

INFLUENCE OF ATTITUDE TOWARD SCIENCE, GENDER AND  
LOCUS OF CONTROL ON STUDENT ACHIEVEMENT IN SCIENCE

Thesis

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## ABSTRACT

From elementary school to the college level, nationwide trends indicate that males are achieving higher in science than females. The aim of this study was to compare the achievement of boys and girls studying 10th grade biology in the public school system. To achieve this a composite survey of attitude toward science, locus of control and achievement in science was administered to 221 biology students in the 10th grade of a large school district situated in a suburb of Rochester, NY.

It was found that females were achieving equally as well as males in 10th grade and that females had a significantly more positive attitude toward science (biology) than males. However, significantly more males chose to elect to study science in the 11th grade. This first major split between the numbers of males and females studying science may be due to the cultural stereotyping of the individual sciences and warrants further investigation.

A negative relationship was found between attitude toward science and locus of control. A weak but positive relationship was also found between attitude toward science and achievement.

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## CHAPTER 1 - INTRODUCTION

A shortage in the scientific workforce has been predicted to occur at a time when society has become increasingly dependent on science and technology to meet many of its needs. Of even greater concern is the disproportionate representation of women in the field of science. In general, women tend not to pursue scientific careers, but for those who do the majority choose medically-orientated careers, a field that perhaps has a more feminine image than other scientific areas. The lack of women in traditionally male-dominated areas such as engineering and industry is astounding.

Many factors have been attributed to causing the male/female imbalance in science. The factor that appears to be a major contributor is attitude toward science. Common sense tells us that if attitude toward science is positive then it is more likely a student will pursue science than if attitude toward science is negative. Research has shown that both males' and females' attitude toward science becomes increasingly negative as students pass on up through the grades, however females tend to have a consistently more negative attitude toward science than males.

Why are these young people so discontented with science, especially at a time when pressure is being put

on the public school system to produce students who are scientifically literate?

Many factors are held responsible for the development of attitude toward science. Factors such as homelife, ethnicity, and socioeconomic status undoubtedly contribute to the development of attitude. Factors that are within the direct control of either the school or the teacher such as the use of motivational techniques and conducive classroom environments are also extremely important in the development of attitude toward science.

Female attitude toward science has been shown to improve when teachers take part in gender bias elimination programs (Sadker & Sadker, 1985). It should be noted here that the majority of teachers, both male and female, are unaware of gender bias in the classroom and if it exists, it is for the most part unintentional (Sadker & Sadker, 1985). Inviting female scientists as guest speakers to the classroom and using female high school or college science students to talk to elementary students have been shown to improve female attitude toward science (Mason & Kahle, 1989).

Science educators then, face two problems: first, how to develop more positive attitudes toward science for all students and second, how to correct for the skewness in attitude toward science as it relates to gender.

This study will attempt to uncover some of the variables involved in why males achieve more than females in science and why they also have a more positive attitude toward science than females. The research for the study shall be conducted in two high schools of a public school district situated in a suburb of Rochester, N.Y.

## CHAPTER 2 - REVIEW OF LITERATURE

Although women received 50% of all B.S. degrees and 32% of all doctorates in 1981, women still accounted for only 20% of science professionals in 1984. Of this 20%, women were found to be clustered mostly in the social sciences, psychology and the life sciences (Weis, 1987). Also in 1984, women were found to make up only 8% of astronomers, 5% of physicists and 2% of engineering professionals.

The first question to be addressed concerning this dilemma is: Are boys "better" at science than girls? The research says yes, that boys consistently achieve higher in science than girls. In a comprehensive review of some 298 independent sources including articles, standardized test results and national and international studies, a difference between male and female achievement was found, with males achieving significantly higher than females (Steinkamp & Maehr, 1984). Of 135,000 students in British Columbia, Erickson and Erickson (1984) found that boys outperformed girls on the British Columbia Science Assessment test in grades 4, 8 and 12, and that sex-related differences were greatest in grade 12.

Males it would seem then are higher achievers in science than females, but why should this be? The research tells us that achievement is affected by both

internal and external influences and an in-depth analysis of these influences reveals some clues as to the basis of observable sex-related differences in science achievement.

Biological, cognitive and affective factors are classified as internal influences which are unique to the individual, whereas factors such as significant others, classroom environment and home environment are considered to be external influences on science achievement as they are often beyond the immediate control of the individual, especially in the case of school children. Although biological and cognitive factors will not be discussed in this thesis the author recognizes that both may contribute greatly to science achievement. There is much controversy over the role biological differences between the sexes plays in contributing to science achievement however there is more support for the contribution that spatial visualization, a cognitive factor, may make toward sex-related differences in science achievement (see Sherman, 1985). The remainder of this chapter will consider each of the other influences separately, with particular emphasis on the contributions that gender, attitude toward science and locus of control have on science achievement.

## 2.1 INTERNAL INFLUENCES

### 2.1.1 Attitude Toward Science

Our feelings, values and attitudes are extremely important in determining who we are and how we behave. Decisions are often based on what we as individuals value or feel as opposed to what we know. This concept first defined by Krathwohl as the affective domain, comprises five hierarchical levels: receiving, responding, valuing, organizing and characterizing. In order to move from a lower level to a higher level it is first necessary to master the lower levels, however it is possible to be at different levels under different conditions. One of the major goals in education is to help students develop skills in the affective domain (Laforgia, 1988).

How are variables within the affective domain measured? At first it seems difficult, if not impossible to measure how much or how little an individual values or feels about something, whether it be an object, a situation or another person. This is the quandary that researchers have found themselves in, and have often been criticized for, especially in terms of a theoretical basis, conceptual clarity and for not measuring what they set out to measure (Krynowsky, 1988). In recent years there has been a move toward building a theoretical basis for examining the affective domain and there has been much advance in the research because of it.

Attitude toward science, which is one of the main foci of this study, falls under the category of the affective domain. The term "attitude toward science" has many connotations and has lacked definitional clarity. It has been defined as the "opinion or position taken with respect to a psychological object in the field of science" (Moore & Sutman, 1970, p.86). A more theoretically based definition of attitude, proposed by Ajzen and Fishbein (1975) describes attitude as "a learned disposition to respond in a consistently favorable or unfavorable manner to a given object" (p.5). Attitude toward science can therefore be described as a learned disposition to respond in a consistently favorable or unfavorable manner toward science.

Note that there is a difference between the term "attitude toward science" defined above and the often misconstrued term "scientific attitudes" which can be, and has been defined as the attitudes of science and scientists, such as intellectual honesty and curiosity. One of the main reasons that the Scientific Attitude Inventory developed by Moore and Sutman (1970) was greatly criticized was because the term "scientific attitudes" was used to measure "attitude toward science" (Munby, 1983). The instrument of choice for this study the "Attitude Toward the Subject Science Scale" (ATSSS) (Krynowsky, 1988) was developed on the basis of the Ajzen

and Fishbein theory and is consistent with their definition of attitude.

Does attitude toward science influence achievement or does achievement influence attitude? Evidence has been presented for both points of view, however Schebeci and Riley (1986) have gone as far as presenting a causal relationship which suggests that students' perceptions of instruction influences attitude which in turn influences achievement. Their hypothesis was tested using data gathered on 17 year old students from the 1976-1977 survey conducted by the National Assessment of Educational Progress (NAEP). The authors recognized that the NAEP did not originally gather the data to be studied for such a relationship and therefore the method used to gather results lacks some validity in terms of their causal model. It also appears that achievement influences attitude to a certain degree, perhaps acting as either a positive or negative reinforcement on student attitude toward science.

How influential attitude toward science and achievement in science are is only far too evident when student choice of science electives in high school, majors in college and ultimately career choices are examined in terms of gender. In the 1978-79 study by the National Science Foundation (1980) the following breakdown of science courses taken by college bound high

school seniors occurred. Boys studied biological sciences for a mean of 1.39 years, girls for 1.41 years. Boys studied physical sciences for a mean of 1.98 years, girls for 1.56 years: almost half a year difference between the two. However, 23.7% percent of boys had taken physical science for 3 years, compared to only 12.9% of girls. One of the main reasons then that women are poorly represented in the physical science and engineering fields is because many do not take that first step to get onto the physics track (Garfinckel, 1989). It is not surprising to find then that fewer women go on to major in science at college and pursue scientific careers than men.

In a study of 2,046 male and female, juniors and seniors pursuing math and science majors in four year colleges and universities, it was found that the students chose to major in these areas for a variety of reasons. The most frequent responses to why they chose science and math majors were interest in science hobbies during childhood, childhood aspirations of being a scientist, receiving encouragement from "significant others" to pursue math and science majors, and because of the grades they received in high school for math and science (Thomas, 1986). It is evident from these responses that attitude and achievement were influential on the decisions made by these students in terms of major in

college.

In a longitudinal study of a group of select and talented high school students who participated in a Science Honors Program at Columbia University, differences in aptitude for science and math between the sexes were observed (Hansen & Neujar, 1974). Depth of interest in science was held accountable for the observed differences in aptitude. Interest was expressed in terms of science hobbies and the availability of a science lab at home. In a follow-up study of these talented students it was found that both sexes were equally likely to graduate from college and to go on to graduate school. However, males were more likely to major in either physics or math whereas females were more likely to major in biology. Even in later life males were found to be more involved in science hobbies and had published more papers than females. From these observations the authors made the recommendation that all students should be encouraged to develop a positive attitude toward science at an early age (Hansen & Neujar, 1974).

Many women who enter college with the intention to major in science do not do so. In a study of 300 college freshmen comprising 150 females and 150 males who intended to major in science only 50% of the females fulfilled their intention whereas 69% of the males did (Ware et al, 1985). The reason given for the low

'survival' rate of the women was that in general they did not enjoy the science courses as much as the men did. Of even greater significance was that the women set very high standards for achievement in science, and the efforts made in trying to live up to these self-imposed expectations often resulted in exhaustion and discouragement leading to a change of major for many of the female freshmen. Another reason given for the higher drop-out rate of women in science was that of differences in locus of control between the sexes. This phenomena will be discussed at length in the following section.

#### 2.1.2 Locus of Control

The concept of locus of control, which is a measure of belief in personal control, evolved from social learning theory (Rotter, 1966). Social learning theory was developed to understand how people make choices. The theory has three major components. The first is that behavior is learned. The second is that behavior is motivated by reinforcements. The third is that behavior is determined by the degree to which people expect reinforcements for specific behaviors (Rotter, 1966).

When considering how choices are made and therefore the consequential behavior, it is important to consider the expectancy, the reinforcement and the psychological situation (Rotter, 1966). From early childhood we are

exposed to both positive and negative reinforcements through contact with our immediate environment and through interactions with people. For example, if a child were to burn his fingers on a hot stove, the result of his action would act as a negative reinforcement if in the future he were to consider touching a stove. If he were subsequently rebuked by a parent for his action, this would serve to increase the magnitude of the negative reinforcement.

The degree to which we expect a reinforcement is therefore dependent on past experiences. A so-called general expectancy for reinforcements is applicable to a wide variety of somewhat related situations, whereas a specific expectancy is only applicable to a specific or unique situation (Rotter, Chance & Phares, 1972). In general each individual expresses both types of expectancies.

As stated earlier the concept locus of control is a measure of personal control over behavior. The measure is based on a scale from those who feel that they are responsible for any reinforcements received (called 'internals') to those who feel that any reinforcements received are probably due to luck, fate and powerful others (called 'externals') (Rotter, 1966). When individuals feel that they are in control of a situation, they are more likely to demonstrate a behavior to cope

with that situation than those who feel that they are not in control. This aspect of personality can be measured using the Internal-External Scale (I-E Scale) which is a forced-item questionnaire (Rotter, 1966). The scale aims to measure general expectancies for reinforcements to gain insight into overall personal control. It does not measure expectancies for reinforcements in specific situations.

### 2.1.3 Locus of Control and Achievement

There is a strong relationship between locus of control and achievement in school, with internals achieving higher than externals (Bar-Tal & Bar-Zohar, 1977; Phares, 1976). This is attributed to internals' belief of being in control of a situation - they are more likely to directly affect their environment by studying harder or paying more attention in class. Externals, on the other hand, attribute success or failure to luck, fate and powerful others. In the school situation, the powerful others are likely to include the teacher and the principal. Attributing failure in this manner will probably not lead to the persistence needed for achievement (Phares, 1976). Internals accept more responsibility for their behaviors and are more likely to persist to achieve their goals. Internals also accept

responsibility for their failures, and because they feel that they are in control, they are more likely to take the necessary steps to correct for their failure.

The relationship between achievement in science and locus of control has not been studied in great depth. The relationship is of interest however as there does appear to be certain similarities between the two. Both measures distinguish between the sexes, and variations in both measures are seen with age. As noted earlier males achieve higher in science than females and the difference becomes more pronounced with age.

Therefore we would expect that since boys achieve higher in science than girls, that they would be more internal than girls. Although boys in general are not more internal than girls, it has been found that internality, especially for males, correlates positively with higher achievement (Crandall et al 1965; Nowicki & Strickland, 1973). Indeed Crandall et al (1965) found that girls scored slightly higher on the internal scale for both success and failure than did boys in their study of 923 students in grades 3,4,5,6,8,10 and 12 in which they used the Intellectual Achievement Responsibility (IAR) scale to measure locus of control. In adults, internality in males is predictive of achievement (Phares, 1976). This is thought to be the result of cultural pressures and sex-role stereotyping. Males in

our society have a higher need to achieve in certain areas such as science and mathematics because of cultural pressures and stereotyping of sex roles, whereas women are thought to have a higher need to achieve in the more social aspects of our society. This is well illustrated in the study by Ryckmann et al (1972) who found that internal college females were more committed to social issues than both internal males and external males. Also Lefcourt and Steffy (1970) found that internal female nursing students were higher achievers than their external counterparts. Therefore it can be seen that although internality for females has not correlated highly with academic achievement, it does correlate to other positive attributes and measures of success.

When looking specifically at achievement in science, females are found to attribute their success in this field to luck rather than to their own ability, leading to a lack of perseverance in science (Kurth, 1987). This information also relates to cultural pressure and stereotyping of sex roles: if a female perceives that society has no need for her to achieve in science, then when she does succeed she will in all likelihood attribute that success to luck, fate or powerful others. More recently Moody and Gifford (1987) found that there was no significant relationship between locus of control (using Rotter's I-E Scale) and achievement for 103 high

school chemistry students. Surprisingly, external males scored higher in achievement than internal males. These external males may indeed have a high need for achievement but a low expectancy for success. These individuals are often referred to as unusual or defensive externals. Because of the cultural pressures on men to succeed, defensive externality appears to work better for males than females (Phares, 1976). This is demonstrated in the aforementioned study of Ware et al (1972) of 300 college freshmen by the reasons the freshmen gave for changing their major from science to some other field of study. The women in the study blamed their failure in science on themselves and their lack of ability, however this internality for failure did not lead to perseverance. The males on the other hand placed responsibility for their failure on others and the difficult content of the science courses that they had taken. Here defensive externality was working to the advantage of the males as they were ridding themselves of any guilt that they might have had for dropping out of a course on external factors, not on themselves. It would have been interesting to find out how well these males and females did in another course of study.

It can be seen that locus of control is highly related to academic achievement. However, variations in locus of control are also observed when scores are

examined in terms of race and socioeconomic background with minorities tending to be more external than whites, and those with a low level income being more external than those with higher level incomes (Rotter, Chance & Phares, 1972; Platt et al, 1970).

In summary, one of the aims of this study was to determine if differences in the measure locus of control would account for some of the gender differences observed in terms of science achievement and attitude toward science.

## 2.2 EXTERNAL INFLUENCES

### 2.2.1 The Home Environment & Significant Others

Each of us is influenced by those people with whom we have or have had a great deal of contact. Children in particular are influenced to varying degrees by their immediate family, peers and others who may be significant in their lives, teachers for example.

Parents undoubtedly exert an influence over the development of their children's attitudes. Parental support, expectations and involvement with the child and school have all been identified as critical factors in influencing a child's desire to learn (Ware & Garber, 1972). The availability of learning materials such as

books, learning games and activities, and the level of parental education have also been identified as being very important for success in school (Schebeci & Riley, 1986).

As to be expected the home environment and parental attitudes correlate highly with preschool children's achievement. In a study of 67 parents with 4 year old children, who were reported to have poverty level incomes, the following variables were found to account for 22% of the variance in student achievement: materials for learning in the home, parental awareness of child's development, expectations for child's schooling and an emphasis on reading. Again the highest correlation between a variable and student achievement was the availability of materials in the home for learning (Ware & Garber, 1972). When specifically looking at science, family attitudes toward science such as family likes watching science programs on T.V., parents like science and like to help with science homework were found to be predictive of student attitude toward science (Talton & Simpson, 1986).

Do parents have any influence on the gender differences that are observed in school science in terms of attitude and achievement? Thomas (1986) has shown that parents involve their sons more than their daughters in science-related activities and hobbies at an early age,

giving boys a distinct advantage in science over girls at the elementary level. At the secondary level boys have a more positive attitude toward science than do girls. This is thought to be the result of boys having more experience with science, and in particular with physics, outside the classroom than girls. Experience with science outside of school helps to nurture a positive attitude toward science.

To help avoid some of the sex-related differences in terms of science that become most evident when the child enters high school, parents should be encouraged and supported by educators to involve their children in science at an early age.

### Peers

The peer group is extremely influential on the individual's development of attitudes, values and goals. Many students elect to attend a certain school or take a course for the sole reason that all of their friends are taking it. Adolescents are constantly striving to find their place and to fit in with their peer group.

Talton and Simpson (1985, 1987) found a strong positive relationship between peer attitude toward science and individual attitude toward science. As peer attitude toward science increases the individual's attitude toward the subject also increases; however the

relationship also holds for negative attitudes. They also found that the relationship between the two variables grew stronger towards the end of the year and peaked at the beginning of grade 9. The authors implied that attitude toward science may be contagious. This finding may have many implications for cooperative learning.

### 2.2.2 The Classroom Environment

The classroom environment must be conducive to student needs before any learning can take place. Background noise, the amount of light in the classroom, seating arrangements and the presence or absence of stimulating materials have all been identified as being pertinent to meeting student needs (Talton & Simpson, 1987). Some students prefer background noise while doing seatwork, others do not. Some students prefer dimmed lighting, others bright (Bowers & Burkett, 1987). The teacher must consider these and other variables in establishing the classroom environment. For example, the presence of living things in the biology classroom has been shown to improve achievement and attitude toward science even though no link was made between the materials and the subject being taught (Saunders & Young, 1985).

Once these physical variables have been established other classroom factors come into play in determining

student achievement. These include, but are not limited to, teacher-student interactions, student participation in science activities and academic discipline. Teacher-student interactions are considered to be extremely important in determining student achievement and may account for some of the gender-related differences that are seen in the science classroom (Haladyna et al, 1982).

Teachers are constantly making on the spot decisions about with which students to interact, to question and to respond. Many of these decisions are made as a result of the class atmosphere. It is difficult, for example, not to respond to the student who constantly raises his/her hand in response to a teacher question and who asks questions of his/her own. However it is easy to ignore the student who sits quietly in class and is reluctant to interact.

Research has shown that differences in teacher-student interactions are gender-related. In a 4 year study of classroom interactions, Sadker and Sadker (1985) found that males were involved in more interactions, were given precise feedback and received more attention when compared to females. Of interest was the observation that boys were eight times more likely to call out in class than girls - these students are often labelled as target students. Target students are defined as those students who dominate class-time by asking or answering questions.

The majority of these students are found to be male (Tobin & Garnett, 1987). Surprisingly both male and female teachers are found to elaborate on male responses to a greater extent than female responses, and males are more often encouraged to move on up to a higher cognitive level (Sadker & Sadker, 1985).

When the behavior of males and females was compared during lab activities, which are an essential part of any science course, males were found to dominate in mixed-sex groupings and to manipulate lab equipment to a greater extent than females (Tobin & Garnett, 1987). Even during off-task behavior in lab time males tended to handle lab equipment through misuse, whereas female off-task behavior was spent socializing with other members of the class. Females however did outperform males in task-oriented independent work such as reading from the text and taking notes. So that girls do not become disadvantaged in the science classroom, this data supports the recommendation that they develop an early interest in science hobbies and that they participate in hands-on science activities.

There is also a definite relationship between scientific academic discipline and the attitudes and achievement of males and females in science (Steinkamp & Maehr, 1984; Zimmerer & Bennett, 1987). Sex-related differences become most evident as students progress in

high school from the life sciences to the physical sciences. Again it has been hypothesized that males have more out of class experience with physics than females and therefore have a more positive attitude toward it, whereas both sexes have had little experience with biology outside of class and therefore the differences between the sexes in terms of attitude and achievement are not as great (Garfinckel, 1989).

In the formation of attitude toward a subject, the image of the academic discipline may be significant. Physical science and those fields that are associated with it such as engineering and astronomy are stereotypically masculine, whereas the biological sciences which are often associated with the medical fields are regarded as more feminine. During adolescence, a time that is often consumed with self-image, girls understandably do not wish to portray themselves as masculine, hence the reluctance to achieve in science or even participate in a science that is stereotyped as masculine. There is, therefore, a need to move away from this stereotyping of the scientific disciplines if we are to encourage more young people, both male and female to enter into science.

### 2.3 SUMMARY

Undoubtedly the primary goal of science educators is to improve student achievement in science. In a world full of self-motivated, enthusiastic learners this would be an easy task to accomplish. Unfortunately we do not live in such a world. At a time when society is dependent on science and its related technologies to meet many of its needs research is telling us that students, in increasing numbers, are becoming less motivated to learn science. Not only are they becoming less motivated to learn science but there is a significant difference in achievement between boys and girls. Boys are achieving higher in science than girls. A causal relationship has been presented which suggests that attitude toward science influences achievement. Males have a more positive attitude toward science than females and this may explain why they achieve higher. Attitudes are formed as the result of societal and cultural pressures. The difference between male and female attitude toward science may be because science is stereotyped as masculine in western society.

The factor, locus of control, may also account for the differences in attitude toward and achievement in science between the sexes. This measure of belief in personal control gives some indication as to the control a person believes they have in a situation. Those who

have internal control of their behavior believe that they can effect situations or consequences by behaving accordingly. Those who have external control believe that they have little control over events or situations and that these situations are under the control of fate, luck or powerful others. Internals tend to be higher achievers than externals because they believe they can influence their success by exhibiting appropriate behavior such as studying harder or paying attention in class. Externals believe that they are unable to influence their achievement and therefore they do not exhibit the necessary behavior to improve their achievement.

In summary, the factors gender, attitude toward science and locus of control are believed to be related to achievement in science. It is anticipated that males will achieve higher than females, that males will have a more positive attitude toward science than females and that internality will be a significant predictor of achievement, especially for males.

## CHAPTER 3 - DESIGN OF THE STUDY

### 3.1 Purpose

A careful review of the literature indicates that girls do not achieve as high in science as boys. It is also evident that the variables attitude toward science, gender and locus of control are significantly related to achievement in high school science, however the investigator was unable to find any study that had these three variables and their relationship with achievement in science as the main focus. Therefore, it was decided that the aim of this study would be to determine if there was a relationship between the three independent variables, attitude toward science, gender and locus of control, and the dependent variable achievement in science.

### 3.2 Research Questions to be Addressed

1. Are achievement, attitude toward science and locus of control different between males and females?
2. Is student attitude toward science reflective of achievement in science, ie. do students who are high achievers in science have positive attitudes toward science and its converse: do low achievers have a negative attitude toward science?
3. Are internals on the locus of control scale higher achievers than externals?

4. Are achievement, attitude toward science and locus of control different between Regents and non-Regents biology students?

### 3.3 Null Hypotheses

1. There will be no significant difference between males and females in terms of mean achievement, attitude toward science and locus of control.
2. There will be no significant difference between Regents and non-Regents biology students in terms of achievement, attitude toward science and locus of control.
3. There will be no significant relationship between each of the independent variables; attitude toward science, gender and locus of control to the dependent variable, achievement in science.
4. None of the independent variables will be significantly predictive of achievement in science.

### 3.4 Sample

The sample consisted of 221 10th grade biology students from two public high schools located in a large suburb of Rochester, N.Y. The sample was not random as participation by both science teachers and students was voluntary. 111 males and 110 females completed the surveys. Of the 221 biology students 152 were taking a

Regents biology course and 69 were taking a non-Regents biology course. For a breakdown of the respective numbers of males and females in Regents and non-Regents biology see Table 1.

Table 1: Numbers of male, female, Regents and non-Regents students who completed the survey.

	Regents	non-Regents	Total
Male	80	31	111
Female	72	38	110
Total	152	69	221

### 3.5 Administration Procedure.

The survey and the administration procedures were designed to be as anonymous as possible in an attempt to elicit honest and truthful responses from the students. A small pilot study was also conducted in another school district to ensure that the directions for the survey were readable and understandable. Five tenth grade students participated in the pilot study and some small changes were made in the directions after receiving their feedback.

The survey was administered to students during normal class-time by individual science teachers. The surveys were administered to all students over a two-week period since it was not possible for the participating teachers to administer the survey at the same time or even on the same day due to class scheduling and other commitments.

The teacher was supplied with a set of instructions that were to be read aloud before the students began (Appendix A). After the instructions were read, students were given as much time as they needed to complete the survey, about 15-20 minutes.

### 3.6 INSTRUMENTS

The survey (Appendix B) was a composition of two well acknowledged scales: the Rotter I-E scale (part 2) and the Attitude Toward the Subject Science Scale (part 3). A small section (part 1) was also included to collect some background information on each student. Data was gathered on gender, achievement in science, school of attendance, Regents or non-Regents biology course and the intention to choose science (chemistry) as an elective the following year. There follows a brief description of each of the instruments with some reasons as to why they were chosen for this study.

#### Achievement

Students were asked to indicate the teacher assigned grades they received for the last three marking periods. Although there is undoubtedly variation in how teachers assign grades, it was the only feasible method available for measuring achievement in this study. Other investigators have used this method for measuring achievement (Moody & Gifford, 1987), and indeed it is the favored method when investigating the relationship between locus of control and achievement (Phares, 1976).

### Attitude toward science

This variable was measured using the "Attitude Toward the Subject Science Scale" (ATSSS) which was developed by B.Krynowsky (1989). The scale was designed to assess 10th grade student attitude toward behaviors related to the learning of science. It comprises 15 questions, each with 3 semantic differential scales. The test-retest reliability of the instrument is 0.82 (correlation coefficient). The correlation coefficient was equal to 0.71 when the ATSSS was compared to the School Science Scale which was used in the British Columbia Science Assessment (Erickson & Erickson, 1984). For direction on how to score this instrument see Appendix C.

### Locus of control

The well known Rotter Internal-External Scale (Rotter,1966) was used to measure this variable. The scale consists of 29 forced-item questions, with 6 filler questions. A total score of 23 is possible. The score consists of the number of external statements which the subject agrees with. See Appendix D for a more detailed account of scoring.

Rotter (1966) states that the scale is suitable for noncollege adults and upper level high school students as well as other adult populations. However most studies

have concentrated on studying college students, perhaps because of their ready accessibility. In studies of school children, mostly in the elementary grades, a children's scale called the Intellectual Responsibility Questionnaire is used most often, (Crandall, Katkovsky & Crandall, 1965). For this study it was felt that the Rotter I-E scale would be most suitable for the population under study given the criteria for its use as stated above.

#### Summary

A survey of attitude toward science, locus of control and achievement in science was administered to 221 biology students in the tenth grade. The purpose of administering the survey was to determine if there was a relationship between gender, attitude toward science, locus of control and achievement in science. The variable of biology course, Regents or non-Regents was also taken into consideration.

## CHAPTER 4 - RESULTS AND DATA ANALYSIS

Two hundred and twenty-one tenth grade biology students participated in the study and completed the survey. A score for achievement, attitude toward science and locus of control was obtained for each student. The scores were analyzed by gender and by course of study (Regents or non-Regents). The statistical significance of the information was calculated with the aid of the DYNASTAT software program. The results and their significance will be described in the remainder of this chapter.

### 4.1 Mean Scores for Achievement, Attitude Toward Science and Locus of Control

#### Achievement

Students reported teacher assigned letter grades for the first three quarters of the school year. Since Regents courses tend to be more difficult than non-Regents courses a weighting system, as adopted by the school district under study, was used to distinguish between the academic achievement of Regents and non-Regents students. The letter grades were interpreted as A = 10, B = 8, C = 6, D = 5, E or lower = 0 for Regents students and A = 8, B = 6, C = 4, D = 3, E or lower = 0

for non-Regents students. This conversion allowed a mean achievement score for each student to be calculated. The overall mean score for Regents students was equal to 6.5 with a standard deviation (s.d.) of 2.2. The overall mean score for non-Regents students was equal to 5.0 with a standard deviation (s.d.) of 1.5.

#### Attitude Toward Science

The range of possible scores on the attitude toward science survey (part 3) was from a low of 45 to a high of 315. The mean student score was equal to 198.1 with a s.d. equal to 48.2. According to the information for scoring the survey (Appendix C) the overall mean score of 198.1 is interpreted as an undecided or mixed reaction toward science.

#### Locus of Control

Results were scored on the external scale of the locus of control measure (part 2). Possible scores were from 0 (low external) to 23 (high external). The overall mean student score was equal to 11.1 with a s.d. of 3.8

#### 4.2 Analysis of Results by Gender

Table 2 - Mean scores and s.d. for achievement, attitude toward science and locus of control for male and female students.

<u>Gender</u>	<u>Sample</u>	<u>Achievement</u>		<u>Attitude</u>		<u>Loc. of Control</u>	
		<u>Mean</u>	<u>s.d.</u>	<u>Mean</u>	<u>s.d.</u>	<u>Mean</u>	<u>s.d.</u>
<u>Male</u>	<u>111</u>	<u>6.0</u>	<u>2.3</u>	<u>191.8</u>	<u>47.2</u>	<u>11.0</u>	<u>3.5</u>
<u>Female</u>	<u>110</u>	<u>6.1</u>	<u>2.0</u>	<u>204.5</u>	<u>48.6</u>	<u>11.2</u>	<u>4.1</u>

Independent t-tests were used to determine if there was a statistically significant difference between male and female students in terms of achievement, attitude toward science and locus of control. The results of the independent t-tests are shown in Appendix E.

Female students were found to have a more positive attitude toward science than males at the 93% confidence level ( $t = -1.85$ ). None of the other variables differed significantly between male and female students.

Table 3 - Number of male and female students electing to study science in the 11th grade.

<u>Gender</u>	<u>Electing to study science</u>		<u>Total</u>
	<u>Yes</u>	<u>No</u>	
<u>Male</u>	86	25	111
<u>Female</u>	70	40	110
<u>Total</u>	156	65	221

A null hypothesis was formulated from the results in Table 2. It states that there will be no statistically significant difference between the number of males and the number of females electing to study science in the 11th grade.

A test of proportionality (see Appendix F) to examine this hypothesis determined that significantly more males than females elected to study science in the 11th grade than females.

4.3 Analysis of Results by Biology Course (Regents and Non-Regents).

Table 4 - Mean scores and s.d. for achievement, attitude toward science and locus of control for Regents and non-Regents students.

<u>Course</u>	<u>Sample</u>	<u>Achievement</u>		<u>Attitude</u>		<u>Locus of Control</u>	
		<u>Mean</u>	<u>s.d</u>	<u>Mean</u>	<u>s.d.</u>	<u>Mean</u>	<u>s.d.</u>
<u>Regents</u>	<u>152</u>	<u>6.5</u>	<u>2.2</u>	<u>195.6</u>	<u>47.2</u>	<u>11.1</u>	<u>3.8</u>
<u>Non-Reg</u>	<u>69</u>	<u>5.0</u>	<u>1.5</u>	<u>203.9</u>	<u>50.9</u>	<u>11.0</u>	<u>3.9</u>

Regents students were found to achieve significantly higher than non-Regents students. However when the two groups were compared in terms of attitude and locus of control no significant differences were found. This result was established by the use of the independent t-test to determine statistical significance. The results of the independent t-tests are shown in Appendix G.

Table 5 - Numbers of Regents and Non-Regents biology students electing to study science in the 11th grade.

<u>Course</u>	<u>Electing to study science</u>		<u>Total</u>
	<u>Yes</u>	<u>No</u>	
<u>Regents</u>	<u>111</u>	<u>41</u>	<u>152</u>
<u>Non-Reg</u>	<u>45</u>	<u>24</u>	<u>69</u>
<u>Total</u>	<u>156</u>	<u>65</u>	<u>221</u>

A null hypothesis was formulated from the results presented in Table 4. The null hypothesis states that there will be no statistically significant difference between the number of Regents and the number of non-Regents students electing to study science in the 11th grade. A test of proportionality (see Appendix H) determined that the null hypothesis be retained since there was no significant difference between the number of Regents and the number of non-Regents students electing to study science.

#### Correlation Analysis

A simple correlation between all the variables (see Appendix I for correlation matrix) demonstrated that there was no strong relationship between any two

variables. However, a positive relationship ( $r = 0.21$ ) was found between attitude toward science and mean achievement. A negative relationship ( $r = -0.27$ ) between attitude toward science and locus of control was also found.

### Summary of Results

The results of the study conclude that female biology students had a statistically significantly more positive attitude toward science than males, however significantly more males elected to study science in the 11th grade than females. The difference between the numbers of males and females electing to study science is of educational importance. The 11th grade would seem to be where the first major split between the numbers of males and females entering into science occurs. The next question to be asked is why does this happen, especially in light of this study which shows females achieving as well as males at the 10th grade level.

No statistically significant differences were found between Regents and non-Regents students in terms of attitude toward science and locus of control. However, Regents students achieved significantly higher than non-Regents students, as to be expected for groups who are tracked on the basis of their academic abilities.

No strong correlation was identified between any

the independent variables, attitude toward science, gender and locus of control and the dependent variable achievement. A positive correlation between attitude toward science and achievement was observed and a negative correlation was observed between attitude toward science and locus of control. Educators should be aware of the importance of these correlations even although both were weak, since it shows that affective factors such as attitude toward science and locus of control do play at least some minor role in the educational process.

## CHAPTER 5 - CONCLUSIONS & IMPLICATIONS

The aim of this study was to determine why males, in general, achieve higher in science than females. Two hundred and twenty one biology students, all in their last year of compulsory science, completed a survey on their attitude toward science, their achievement and their beliefs in personal control. The relationship between the three independent variables, gender, attitude toward science and locus of control to the dependent variable, achievement in science was the main focus of the study.

The results of the study indicated that males did not achieve higher in science than females. Indeed the female mean for achievement was slightly higher than the male mean for achievement however the difference was not significant. This result was unexpected but promising since females were achieving as well as males at the 10th grade level.

The mean student attitude toward science was that of a mixed or undecided reaction. In a study of students in grades six through ten, Simpson and Oliver (1985) found that attitude toward science was most positive at the beginning of the year and became less positive as the year continued until it hit a low at the end of the school year. The timing of administration of a survey is

therefore crucial and a different result may have been obtained if the survey had been administered at the beginning of the year, for example. Since this survey was administered at the end of the year, attitude toward science may be more negative than expected and it would have been advantageous to have administered the survey at other times during the school year.

Females were found to have a significantly more positive attitude toward science than males, however significantly more males than females chose to elect to study science (chemistry) in the 11th grade. This result may be reflective of the cultural stereotyping of the individual sciences in western society. Girls may have a more positive attitude toward biology than males because of biology's feminine image. On the other hand boys, more so than girls, may be attracted to study chemistry and perhaps physics because of the masculine stereotyping of the physical sciences (Steinkamp & Maehr, 1984).

The mean student external score on the locus of control scale was equal to 11.1 and no significant differences were found between male and female students. This score compares to a mean score of 7.96 for seventy-three 12th grade college applicants and 9.56 for fifty-seven 18 year old subjects from the Boston area (Rotter, 1966). Differences in age and in the selection of the

groups may account for the higher external score of the group under study.

A weak but positive relationship between attitude toward science and achievement was found, which is in agreement with the findings of Hansen and Neujar (1974) and Ware et al (1985). This relationship gives support for the model that teachers and parents should help students develop a positive attitude toward science if achievement in science is to improve. Attitude toward science also yielded a negative correlation with the variable locus of control, which was scored on the external scale. Therefore as attitude toward science became more positive, externality decreased and internality increased. It follows that attitude toward science correlates positively with internality on the locus of control scale. This finding is in agreement with the results of Bar-Tal & Bar-Zohar (1977) and with Phares (1976). The internals belief system enables them to alter their behavior to improve their achievement. Externals, on the other hand, believe that they are not in control of their achievement and are therefore unable to alter their behavior to improve it.

Although no relationship between locus of control and achievement was identified, it would seem that internality leads to an improved attitude toward science which in turn leads to higher achievement. In conclusion,

internality and a positive attitude toward science are qualities to be encouraged for student achievement in science to improve.

### 5.1 Educational Implications

The results of this study imply that stereotyping of the individual sciences plays a major role in the attitudes toward science of young people as evidenced by the more positive attitude toward biology by females and by more males electing to study chemistry than females in the 11th grade. A move away from such stereotyping is required not only by schools but by society if students are to be encouraged to enter the field of science.

It would be interesting to continue to survey this group of students as they complete their high school education, to determine if gender differences become more or less marked with the study of the physical sciences. To gain a wider cross-section and fairer representation of the student population future research should include not only suburban schools, as in this study, but both rural and urban schools also.

In conclusion, the results of the study indicate that gender differences are limited however there is a definite relationship between attitude toward science, locus of control and achievement. It follows that science

educators should focus not only on the academics of science but also on the affective domain to encourage students to develop good self-esteem and a positive attitude toward science.

## References

Ajzen & Fishbein, (1975). *Belief, attitude, intention & behavior: An introduction to theory & research*. Addison-Wesley Publishing Company.

Bar-Tal,D., & Bar-Zohar,Y. (1977). The relationship between perception of locus of control and academic achievement. Contemporary Educational Psychology, 2, 181-199.

Bowers,J.H., & Burkett,C.W. (1987). Relationship of student achievement and characteristics in two selected school facility environmental settings. Paper presented at the 64th Council of Educational Facility Planners, International Conference in Edmonton, Alberta, Canada. ERIC Report # ED 286278.

Crandall,V.C., Katkovsky & Crandall,V.J. (1965). Children's beliefs in their own control of reinforcements in intellectual - academeic achievement situations. Child Development, 36, 91-96.

Erickson,G.L. & Erickson,L.J. (1984). Females and science achievement: Evidence, explanations and implications. Science Education, 68(2), 63-89.

Garfinckel, S.L. (1989). Gender gap on the science track. The Christian Science Monitor, May 9, p.12.

Haladyna, T., Olsen, R. & Shaughnessy, J. (1982). Relations of student, teacher & learning environment variables to attitudes toward science. Science Education, 66(5), 671-687.

Hansen, R., & Neujar, J. (1974). Career development of males and females gifted in science. The Journal of Educational Research, 68(1), 43-45.

Krynowsky, B.A. (1988). Problems in assessing student attitude in science education: A partial solution. Science Education, 72(4), 575-584.

Kurth, K. (1987). Factors which influence a female's decision to remain in science. ERIC Report # ED 268739.

Laforgia, J. (1988). The affective domain related to science education and its evaluation. Science Education, 72(4), 407-421.

Lefcourt, H.M., & Steffy, R.A. (1970). Level of aspiration, risk-taking behavior, and projective test performance; a search for coherence. Journal of Consulting and Clinical Psychology, 34, 193-198.

Mason, C.L., & Kahle, J.B. (1989). Student attitudes toward science and science-related careers: A program designed to promote a stimulating gender - free learning environment. Journal of Research in Science Teaching, 26(1), 25-39.

Moody, J.D., & Gifford, V. (1987). The effect of locus of control on achievement in chemistry. Paper presented at the Annual Meeting of the Mid-South Educational Research Association (Mobile, AL, November, 1987). ERIC Report # ED290634.

Moore, R.W., & Sutman, F.X. (1970). The development, field-test and validation of an inventory of scientific attitudes. Journal of Research in Science Teaching, 7(1), 85-94.

Munby, H. (1983). Thirty studies involving the "Scientific Attitude Inventory": What confidence can we have in the instrument. Journal of Research in Science

Teaching, 20(2), 1141-1162.

National Science Foundation (1980). Science Education Databook. NSF, Washington, D.C. Directorate for Science Education. ERIC Report # ED186286.

Nowicki, Jr. S., & Strickland, B.R. (1973). A locus of control scale for children. Journal of Consulting & Clinical Psychology, 40, 148-154.

Phares, E.J. (1976). Locus of Control in Personality. Published by General Learning Press, Morristown, N.J.

Platt, J.J., Pomeranz, D., Eisenman, R., & DeLisser, O. (1970). Importance of considering sex differences in relationships between locus of control and other personality variables. Proceedings, 78th Annual Convention of the American Psychological Association, 5, 463-464.

Rotter, J.B. (1966). Generalized expectancies for internal versus external control of reinforcement. Psychological Monographs, 66(1), 609-625.

Rotter, J.B., Chance, J.E., Phares, E.J. (1972). Applications of a Social Learning Theory of Personality.

Published by Holt, Rinehart & Winston, New York.

Ryckman, R.M., Gold, J.A., Rodda, W.C., & Sherman, M.F. (1972). Locus of control and attitudes toward women's liberation in a college population. Journal of Social Psychology, 87, 157-158.

Sadker, D. & Sadker, M. (1985). Is the O.K. classroom O.K.? Phi Delta Kappan 66(5), 358-361.

Saunders, W.L. & Young, G.D. (1985). An experimental study of the effect of the presence or absence of living visual aids in high school biology classrooms upon attitudes toward science and biology achievement. Journal of Research in Science Teaching, 22(7), 619-629.

Schebeci, R.A., & Riley, J.P. (1986). Influence of students' background and perceptions on science attitudes and achievement. Journal of Research in Science Teaching, 23(3), 177-187.

Sherman, J. (1985). Mathematics, spatial visualization and related factors: Changes in girls and boys, grades 8-11. Journal of Educational Psychology, 72(4), 476-482.

Simpson, R.D., & Oliver, S. (1985). Attitude toward science and achievement profiles of male and female science students in grades six through ten. Science Education, 69(4), 511-526.

Steinkamp, M.W., & Maehr, M.L. (1984). Gender differences in motivational orientations toward achievement in school science: A quantitative synthesis. American Educational Research Journal, 21(1), 39-59.

Talton, E.L., & Simpson, R.D. (1985). Relationships between peers and individuals attitude toward science among adolescent students. Science Education, 69, 19-24.

Talton, E.L., & Simpson, R.D. (1986). Relationships of attitudes toward self, family, and school with attitude toward science among adolescents. Science Education, 70(4), 365-374.

Talton, E.L., & Simpson, R.D. (1987). Relationship of attitude toward classroom environment with attitude toward and achievement in science among tenth grade biology students. Journal of Research in Science Teaching, 24(6), 507-525.

Thomas, G.E. (1986). Cultivating the interest of women and minorities in high school math and science. Science Education, 70(1), 31-43.

Tobin, K. & Garnett, P. (1987). Gender related differences in science activities. Science Education, 71(1), 91-103.

Ware, N.C., Steckler, N.A., & Leserman, J. (1985). Undergraduate women, who chooses a science major? Journal of Higher Education, 56, 73-84.

Ware, W.B., & Garber, M. (1972). The home environment as a predictor of school achievement. Theory Into Practice, 11(3), 190-195.

Weis, L. (1987). Academic women in science 1977-1984. Academe, 73(1), 43-47.

Zimmerer, L.K., & Bennett, S.M. (1987). Gender differences on the California statewide assessment of attitudes and achievement in science. 1987 Annual Meeting of the American Educational Research Association, Washington, D.C.

APPENDICES

APPENDIX A - ADMINISTRATION INSTRUCTIONS

APPENDIX B - ATTITUDE TOWARD SCIENCE & PERSONAL BELIEFS  
SURVEY

APPENDIX C - INSTRUCTIONS FOR SCORING ATTITUDE TOWARD  
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OF MALES AND FEMALES ELECTING TO STUDY  
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APPENDIX H - TEST OF PROPORTIONALITY BETWEEN THE NUMBER  
OF REGENTS AND NON-REGENTS STUDENTS  
ELECTING TO STUDY SCIENCE

APPENDIX I - CORRELATION MATRIX

## APPENDIX A

### ADMINISTRATION INSTRUCTIONS

Each student should be supplied with one survey (face-down) and one answer grid.

Please read these directions aloud to the students who are participating in the survey, before they begin.

1. The purpose of this survey is to find out how you feel about yourself and about science.
2. This is not a test.
3. The survey is completely anonymous so do not write your name on either the survey or the answer grid.
4. There are 3 parts to the survey. Answers to Part 1 & 2 are to be marked on the answer grid, answers to Part 3 are to be marked directly on to the survey.
5. Turn over the survey and read the directions.
6. After reading the directions you may begin.

## APPENDIX B

### ATTITUDE TOWARD SCIENCE AND PERSONAL BELIEFS SURVEY

This survey is being conducted to find out how you feel about yourself and about science, so there are no right or wrong answers to the questions being asked. This is not a test. The survey is completely anonymous so please answer as honestly and truthfully as you can.

#### INSTRUCTIONS

There are three parts to the survey. Answers to Parts 1 and 2 should be marked on the 'computer-scored' answer grid. Starting at the top left hand side and at number 1 choose your answer and completely fill in the blank of your choice. If you make a mistake, erase it and fill in the blank of your new choice.

#### EXAMPLE

Here is an example of a question in the survey which has been responded to.

1. Are you?

- A. female
- B. male

If you were female you would completely fill in the Ⓐ space on the answer grid at question number 1.

If you were male you would completely fill in the Ⓑ space on the answer grid at question number 1.

Instructions for Part 3 are given inside, however answers are **not** to be marked on the answer grid.

If you have any questions about these directions please ask your teacher **now**.

\* Part 2- "Internal-External Rotter Scale" Rotter, J.B. (1966) Psychological Monographs 80 (whole issue)

Part 3- "Attitude Toward the Subject Science Scale" Permission for use given by B. Krynowsky, University of British Columbia, 1924 West Mall, Vancouver, B.C. Canada V6T 1W5

## PART 1

Read each question carefully. Questions 1-7 asks for some basic information about yourself. Choose your answer and then fill in the blank on the computer- scored answer grid. If you make a mistake, erase it and fill in the blank of your new choice.

1. Are you?

- A. female
- B. male

2. Which science course are you **currently** taking?

- A. non-Regent's biology
- B. Regent's biology

3. What high school do you attend now?

- A. Olympia
- B. Arcadia
- C. Athena

4. What grade did you receive for biology in the first quarter of this school year?

- If you received an A fill in the A space on the answer grid
- If you received a B fill in the B space on the answer grid
- If you received a C fill in the C space on the answer grid
- If you received a D fill in the D space on the answer grid
- If you received an E or lower fill in the E space on the answer grid

5. Using the choices in Q.4 indicate the grade you received for the second quarter.

6. Using the choices in Q.4 indicate the grade you received for the third quarter.

7. Do you intend to choose science as an elective next year?

- A. yes
- B. no

For the remainder of the questions in Part 1 choose the statement which **MOST** reflects your own feelings or opinions. Then fill in the blank associated with that choice on the computer-scored answer grid.

8. A. Children get into trouble because their parents punish them too much.  
B. The trouble with most children nowadays is that their parents are too easy with them.
9. A. Many of the unhappy things in people's lives are partly due to bad luck.  
B. People's misfortunes result from the mistakes they make.
10. A. One of the major reasons we have wars is because people don't take enough interest in politics.  
B. There will always be wars, no matter how hard people try to prevent them.
11. A. In the long run people get the respect they, deserve in this world.  
B. Unfortunately, an individual's worth often passes unrecognized no matter how hard he tries.
12. A. The idea that teachers are unfair to students is nonsense.  
B. Most students don't realize the extent to which their grades are influenced by accidental happenings.
13. A. Without the right breaks one cannot be an effective leader.  
B. Capable people who fail to become leaders have not taken advantage of their opportunities.
14. A. No matter how hard you try some people just don't like you.  
B. People who can't get others to like them don't understand how to get along with others.
15. A. Heredity plays an important role in determining one's personality.  
B. It is one's experiences in life which determine what they're like.
16. A. I have often found that what is going to happen will happen.  
B. Trusting to fate has never turned out as well for me as making a decision to take a definite course of action.
17. A. In the case of the well prepared student there is rarely, if ever, such a thing as an unfair test.  
B. Many times exam questions tend to be so unrelated to course work that studying is really useless.

18. A. Becoming a success is a matter of hard work; luck has little or nothing to do with it.  
B. Getting a good job depends mainly on being in the right place at the right time.
19. A. The average citizen can have an influence in government decisions.  
B. This world is run by the few people in power, and there is not much the little guy can do about it.
20. A. When I make plans, I am almost certain that I can make them work.  
B. It is not always wise to plan too far ahead because many things turn out to be a matter of good or bad fortune anyway.
21. A. There are certain people who are just no good.  
B. There is some good in everybody.
22. A. In my case, getting what I want has little or nothing to do with luck.  
B. Many times we might just as well decide what to do by flipping a coin.
23. A. Who gets to be boss often depends on who was lucky enough to be in the right place first.  
B. Getting people to do the right thing depends upon ability; luck has little to do with it.
24. A. As far as world affairs are concerned, most of us are the victims of forces we can neither understand nor control.  
B. By taking an active part in political and social affairs the people can control world events.
25. A. Most people don't realize the extent to which their lives are controlled by accidental happenings.  
B. There is really no such thing as "luck".
26. A. One should always be willing to admit mistakes.  
B. It is usually best to cover up one's mistakes.
27. A. It is hard to know whether or not a person really likes you.  
B. How many friends you have depends upon how nice a person you are.
28. A. In the long run the bad things that happen to us are balanced by the good ones.  
B. Most misfortunes are the result of lack of ability, ignorance, laziness, or all three.

29. A. With enough effort we can wipe out political corruption.  
B. It is difficult for people to have much control over the things politicians do in office.
30. A. Sometimes I can't understand how teachers arrive at the grades they give.  
B. There is a direct connection between how hard I study and the grades I get.
31. A. A good leader expects people to decide for themselves what they should do.  
B. A good leader makes it clear to everybody what their jobs are.
32. A. Many times I feel that I have little influence over the things that happen to me.  
B. It is impossible for me to believe that chance or luck plays an important role in my life.
33. A. People are lonely because they don't try to be friendly.  
B. There's not much use in trying hard to please people; if they like you they like you.
34. A. There is too much emphasis on athletics in high school.  
B. Team sports are an excellent way to build character.
35. A. What happens to me is my own doing.  
B. Sometimes I feel that I don't have enough control over the direction my life is taking.
36. A. Most of the time I can't understand why politicians behave the way they do.  
B. In the long run the people are responsible for bad government on a national as well as local level.
37. A. Most parents don't reward their children enough for good behavior.  
B. Children should behave properly regardless of how their parents treat them.

END OF PART 2 - Please put answer grid to one side. All further answers are to be marked directly on to the survey. Now read the directions for part 3 carefully.

### **PART3**

#### **PURPOSE**

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

#### **INSTRUCTIONS AND EXAMPLE**

##### **Instructions**

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

##### **Example**

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

MY READING A SCIENCE RELATED MAGAZINE IS

BORING INTERESTING  
extremely | quite | slightly | undecided | slightly | **quite** | extremely

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

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

##### **REMEMBER**

- \* There are 3 scales per statement. Respond to all of the statements and scales.
  - \* Answer honestly and to the best of your ability.
  - \* This is not a test. Your answers are confidential.
- Are there any questions? ..... you may begin

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

Please respond to all three scales for each statement.

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

INTERESTING BORING  
extremely | quite | slightly | undecided | slightly | quite | extremely

PLEASANT UNPLEASANT  
extremely | quite | slightly | undecided | slightly | quite | extremely

AWFUL NICE  
extremely | quite | slightly | undecided | slightly | quite | extremely

2. MY ACTIVELY PARTICIPATING IN MOST LAB ACTIVITIES IS

INTERESTING BORING  
extremely | quite | slightly | undecided | slightly | quite | extremely

PLEASANT UNPLEASANT  
extremely | quite | slightly | undecided | slightly | quite | extremely

NICE AWFUL  
extremely | quite | slightly | undecided | slightly | quite | extremely

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

INTERESTING BORING  
extremely | quite | slightly | undecided | slightly | quite | extremely

UNPLEASANT PLEASANT  
extremely | quite | slightly | undecided | slightly | quite | extremely

AWFUL NICE  
extremely | quite | slightly | undecided | slightly | quite | extremely

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

4. MY TRYING TO KEEP A GOOD SCIENCE NOTEBOOK IS

INTERESTING BORING  
extremely | quite | slightly | undecided | slightly | quite | extremely

UNPLEASANT PLEASANT  
extremely | quite | slightly | undecided | slightly | quite | extremely

AWFUL NICE  
extremely | quite | slightly | undecided | slightly | quite | extremely

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

INTERESTING BORING  
extremely | quite | slightly | undecided | slightly | quite | extremely

UNPLEASANT PLEASANT  
extremely | quite | slightly | undecided | slightly | quite | extremely

NICE AWFUL  
extremely | quite | slightly | undecided | slightly | quite | extremely

6. MY ASKING THE SCIENCE TEACHER QUESTIONS ABOUT SCIENCE  
IS

INTERESTING BORING  
extremely | quite | slightly | undecided | slightly | quite | extremely

UNPLEASANT PLEASANT  
extremely | quite | slightly | undecided | slightly | quite | extremely

AWFUL NICE  
extremely | quite | slightly | undecided | slightly | quite | extremely

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

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

BORING INTERESTING  
extremely | quite | slightly | undecided | slightly | quite | extremely

UNPLEASANT PLEASANT  
extremely | quite | slightly | undecided | slightly | quite | extremely

NICE AWFUL  
extremely | quite | slightly | undecided | slightly | quite | extremely

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

INTERESTING BORING  
extremely | quite | slightly | undecided | slightly | quite | extremely

PLEASANT UNPLEASANT  
extremely | quite | slightly | undecided | slightly | quite | extremely

NICE AWFUL  
extremely | quite | slightly | undecided | slightly | quite | extremely

9. MY TAKING SCIENCE AS A SCHOOL SUBJECT IS

BORING INTERESTING  
extremely | quite | slightly | undecided | slightly | quite | extremely

UNPLEASANT PLEASANT  
extremely | quite | slightly | undecided | slightly | quite | extremely

AWFUL NICE  
extremely | quite | slightly | undecided | slightly | quite | extremely

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

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

INTERESTING BORING  
extremely | quite | slightly | undecided | slightly | quite | extremely

UNPLEASANT PLEASANT  
extremely | quite | slightly | undecided | slightly | quite | extremely

AWFUL NICE  
extremely | quite | slightly | undecided | slightly | quite | extremely

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

INTERESTING BORING  
extremely | quite | slightly | undecided | slightly | quite | extremely

UNPLEASANT PLEASANT  
extremely | quite | slightly | undecided | slightly | quite | extremely

AWFUL NICE  
extremely | quite | slightly | undecided | slightly | quite | extremely

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

BORING INTERESTING  
extremely | quite | slightly | undecided | slightly | quite | extremely

UNPLEASANT PLEASANT  
extremely | quite | slightly | undecided | slightly | quite | extremely

NICE AWFUL  
extremely | quite | slightly | undecided | slightly | quite | extremely

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

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

INTERESTING BORING  
extremely | quite | slightly | undecided | slightly | quite | extremely

PLEASANT UNPLEASANT  
extremely | quite | slightly | undecided | slightly | quite | extremely

AWFUL NICE  
extremely | quite | slightly | undecided | slightly | quite | extremely

14. MY TAKING UP OF MOST SCIENCE TOPICS IS

BORING INTERESTING  
extremely | quite | slightly | undecided | slightly | quite | extremely

PLEASANT UNPLEASANT  
extremely | quite | slightly | undecided | slightly | quite | extremely

AWFUL NICE  
extremely | quite | slightly | undecided | slightly | quite | extremely

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

INTERESTING BORING  
extremely | quite | slightly | undecided | slightly | quite | extremely

UNPLEASANT PLEASANT  
extremely | quite | slightly | undecided | slightly | quite | extremely

AWFUL NICE  
extremely | quite | slightly | undecided | slightly | quite | extremely

THANK YOU FOR YOUR ASSISTANCE AND COOPERATION!

## APPENDIX C

### INSTRUCTIONS FOR SCORING THE ATTITUDE TOWARD THE SUBJECT SCIENCE SCALE (ATSSS).

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

It is also possible to get an overall individual or class attitude toward the subject science by totalling

the scores for all of the activities together. Scores can range from 45-315. Roughly the total scores would mean the following:

45-85 - extremely negative

85-125 - quite negative

125-165 - slightly negative

165-205 - undecided or mixed reaction

205-245 - slightly positive

245-285 - quite positive

285-315 - extremely positive

The ATSSS can be used to assess class attitudes' toward activities related to the learning of science; individual student attitudes toward the subject science; or to measure changes of student attitude toward specific activities during the course of the school year.

APPENDIX D

**INSTRUCTIONS FOR SCORING THE INTERNAL-EXTERNAL LOCUS OF CONTROL (ROTTER) SCALE.**

There are two responses to each item in the Rotter Scale. One response is an external choice, the other an internal choice. Each item is scored for an external response, as indicated by the letter E on the key below. The numbers 8-37 used on the key below correspond to the numbers used on the composite survey Part 2. Each external answer is given one point so that scores range from 0-21. A high score indicates high externality and a low score indicates high internality. There are also seven filler items (Those items that are not marked for any response).

A	B	A	B	A	B	
8.	-	-	18.	-	E	
9.	E	-	19.	-	E	
10.	-	E	20.	-	E	
11.	-	E	21.	-	-	
12.	-	E	22.	-	E	
13.	E	-	23.	E	-	
14.	E	-	24.	E	-	
15.	-	-	25.	E	-	
16.	E	-	26.	-	-	
17.	-	E	27.	E	-	
				28.	E	-
				29.	-	E
				30.	E	-
				31.	-	-
				32.	E	-
				33.	-	E
				34.	-	-
				35.	-	E
				36.	E	-
				37.	-	-

APPENDIX E

INDEPENDENT T-TESTS BETWEEN MALE AND FEMALE ACHIEVEMENT,  
ATTITUDE TOWARD SCIENCE AND LOCUS OF CONTROL.

Achievement - 2-sample t-Test

Male (n=108), Mean=5.947, S.D.=2.336

Female (n=109), Mean=6.153, S.D.=1.999

t-value = -0.695, 2-Tail Probability= 0.488

Attitude Toward Science - 2 Sample t-Test

Male (n=99), Mean=191.818, S.D.=47.187

Female (n=97), Mean=204.464, S.D.=48.594

t-value= -1.848, 2-Tail Probability= 0.062

Locus of Control - 2 Sample t-Test

Male (n=111), Mean=10.991, S.D.=3.47

Female (n=110), Mean=11.190, S.D.=4.140

t-value= -0.389, 2-Tail Probability= 0.699

APPENDIX - F

TEST OF PROPORTIONALITY BETWEEN THE NUMBER OF MALES  
AND THE NUMBER OF FEMALES ELECTING TO STUDY SCIENCE IN  
THE 11TH GRADE.

$$p = \frac{n_1 p_1 + n_2 p_2}{n_1 + n_2}$$

where:

$$n_1 = \# \text{ of males} = 111$$

$$p_1 = \text{ratio of males electing science} = \frac{86}{111} = 0.77$$

$$n_2 = \# \text{ of females} = 110$$

$$p_2 = \text{ratio of females electing science} = \frac{70}{110} = 0.63$$

Therefore

$$p = \frac{(111 * 0.77) + (110 * 0.63)}{111 + 110} = 0.70$$

If  $p = 0.70$ , then  $q = 0.30$  ( $q = 1.00 - p$ )

And

$$\begin{aligned} \text{s.e.p} &= p * q * \left( \frac{1}{n_1} + \frac{1}{n_2} \right) = 0.7 * 0.3 * \left( \frac{1}{111} + \frac{1}{110} \right) \\ &= 0.06 \end{aligned}$$

Allowance = s.e.p \* tvalue =  $0.06 * 1.97 = \pm 0.12$

If  $p_1 - p_2$  is between  $\pm 0.12$  retain null hypothesis

$$p_1 - p_2 = 0.77 - 0.63 = 0.14$$

Therefore reject null hypothesis

ie. Significantly more males than females elect to study science in the 11th grade.

APPENDIX G

INDEPENDENT T-TESTS BETWEEN REGENTS AND NON-REGENTS  
ACHIEVEMENT, ATTITUDE TOWARD SCIENCE AND LOCUS OF  
CONTROL.

Achievement - 2-sample t-Test

Regent (n=150), Mean=6.515, S.D.=2.255

Non-Regent (n=67), Mean=5.001, S.D.= 1.534

t-value = 5.730, 2-Tail Probability= 0.001

Attitude Toward Science - 2 Sample t-Test

Regent (n=140), Mean=195.593, S.D.=47.163

Non-Regent (n=55), Mean=203.945, S.D.=50.947

t-value= -1.052, 2-Tail Probability= 0.0.300

Locus of Control - 2 Sample t-Test

Regent (n=151), Mean=11.152, S.D.=3.801

Non-Regent (n=68), Mean=11.015, S.D.=3.884

t-value=0.244 , 2-Tail Probability= 0.808

APPENDIX - H

TEST OF PROPORTIONALITY BETWEEN THE NUMBER OF REGENTS AND THE NUMBER OF NON-REGENTS STUDENTS ELECTING TO STUDY SCIENCE IN THE 11TH GRADE.

$$p = \frac{n_1 p_1 + n_2 p_2}{n_1 + n_2}$$

Where

$n_1$  = # of Regents students = 152

$p_1$  = ratio of Regents electing science =  $\frac{111}{152} = 0.73$

$n_2$  = # of non-Regents electing science = 69

$p_2$  = ratio of non-Regents electing science =  $\frac{45}{69} = 0.65$

$$\text{Therefore } p = \frac{(152 * 0.73) + (69 * 0.65)}{152 + 69} = 0.70$$

If  $p = 0.70$ , then  $q = 0.30$  ( $q = 1.00 - p$ )

$$\text{And s.e. } p = p * q * \left( \frac{1}{n_1} + \frac{1}{n_2} \right)$$

$$= 0.7 * 0.3 * (1/152 + 1/69)$$

$$= 0.07$$

$$\text{Allowance} = \text{s.e. } p * t\text{value} = 0.07 * 1.97 = \pm 0.14$$

If

$p_1 - p_2$  is between  $\pm 0.14$  then retain null hypothesis

$$p_1 - p_2 = 0.73 - 0.65 = 0.08$$

Therefore retain null hypothesis. ie. there is no significant difference between the numbers of Regents and non-Regents students electing to study science in the 11th grade.

APPENDIX I

CORRELATION MATRIX

--CORRELATION MATRIX--

	1	2	3 *	4 *
	gender	regent	grade1	grade2
gender	1	.0714	.00744	.01481
regent	.0714	1	-.26444	-.28428
grade1*	.00744	-.26444	1	.8966
grade2*	.01481	-.28428	.8966	1
grade3*	.09644	-.30973	.48867	.63347
mean*	.0474	-.3211	.82623	.95531
elect	.15188	.07942	-.3057	-.34399
locus	.02742	-.01264	-.0664	-.02996
attit*	.13163	.08142	.14969	.22255

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	5 *	6 *	7	8
	grade3	mean	elect	locus
gender	.09644	.0474	.15188	.02742
regent	-.30973	-.3211	.07942	-.01264
grade1*	.48867	.82623	-.3057	-.0664
grade2*	.63347	.95531	-.34399	-.02996
grade3*	1	.83389	-.19925	.00681
mean*	.83389	1	-.32149	-.01877
elect	-.19925	-.32149	1	.15487
locus	.00681	-.01877	.15487	1
attit*	.14163	.21377	-.29631	-.272

	9 *
	attit
gender	.13163
regent	.08142
grade1*	.14969
grade2*	.22255
grade3*	.14163
mean*	.21377
elect	-.29631
locus	-.272
attit*	+

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RIABLE HAS MISSING VALUES