).

Second, it is possible that the behavioral intention items (e.g., I plan to do the science projects and science experiments my teacher asks me to do) were not
discriminatory enough. That is, if the items did not discriminate extremely well between those who intended to do their science and those who did not, then it would be difficult for independent variables to explain large amounts of variance in intention. An analysis of this potential problem could be undertaken.

Third, perhaps the protocol devised by Ajzen and Fishbein (1980) (Appendix A) is not sufficient or comprehensive enough in terms of eliciting salient beliefs from subjects. There may be other questions that should be asked of subjects in order to find out which beliefs are most significant in terms of determining attitude toward behavior and subjective norm. For example, it might be that a more direct question (e.g., Why would you want to do your science activities?) would more readily elicit salient beliefs or reasons. This may particularly be true for young children.

Fourth, it may be that there is some significant difference between children and adults with respect to the validity of the theory of reasoned action. No research was found which used the theory of reasoned action with people younger than high school age; this study involved children in grades 3 to 8. Perhaps beliefs which are salient to attitude toward behavior and subjective norm are not yet clear and stable in children in grades 3 to 8. In addition, it may be that the
constructs of attitude toward behavior and subjective norm simply do not explain a large amount of variance in intention for children. This theoretical consideration might be explored to some extent in order to understand the application of the theory of reasoned action with respect to people of different ages.

In summary, the theory of reasoned action has proven useful in providing significant information about children and their intentions to engage in laboratory and non-laboratory science. However, the findings of this study should stimulate others to continue a critical analysis, and possibly revision, of the theory of reasoned action. In particular, researchers should thoughtfully consider the findings of this study if they plan to use the theory of reasoned action in order to understand and predict the intentions and behavior of subjects who are younger than high school age.

Recommendations

The conclusions and the nature of the study suggest the following various possibilities for future study and practice:

1. Perform a detailed analysis of the students' behavioral beliefs in order to ascertain whether any of them are of particular significance in predicting attitude toward behavior.

2. Concentrate on the construct of attitude toward
behavior (and behavioral beliefs and outcome evaluations), rather than subjective norm, in future research regarding science learner intention and behavior in both laboratory and non-laboratory environments.

3. Investigate why the attitude toward behavior-intention and the normative beliefs and motivations to comply-subjective norm correlations were larger for non-laboratory science than for laboratory science.

4. If a preference were needed to be made, first concentrate on research related to non-laboratory science intention and behavior rather than the same for laboratory. This is suggested since the determinants in non-laboratory science explain more variance in succeeding constructs than do the analogous ones in laboratory science.

5. Concentrate on the external variable of grade level of student, rather than gender, in future research regarding the determinants of science learner intention and behavior in both laboratory and non-laboratory environments.

6. If a preference were needed to be made, first concentrate on research related to males' normative beliefs and motivations to comply rather than the same for females. This is suggested since the only significant gender effect that existed was for males on normative beliefs and motivations to comply.
7. Develop a research plan that may lead to experiments aimed at influencing the determinants of student intention to engage in science learning behavior.

8. Apply other statistical methods which may reveal more information and provide clearer understanding of the data which results from use of the theory of reasoned action. For example, measures of association (Nie, Hull, Jenkins, Steinbrenner, and Bent, 1975) might reveal relationships which did not appear within the present study. Or, path analysis (Borg & Gall, 1983) could be used to further test the validity of the theory of reasoned action, especially since the theory is constantly under revision (Ajzen & Fishbein, 1980; Ajzen & Madden, 1986) and there may be a more useful way to understand, predict, and eventually influence science learner intention and behavior.

9. Teachers might concentrate on affecting students' behavioral beliefs and their corresponding outcome evaluations about doing science rather than concentrating on normative beliefs and motivations to comply in order to most efficiently affect science learners' intentions.

10. Teachers could concentrate on the core of salient behavioral beliefs identified in this study when they are attempting to educate children about engaging in science learning activities.
References


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APPENDICES
Appendix A

"Appendix A: Steps in the construction of a standard questionnaire" is from Ajzen and Fishbein (1980, p. 260-263). It is reproduced herein with permission of Icek Ajzen.
Steps In the Construction of a Standard Questionnaire

1. Define the behavior of interest in terms of its action, target, context, and time elements (see chapter 3).
   Example: Voting in the next presidential election.
   In this example action (voting), target (presidential election), and time (the next election) are specified. Make sure that your criterion measure corresponds exactly to the behavior you have in mind.

2. Define the corresponding behavioral intention (see chapter 4).
   Example: Intention to vote in the next presidential election
   Proposed measurement format
   
   I intend to vote in the next presidential election.
   
   likely unlikely
   extremely quite slightly neither slightly quite extremely

3. Define the corresponding attitude and subjective norm (see chapter 5).
   Examples: (a) Attitude toward voting in the next presidential election
   (b) Subjective norm with respect to voting in the next presidential election
   Proposed measurement format
   
   (a) Attitude
   
   My voting in the next presidential election is
   
   harmful beneficial
   extremely quite slightly neither slightly quite extremely

1*Any standard scaling procedure can be used to measure attitude toward the behavior. If the semantic differential is used, the adjective scales included must be evaluative in nature. The four scales listed in 3(a) are merely illustrations.
Appendix A

Steps in the Construction of Standard Questionnaire

Examples: (a) Behavioral belief: My voting in the next presidential election will help Candidate X get elected.
(b) Normative belief: My parents think I should vote in the next presidential election.

Proposed measurement format

(a) Behavioral beliefs

My voting in the next presidential election will help Candidate X get elected.

(b) Outcome evaluations

Helping Candidate X get elected is

(c) Normative beliefs

My parents think

(d) Motivations to comply

Generally speaking, how much do you want to do what your parents think you should do?

Notes

1. Except for the motivation to comply scales, which are scored from 1 (not at all) to 7 (very much), all scales described in this outline are scored from -3 (unlikely, bad, harmful, punishing, unpleasant) to 3 (likely, good, beneficial, rewarding, pleasant).
2. It is possible to employ variations of the graphic scales described in this outline. For examples of somewhat different formats for measuring subjective norms, normative beliefs, and motivations to comply, see appendix B.
January 11, 1988

Icek Ajzen
Department of Psychology
University of Massachusetts
Amherst MA 01002

Dear Dr. Ajzen,

First, I would like to thank you for your friendliness and assistance on the telephone in April 1987; I called to ask you some questions about the theory of reasoned action. Since then I have indeed used the theory for my dissertation study in the area of science education. I also thank you for informing me about the theory of planned behavior and sending a reprint of an article on that subject.

Second, may I please have your permission to include in my dissertation a copy of "Appendix A" (Steps in the Construction of a Standard Questionnaire) from your book Understanding attitudes and predicting social behavior (1980)? Naturally, I would give full credit to you and Dr. Fishbein.

If you would like to receive a summary of my study, please let me know. I look forward to hearing from you soon.

Sincerely,

Brian D. Ray
Doctoral Candidate
Appendix B

Protocol used in elicitation sessions with subjects.
Elicitation Sessions

Theory of Reasoned Action Study

"elicit.4"

by Brian Ray
August 1987

The two defined intentions are:

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

2. **Non-laboratory:** I plan to do the science reading and science writing my teacher asks me to do.
Intention 1: LABORATORY

The following will be read to the student in order to set the atmosphere and encourage the student to think in terms of the context the researcher is considering:

Thank you for helping me. You only have to do this if you want to. Please listen carefully as I read something to you. Then I will ask you some questions.

Think of science as doing experiments or projects on things in nature. You might test to see if plants grow better in salt water or in regular water. You might collect insects and study their parts. You might go outside and look at and feel different kinds of rocks and soil. Think of these kinds of things as science.

Now I'll ask some questions. I'm not grading your answers. There are no right or wrong answers, so just answer with your ideas.

The following questions will be addressed to the students and their responses will be audiotaped:

A. Salient outcomes:

1. What do you think are the advantages or good things that might come from you doing the science projects and science experiments your teacher asks you to do?

2. What are some disadvantages or things you would not like that might come from you doing the science projects and science experiments your teacher asks you to do?

3. Is there anything else you think about when you think of doing the science projects and science experiments your teacher asks you to do?

B. Salient referents:

1. Are there any groups or people or a god who would like you to do the science projects and science experiments your teacher asks you to do?

2. Are there any groups or people or a god who would not want you to do the science projects and science experiments your teacher asks you to do?

3. Are there any other groups or people or a god who you think about when you think of doing the science projects and science experiments your teacher asks you to do?
Intention 2: NON-LABORATORY

The following will be read to the student in order to set the atmosphere and encourage the student to think in terms of the context the researcher is considering:

Thank you for helping me. You only have to do this if you want to. Please listen carefully as I read something to you. Then I will ask you some questions.

Think of science as reading or writing about things in nature. Think of science as reading or your teacher reading to you about things in nature. Someone could read about plants, animals, or rocks and soil. In science, you might write a story about insects. You might do a worksheet about plants. You might read about rocks. Think of these things kinds of things as science.

Now I'll ask some questions. I'm not grading your answers. There are no right or wrong answers, so just answer with your ideas.

The following questions will be addressed to the students and their responses will be audiotaped:

A. Salient outcomes

1. What do you think are the advantages or good things that might come from you doing the science reading and science writing your teacher asks you to do?

2. What are some disadvantages or things you would not like that might come from you doing the science reading and science writing your teacher asks you to do?

3. Is there anything else you think about when you think of doing the science reading and science writing your teacher asks you to do?

B. Salient referents

1. Are there any groups or people or a god who would like you to do the science reading and science writing your teacher asks you to do?

2. Are there any groups or people or a god who would not want you to do the science reading and science writing your teacher asks you to do?

3. Are there any other groups or people or a god who you think about when you think of doing the science reading and science writing your teacher asks you to do?
Appendix C

Instruments used with laboratory ("L") and non-laboratory ("N") subjects.
Instructions

The following items are asking for your opinions or ideas. The items or questions use rating scales with five places. You are to make an "X" in the place that best describes your opinion. For example, you might be asked to rate "Getting good grades."

Getting good grades is

wise : sort of : not wise : sort of : foolish
wise or foolish foolish

If you think getting good grades is wise, then you would place your "X" like this:

Getting good grades is

wise : sort of : not wise : sort of : foolish
wise or foolish foolish

If you think getting good grades is not wise or foolish, then you would place your "X" like this:

Getting good grades is

wise : sort of : X : sort of : foolish
wise or foolish foolish

Do you understand?

Please do the following:

1. Place your "X" in the middle of the space, not in between spaces.

   wise : YES : not wise : NOT like
   sort of wise : this
   sort of or foolish foolish

2. Be sure you answer all questions or items.

3. Only make one "X" for one question or item, no more.

Do you have any questions?
Think of science as doing experiments or projects on things in nature. You might test to see if plants grow better in salt water or in regular water. You might collect insects and study their parts. You might go outside and look at and feel different kinds of rocks and soil. Think of these kinds of things as science.

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

   yes    maybe yes  not sure   maybe no   no

2. Doing the science projects and science experiments my teacher asks me to do is

   good   sort of   not good   sort of   bad
   good   or bad   bad

3. Doing the science projects and science experiments my teacher asks me to do is

   wise   sort of   not wise   sort of   foolish
   wise   or foolish   foolish

4. Doing the science projects and science experiments my teacher asks me to do is

   pleasant   sort of   not   sort of   unpleasant
   pleasant   or unpleasant   unpleasant

5. Learning is

   good   sort of   not good   sort of   bad
   good   or bad   bad

6. Having fun with science and enjoying science is

   good   sort of   not good   sort of   bad
   good   or bad   bad

7. Getting to do science activities and experiments is

   good   sort of   not good   sort of   bad
   good   or bad   bad
8. Getting good or better grades is

<table>
<thead>
<tr>
<th>good</th>
<th>sort of</th>
<th>not good</th>
<th>sort of</th>
<th>bad</th>
</tr>
</thead>
</table>

9. Having to work on science assignments is

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<tr>
<th>good</th>
<th>sort of</th>
<th>not good</th>
<th>sort of</th>
<th>bad</th>
</tr>
</thead>
</table>

10. Being confused and not understanding science is

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<tr>
<th>good</th>
<th>sort of</th>
<th>not good</th>
<th>sort of</th>
<th>bad</th>
</tr>
</thead>
</table>

11. Thinking about how a science experiment will turn out is

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<thead>
<tr>
<th>good</th>
<th>sort of</th>
<th>not good</th>
<th>sort of</th>
<th>bad</th>
</tr>
</thead>
</table>

12. Being interested and not bored is

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<tr>
<th>good</th>
<th>sort of</th>
<th>not good</th>
<th>sort of</th>
<th>bad</th>
</tr>
</thead>
</table>

13. Having an experiment work well is

<table>
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<tr>
<th>good</th>
<th>sort of</th>
<th>not good</th>
<th>sort of</th>
<th>bad</th>
</tr>
</thead>
</table>

14. Dissecting animals and touching their parts is

<table>
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<tr>
<th>good</th>
<th>sort of</th>
<th>not good</th>
<th>sort of</th>
<th>bad</th>
</tr>
</thead>
</table>

15. Having dangerous things happen is

<table>
<thead>
<tr>
<th>good</th>
<th>sort of</th>
<th>not good</th>
<th>sort of</th>
<th>bad</th>
</tr>
</thead>
</table>
16. Doing the science projects and science experiments my teacher asks me to do would cause me to learn.

   yes : maybe yes : not sure : maybe no : no

17. Doing the science projects and science experiments my teacher asks me to do would cause me to have fun with science and enjoy science.

   yes : maybe yes : not sure : maybe no : no

18. Doing the science projects and science experiments my teacher asks me to do would allow me to do science activities and experiments.

   yes : maybe yes : not sure : maybe no : no

19. Doing the science projects and science experiments my teacher asks me to do would cause me to get good or better grades.

   yes : maybe yes : not sure : maybe no : no

20. Doing the science projects and science experiments my teacher asks me to do would cause me to have to do work on science assignments.

   yes : maybe yes : not sure : maybe no : no

21. Doing the science projects and science experiments my teacher asks me to do would cause me to be confused and not understand science.

   yes : maybe yes : not sure : maybe no : no

22. Doing the science projects and science experiments my teacher asks me to do would cause me to think of how a science experiment will turn out.

   yes : maybe yes : not sure : maybe no : no

23. Doing the science projects and science experiments my teacher asks me to do would cause me to be interested and not bored.

   yes : maybe yes : not sure : maybe no : no
24. Doing the science projects and science experiments my teacher asks me to do would cause me to have an experiment work well.

   yes : maybe yes : not sure : maybe no : no

25. Doing the science projects and science experiments my teacher asks me to do would cause me to dissect animals and touch their parts.

   yes : maybe yes : not sure : maybe no : no

26. Doing the science projects and science experiments my teacher asks me to do would cause dangerous things to happen.

   yes : maybe yes : not sure : maybe no : no

27. Most people who are important to me think I should do the science projects and science experiments my teacher asks me to do.

   yes : maybe yes : not sure : maybe no : no

28. My parents think I should do the science projects and science experiments my teacher asks me to do.

   yes : maybe yes : not sure : maybe no : no

29. My teacher thinks I should do the science projects and science experiments my teacher asks me to do.

   yes : maybe yes : not sure : maybe no : no

30. My brothers or sisters think I should do the science projects and science experiments my teacher asks me to do.

   yes : maybe yes : not sure : maybe no : no

31. My grandparents think I should do the science projects and science experiments my teacher asks me to do.

   yes : maybe yes : not sure : maybe no : no
32. My friends think I should do the science projects and science experiments my teacher asks me to do.

- yes
- maybe yes
- not sure
- maybe no
- no

33. God thinks I should do the science projects and science experiments my teacher asks me to do.

- yes
- maybe yes
- not sure
- maybe no
- no

34. In general, I want to do what my parents think I should do.

- yes
- maybe yes
- not sure
- maybe no
- no

35. In general, I want to do what my teacher thinks I should do.

- yes
- maybe yes
- not sure
- maybe no
- no

36. In general, I want to do what my brothers or sisters think I should do.

- yes
- maybe yes
- not sure
- maybe no
- no

37. In general, I want to do what my grandparents think I should do.

- yes
- maybe yes
- not sure
- maybe no
- no

38. In general, I want to do what my friends think I should do.

- yes
- maybe yes
- not sure
- maybe no
- no

39. In general, I want to do what God thinks I should do.

- yes
- maybe yes
- not sure
- maybe no
- no

Information

40. Circle whether you are a boy or a girl: BOY

GIRL
41. Circle the grade you are in:

3 4 5 6 7 8

42. What is your age? ________
Instructions

The following items are asking for your opinions or ideas. The items or questions use rating scales with five places. You are to make an "X" in the place that best describes your opinion. For example, you might be asked to rate "Getting good grades."

Getting good grades is

wise : sort of : not wise : sort of : foolish

If you think getting good grades is wise, then you would place your "X" like this:

Getting good grades is

wise : sort of : not wise : sort of : foolish

If you think getting good grades is not wise or foolish, then you would place your "X" like this:

Getting good grades is

wise : sort of : not wise : sort of : foolish

Do you understand?

Please do the following:

1. Place your "X" in the middle of the space, not in between spaces.

2. Be sure you answer all questions or items.

3. Only make one "X" for one question or item, no more.

Do you have any questions?
Think of science as reading or writing about things in nature. Someone could read about plants, animals, or rocks and soil. In science, you might write a story about insects. You might do a worksheet about plants. You might read about rocks. Think of these kinds of things as science.

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

| yes | maybe yes | not sure | maybe no | no |

2. Doing the science reading and science writing my teacher asks me to do is

| good | sort of | not good | sort of | bad |

3. Doing the science reading and science writing my teacher asks me to do is

| wise | sort of | not wise | sort of | foolish |

4. Doing the science reading and science writing my teacher asks me to do is

| pleasant | sort of | not pleasant | sort of | unpleasant |

5. Learning is

| good | sort of | not good | sort of | bad |

6. Having fun with science and enjoying science is

| good | sort of | not good | sort of | bad |

7. Becoming someone who uses science in their job is

| good | sort of | not good | sort of | bad |
8. Getting good or better grades is
   __________ : __________ : __________ : __________ : __________
   good        sort of      not good      sort of      bad
   good        or bad      bad

9. Thinking about science activities and experiments is
   __________ : __________ : __________ : __________ : __________
   good        sort of      not good      sort of      bad
   good        or bad      bad

10. Doing questions that are difficult and hard to understand is
    __________ : __________ : __________ : __________ : __________
    good        sort of      not good      sort of      bad
    good        or bad      bad

11. Doing more writing is
    __________ : __________ : __________ : __________ : __________
    good        sort of      not good      sort of      bad
    good        or bad      bad

12. Having to work on science assignments is
    __________ : __________ : __________ : __________ : __________
    good        sort of      not good      sort of      bad
    good        or bad      bad

13. Doing the science reading and science writing my teacher asks me to do would cause me to learn.
    __________ : __________ : __________ : __________ : __________
    yes         maybe yes    not sure      maybe no      no

14. Doing the science reading and science writing my teacher asks me to do would cause me to have fun with science and enjoy science.
    __________ : __________ : __________ : __________ : __________
    yes         maybe yes    not sure      maybe no      no

15. Doing the science reading and science writing my teacher asks me to do would allow me to become someone who uses science in their job.
    __________ : __________ : __________ : __________ : __________
    yes         maybe yes    not sure      maybe no      no
16. Doing the science reading and science writing my teacher asks me to do would cause me to get good or better grades.

   yes : maybe yes : not sure : maybe no : no

17. Doing the science reading and science writing my teacher asks me to do would cause me to think about science activities and experiments.

   yes : maybe yes : not sure : maybe no : no

18. Doing the science reading and science writing my teacher asks me to do would cause me to do questions that are difficult and hard to understand.

   yes : maybe yes : not sure : maybe no : no

19. Doing the science reading and science writing my teacher asks me to do would cause me to do more writing.

   yes : maybe yes : not sure : maybe no : no

20. Doing the science reading and science writing my teacher asks me to do would cause me to have to do work on science assignments.

   yes : maybe yes : not sure : maybe no : no

21. Most people who are important to me think I should do the science reading and science writing my teacher asks me to do.

   yes : maybe yes : not sure : maybe no : no

22. My parents think I should do the science reading and science writing my teacher asks me to do.

   yes : maybe yes : not sure : maybe no : no

23. My teacher thinks I should do the science reading and science writing my teacher asks me to do.

   yes : maybe yes : not sure : maybe no : no
24. My grandparents think I should do the science reading and science writing my teacher asks me to do.

yes : maybe yes : not sure : maybe no : no

25. My relatives think I should do the science reading and science writing my teacher asks me to do.

yes : maybe yes : not sure : maybe no : no

26. My brothers or sisters think I should do the science reading and science writing my teacher asks me to do.

yes : maybe yes : not sure : maybe no : no

27. My friends think I should do the science reading and science writing my teacher asks me to do.

yes : maybe yes : not sure : maybe no : no

28. God thinks I should do the science reading and science writing my teacher asks me to do.

yes : maybe yes : not sure : maybe no : no

29. In general, I want to do what my parents think I should do.

yes : maybe yes : not sure : maybe no : no

30. In general, I want to do what my teacher thinks I should do.

yes : maybe yes : not sure : maybe no : no

31. In general, I want to do what my grandparents think I should do.

yes : maybe yes : not sure : maybe no : no

32. In general, I want to do what my relatives think I should do.

yes : maybe yes : not sure : maybe no : no
33. In general, I want to do what my brothers or sisters think I should do.

___ : ___ : ___ : ___ : ___

yes
maybe yes
not sure
maybe no
no

34. In general, I want to do what my friends think I should do.

___ : ___ : ___ : ___ : ___

yes
maybe yes
not sure
maybe no
no

35. In general, I want to do what God thinks I should do.

___ : ___ : ___ : ___ : ___

yes
maybe yes
not sure
maybe no
no

Information

36. Circle whether you are a boy or a girl: BOY GIRL

37. Circle the grade you are in:

3 4 5 6 7 8

38. What is your age? _____
Appendix D

Procedure for administration of instruments for pilot study.
NOTE: Items without parentheses and in boldface are to be read aloud (in a conversational manner) to the students. Items in parentheses are instructions to the administrator.

1. (If a student is noted as "S" on the class list, ask the teacher to identify that student to you. When you collect the questionnaires at the end, discretely mark an "S" at the top of his or her first page.)

2. Good morning (or good afternoon). Thank you for helping me to learn about students and their ideas. This is not a test. You only have to do it if you want to. Thank you! Let's continue.

3. Now I will pass out the questionnaire to get your ideas and opinions.

4. (Hand out one questionnaire per student.)

5. Please be sure there is a ________ at the top of your questionnaire.

6. (Make a copy of the first scale of the instrument on the chalkboard.)

7. (Read instructions. Copy examples of placement of the "X" on the chalkboard.)

8. (When instructions say, "Do you understand?", give them at least 5 seconds to respond. Give answers to clarify the instructions.)

9. (Emphasize the 3 points at the bottom of page 1. Use the chalkboard to show proper and improper placement of the one "X" that they make.)
10. (Read the paragraph at the top of page 2 to them. Read relatively slowly and enunciate clearly.)

11. Now I will read the items and choices to you.

12. (Read Item 1, clearly, and read the response options. Give them about 5 seconds to respond with an "X". Watch their nonverbal behavior to determine whether they are ready to continue.)

13. (If a student raises a hand and/or asks a question, cheerfully say that you will read the item again; read the response options also. Do not read it a third time.)

14. (For "L" instrument, stop before Item 30. For "N" instrument, stop before Item 24.) Say, "If you do not have brothers or sisters or grandparents and a question is about them, then do not mark an "X" on that question."

15. (Read the next item and the five response options. Give them time to respond. Continue in this manner through the last item with five response options.)

16. (Read aloud the last three items under "information." If they have questions about these items, you may answer them. I want them to report their age as a number.)

17. Now I will collect the questionnaires one at a time.

18. (Collect the questionnaires one at a time. Be sure to mark an "S" at the top of page 1 if a student was identified as "S" by the teacher.)

19. Thank you very much for helping in this study.
Appendix E

Procedure for administration of instruments for final study.
Administration of Instrument

Brian Ray

30 October 1987
"admin2.dis"

NOTE: Items without parentheses and in boldface are to be read aloud (in a conversational manner) to the students. Items in parentheses are instructions to the administrator.

1. (If a student is noted as "S" on the class list, ask the teacher to identify that student to you. When you collect the questionnaires at the end, discretely mark an "S" at the top of his or her first page.)

2. Good morning (or good afternoon). Thank you for helping me to learn about students and their ideas. This is not a test. You only have to do it if you want to. No one will know your personal answers because your name will not be on the questionnaire. Thank you! Let’s continue.

3. Now I will pass out the questionnaire to get your ideas and opinions. There will be no talking by students.

4. (Hand out one questionnaire per student.)

5. Please be sure there is a _____ at the top of your questionnaire. This first page is just instructions. You don’t need to mark anything.

6. (Make a copy of the first scale of the instrument on the chalkboard.)

7. (Read instructions. Copy examples of placement of the "X" on the chalkboard.)

8. (When instructions say, "Do you understand?", give them at least 5 seconds to respond. Give answers to clarify the instructions.)

9. (Emphasize the 3 points at the bottom of page 1. Use the chalkboard to show proper and improper placement of the one "X" that they make.)
10. (Read the paragraph at the top of page 2 to them. Read relatively slowly and enunciate clearly.)

11. Now I will read the items and choices to you. There should be no talking. Please just concentrate on the questions and answer honestly.

12. (Read Item 1, clearly, and read the response options. Give them about 5 seconds to respond with an "X". Watch their nonverbal behavior to determine whether they are ready to continue.)

13. (If a student raises a hand and/or asks a question, cheerfully say that you will read the item again; read the response options also. Do not read it a third time.)

14. (For "L" instrument, stop before Item 30. For "N" instrument, stop before Item 24.) Say, "If a question asks about brothers or sisters or grandparents and you don't have any, then don't mark an "X" for that one.

15. (Read the next item and the five response options. Give them time to respond. Continue in this manner through the last item with five response options.)

16. (Read aloud the last three items under "information." If they have questions about these items, you may answer them. I want them to report their age as a number.)

17. Now I will collect the questionnaires one at a time. Please stay in your seats.

18. (Collect the questionnaires one at a time. Be sure to mark an "S" at the top of page 1 if a student was identified as "S" by the teacher. Check the last page to be sure they accurately indicated their gender.)

19. Thank you very much for helping in this study.