AN INVESTIGATION INTO THE LOW PARTICIPATION RATES OF SENIOR HIGH SCHOOL STUDENTS IN SCIENCE FAIRS

by

Michael J. Mattocks

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The undersigned certify that they have read, and recommend to the Faculty of Education for acceptance, a thesis entitled **AN INVESTIGATION INTO THE LOW PARTICIPATION RATES OF SENIOR HIGH SCHOOL STUDENTS IN SCIENCE FAIRS** submitted by Michael J. Mattocks in partial fulfillment of the requirements for the degree of MASTER OF ARTS (EDUCATION).

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(Supervisor)

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Date: JULY 24, 1995

Abstract

This study examines the low participation rate of senior high school students in school science fairs and in the Colchester/East Hants Regional Science Fair as well as the declining rate of participation of previous contestants in science fairs as they progress through the three levels of schooling.

The results show statistically significant declines between elementary school and junior high school for responses to the following questions: i) choice in doing a project, ii) teacher enthusiasm for science fairs, iii) perceived ability required to complete a science project, iv) science is "fun" at school and v) science evokes curiosity. Sixty seven percent of the reasons given for not participating in science fairs claimed that too much time/work was involved. Students also reported that they would do a science fair project if they had to or if an interesting topic could be found.

I would like to take this opportunity to thank my thesis advisor, Dr. Bernie Davis whose invaluable help, guidance and patience allowed me to finish this project with my sanity intact. I would also like to thank Allan Moore of the Nova Scotia Teacher's College for providing input and suggestions for change. Sue Conrad at the Curriculum Resource Centre at St. Mary's University provided access to the world of electronic transfer of information which saved time and money during the course of this project and my thanks are offered to her.

This project could not have been accomplished without the cooperation and support of my family, wife Kathy and children Kate and Claire. Their patience was stretched beyond normal limits and I thank them dearly for that.

I would like to dedicate this thesis to the memory of my mother, Marian, whom I think of often and miss dearly and to my father, Joseph whose influence on me has been and is immeasureable, lifelong and is more than I can adequately express in words.

"Scientific discovery is a private event, and the delight that accompanies it or the dispair of finding it illusory does not travel"

Sir Peter Medawar

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CHAPTER 1

Introduction

Background :

A science fair is a competition among students, usually elementary and secondary school students, based on the quality of the science projects that the students have done throughout the school year. Science fairs originated in the United States, evolving from science clubs, (Youth Science Foundation, 1990). Science fairs are organized on at least four levels. In some large schools, class science fairs (held in each classroom or science section) may be a qualifying competition for the school science fair. Many schools have a school-based science fair, the winners of which may be eligible to take part in a regional fair. Not all school districts have regional fairs. The regional fairs and their eligible participants are usually within the geographical area that is servedby a school board. The winners of the regional fairs are then eligible to attend the Canada-Wide Science Fair, a national competition, that is held annually during the month of May at different locations throughout Canada. A region must be affiliated with the Youth Science Foundation of Canada (the governing body for Canada) in order to send participants to the Canada-Wide Science Fair.

The first Canada-Wide Science Fair was held in 1962 in Ottawa. Since then the Canada-Wide Science Fair has grown to involve approximately four hundred students (Youth Science Foundation, 1990). These students come from over one hundred regions throughout Canada. This week long fair is an opportunity for students to compete against each other with their science projects and to take part in a cultural and social exchange with students from all over Canada, as well as invited international competitors . (In the past small numbers of invited competitors have included students from Sweden, Japan and Australia).

It is the mission of the organizing committee of the Colchester/East Hants Regional Science Fair (all volunteers) to encourage students at all levels of the general school population to participate in science fairs and to send its best students to the Canada-Wide Science Fair. For the past eight years the Colchester/East Hants Regional Science Fair organising committee, of which the researcher is a member has sent its top competitors to the Canada-Wide Science Fair. Students from the Colchester/East Hants Regional Science Fair have in the past excelled at the Canada-Wide Science Fair, bringing home medals and certificates. Indeed, the quality of the local projects has been improving as evidenced by an increasing number of awards.

One very noticeable trend, identified by the researcher and acknowledged by the members of the organising committee of the Colchester/East Hants Regional Science Fair, is that over the past several years, the numbers of senior high school participants, particularly Grade 11 and 12 have been low. Also, the rate of participation from elementary school through to senior high school declines markedly. Paul Myers, a member of the Halifax City Regional Science Fair organising committee for many years, acknowledged these problem in his region. These problems were the focus of a workshop held at the 1992 Canada-Wide Science Fair, held in Sudbury, Ontario three years ago which the researcher was privileged to attend. Low participation rates of senior students was identified as a concern by representatives from regions all over the country.

The focus of this research will be to try to determine the reasons for this low participation rate at the senior high level and the declining participation rates from elementary school through to senior high school. Various science experiences will be investigated in an attempt to find evidence that helps to explain this situation. Also, trends in the affective and cognitive domains in science and science fairs, as well as the influences on home and school across the three levels of schooling, will be investigated.

Review of Relevant Literature

An extensive review of the literature reveals very little on science fair enrollment patterns. There are many articles on how to run, judge, finance and compete in science fairs. There are also numerous articles suggesting science fair projects for participants. However, there is a vast body of work on how students relate to school science and this review will draw on that work. The reader should bear the following in mind when reading the review. Many of the affective and cognitive attributes and the various influences cited in this research have involved science in school. This present research deals with science fair projects. This researcher has been unable to establish a direct link in the literature between science in general and science fair projects such that attributes related to school science have the same relation to science fairs. This possible link between extracurricular and curricular science will constitute part of the research.

The literature review is broken down into three broad areas, i) the affective domain which covers such attributes as attitude, interest, motivation and curiosity, ii) the cognitive domain which looks at reasoning ability and aptitude and iii) home and school environment. A summary at the end of the review will attempt to blend these together. A theme that was important to the researcher and that the reader should look for in this research, is that of trends and changes. This research is retrospectively looking at school experiences.

The student affective domain:

Academic interest and attitude toward academics in general :

Definitions of attitude and interest are appropriate at this stage. A social psychological definition of attitude toward an object, event or idea was previously defined as "a general and enduring positive or negative feeling about that object, event or idea", Petty and Cacioppo (1981). A dictionary definition refers to interest as curiosity or attentiveness (Funk and Wagnell, 1983). Fishbein (1967) linked attitude and behaviour together in saying that a person's attitude toward an object or idea is a major determinant of his/her behaviour toward that idea or object. Since this present research, being retrospective, is looking at the decline in participation rates of senior high students in science fairs, it is appropriate to identify and examine the trends of attitude, interest and other affective attributes toward science that span the school years and to identify any changes and trends.

There appears to be an abrupt change in outlook comparing elementary school to junior high school. Elementary school is seen as a new and exciting place to be, whereas junior and senior high school are regarded as more serious, more of a means to an end. Baker et al (1992) made the following suggestion to explain this change saying that "the decline in attitude from earlier to later grades might at least in part be attributed to the shift from a student-centered to a teacher-centred classroom climate" (p.17).

Goodlad's (1984) study examined all subject areas to determine if a pattern existed in students' reporting of their interest in the different subjects. Math and science showed similiar patterns of decline from elementary school to junior high school, with a flattening out for senior high school. Interest in English and social studies remained fairly flat across school levels and lower than science. The subject areas that consistently, across the grade levels, remained high in student interest are the "hands-on" activities of art, physical education and 'shop'.

Deci & Ryan (1981) reported that teachers acknowledge that as children move through the school system, they seem to resist learning and that this learning is increasingly based on rewards (extrinsic rewards) and is dependent on "directives" from the teachers. Suchman (1971) noted shifting of patterns of inquiry as people grow older. "Their patterns of inquiry shift from an existential and intrinsically motivated playful experience to a more pragmatic, goal-oriented and somewhat more grim work experience." p. (71)

Suchman (1971) also noted that the "desire to inquire" changes with age. Young inquirers, the authors wrote:

> tend to do more sensing, more acting to control and encounter and more searching to recognize familiarity in new encounters. Young inquirers create more for the experience of creating while older inquirers create to achieve, to produce new products. Young inquirers attempt to control their environment more for the experience of controlling than for the pleasure of being in control, whereas older inquirers control more as an end or the means to an end rather for the pleasure of controlling in and for itself p. (70)

Science interest :

Teachers of science would probably hope that some, or perhaps many, of their students take an interest in their subject. Several affective attributes on science (attitude, interest and curiosity) are linked together in a number of studies by Harty and others. Looking at elementary school students, Harty, Andersen and Enochs (1984) found a significant correlation between an interest in science and attitude toward science ($r = 0.58$, $p < 0.001$) and interest in science and curiosity about science ($r = 0.47$, $p = 0.002$) and a correlation between curiosity and attitude in science ($r = 0.69$, $p < 0.001$). Care must be taken in generalizing these results, which apply to elementary school students, and not to junior high and senior high school students.

In another study, Harty (1985) correlated science and a number of affective attributes all of which show moderate correlations.

Table I

Affective attributes and their correlates in science

	curiosity	interest	Self-concept of ability
attitude	r = 0.47*	r = 0.39*	r = 0.37*
curiosity			r = 0.26*
interest	r = 0.42*		r = 0.27**

Notes. *p < 0.001, **p < 0.01

Harty, Samuel and Beall (1986) reported a positive correlation between attitudes and curiosity in science and Harty, Beall and Scharmann (1985) reported a positive correlation between curiosity and interest in science. Yager and Penick (1986) in an analysis of the National Assessment of Educational Progress (NAEP) study of 1984 compared the change in attitude (or interest; for the younger grades attitude and interest are indistuishable) toward science in grades three, seven and eleven. The numbers who found science interesting were respectively, 84%, 51% and 46%. The equivalent data for the study by Goodlad (1984) showed that the numbers who found science interesting in upper elementary, junior high school and senior high school were respectively, 80%, 66% and 69%. Further evidence for this trend was presented in the research by Hofstein and Welch (1984), who reported that interest in science declined from 45.9% at the junior high level to 37.7% at the senior high school.

Science attitude change over time :

Science is viewed differently by students at different grade levels. A decline in science attitude spanning the school grades is noted by several authors . James and Smith (1985), on the basis of a study, concluded that there was a significantly large decline in attitude toward science in the transition between grade six and seven which is, coincidentally, the change from elementary school to junior high school, i.e. from a one-teacher system to a many-teacher system. In a meta-analysis on the subject of motivation, Anderman and Maehr (1994) focused on the middle grades, which they called grade six and seven. These authors reported that positive attitudes, motivation and self-concept of ability all decreased in grades six and seven and more specifically, that domain-specific attitudes decreased between grades five and six.

The National Assessment of Educational Progress (NAEP) surveys students every four years and provides some interesting data from the United States on the changing attitudes of students toward many subjects including science. The NAEP study by Mullis and Jenkins (1986) under the title " The Science Report Card" which surveyed students in grades 4 , 8 and 12 asked the question, "Do you like science ?". The results were that 80% percent of grade 4 students said yes while 68% of grade 8 and 65% of grade 12 students said yes. (Presumably, science for grade 12 students includes chemistry, physics and biology). In another article that examined the results of the "The Science Report Card", Jones et al (1992) noted that science achievement levels for those who reported "yes" are higher than for those who reported "no".

Hofstein and Welch (1984) examined the change in attitude from junior to senior high over a five year period and showed that a positive attitude toward science that started at 52.7% in junior high school had declined to 47.7% in senior high. The strongest influence on science attitude of students was reported as being the science classroom. Simpson and Oliver (1990) found a steady decline in attitude from grade six to ten with grade ten being nearly "neutral". The authors also noted a decline in motivation as grade level increased. To add to the evidence of decline in attitude across the three levels of schooling, Yager and Penick (1986) reported that 40 % of 13 year olds and 27% of 17 year olds thought that science was fun. The same authors also noted that 39% of 13 year olds and 32% of 17 year olds reported that their teachers encouraged them to be creative.

Motivation in general :

A motive is defined as "a conscious or unconscious need or drive that incites a person to some action or behaviour" (Funk and Wagnells, 1983). To have motivation then is to possess that need or drive. The flow experience is considered to be the definitive reason for participation in any activity (Csikszentmihalyi, 1975). Flow conditions according to this author are those under which participants experience fun and excitement and where the following characteristics are in place; involvement, loss of self-consciousness, feedback from the task, feeling like you are in control and importantly, the absence of any extrinsic pressures or rewards.

A distinction has to be made here when discussing engagement in any activity and that is the difference between wanting to participate because of an interest in a particular activity or participating because a reward (or incentive) is offered. An incentive could be a failing mark for non-participation. Intrinsic and extrinsic motivation are clearly involved here. According to Deci (1975) intrinsically motivated behaviours are "behaviour which a person engages in to feel competent and self-determining" (p. 147).

This feeling of competence suggested being able in that particular behaviour. Deci and Ryan (1981) in a literature review suggested that choice in participating in an activity and positive feedback can increase intrinsic motivation. Bandura and Schunk (1981) reported that children in a self-motivated condition, all of whom felt highly self-efficacious, displayed levels of intrinsic interest. McGraw (1978) proposed that intrinsically motivated people perform better at learning or other challenging activities.

Several researchers have reported on the correlation between extrinsic rewards and intrinsic motivation. Greene and Lepper (1974) proposed that extrinsic rewards can actually undermine or reduce intrinsic motivation. This is in agreement with Deci (1975), who wrote that the more a person engaged in an activity for which no extrinsic rewards are present, the higher the intrinsic motivation for this activity. Bandura (1977) is in agreement with the previous two authors having said that "extrinsic reinforcement for activities can [therefore] reduce the intrinsic motivation to engage in them" (p.107). Also, face to face competition with the reward of victory decreased the level of intrinsic motivation, (Deci et al, 1981).

In a sports setting, Ryan (1980) studied scholarship and non/scholarship athletes and found that the athletes who did not receive scholarships (an extrinsic reward), on average, reported higher levels of intrinsic motivation than those who received scholarships. Also in the field of participation in sports, Gill (1986), suggested that developing positive attitudes toward sports may increase subsequent participation. As a way to increase participation in exercise programs teachers, according to Riddle (1980) focused on convincing non-participants in sports, for instance, of the positive effects and refute the negative effects.

Previous research concerning intrinsic motivation and extrinsic rewards (Deci, 1981; Deci, 1975 ; Greene & Lepper, 1974) was regarded as ground breaking in the 1970's but a recent meta-analysis on intrinsic motivation and reward suggests that the findings should be reevaluated. Cameron and Pierce (1994) proposed that subjects who received a tangible reward regardless of the level of performance for a task spend less time on the task. This last proposal is in agreement with the findings of (Deci, 1981; Deci, 1975 ; Greene & Lepper, 1974). However, Cameron and Pierce (1994) also concluded that tangible rewards produce no effect on intrinsic motivation when the reward was unexpected. Both unexpectedness and tangible rewards regardless of performance have no bearing on the class science fair projects that were the subject of this present research since the projects are evaluated with no surprises.

Finally, Cameron and Pierce (1994) in studying whether extrinsic motivation or rewards decrease intrinsic motivation found that: "rewarded people are not less willing to work on activities and they do not display a less favourable attitude toward tasks than people who do not receive rewards" (p.394). The two schools of thought on the effect of extrinsic rewards decreasing intrinsic motivation appear to contradict each other.

Since this present research is a retrospective study examining the trends of many affective attributes in science, a piece of research that regards the change in types of motivation across the grade levels is worth looking at. Harter (1981), who measured intrinsic and extrinsic motivation across grades 3-9, found that her three indicators of intrinsic motivation; preference for a challenge, curiosity/interest (sic) and independent mastery all declined during this time frame. (Harter's indicators are different from those of previously mentioned authors (Deci, 1981; Deci, 1975 ; Greene & Lepper, 1974).

Motivation for science:

Although the various science curriculum guides suggest that students in junior high and senior high schools do a science fair project, the desire to engage in science outside the classroom for the pure enjoyment of it must, in part, be a measure of the students' motivation in that topic. Student motivation was previously linked to different affective attributes in science in many studies. Motivation was reported as a significant predictor of attitude in science (Foong, 1992 ; Fraser, 1985). Student motivation was shown to have a strong correlation to achievement (Kremer and Walberg, 1981). Children who reported higher academic intrinsic motivation also report significantly higher school achievement, more favourable perceptions of their academic competence and lower academic anxiety, (Gottfried, 1985). Deci, Nezlek and Sheimann (1981) in their study showed that teachers who exerted more control over their classroom had children who showed a lower level of intrinsic motivation than teachers having a more autonomy-oriented classroom environment.

Research by Caruso (1985) that examined motivation in participating in science fairs for junior high school students in the San Fransisco Bay Area Science Fair came to the conclusion that the strongest motivational influence for participation in science fairs was the intrinsic motivator of "self-accomplishment by completing a science project" (p.56). Caruso compiled a list of ten intrinsic and ten extrinsic motivators and the respondents to his survey gave a ranked list of their reasons for competing in their regional science fair. Ten intrinsic and five extrinsic rewards were the most popular reasons for fifty percent or more of these entrants to participate.

A recent intervention exercise by Salmi (1993) with grade 7 science students enabled him to measure and subsequently increase the intrinsic motivation levels with an experimental group of students. The focus of the study involved a visit to a science center. The research also suggested that intrinsic motivation is acquired over a long period of time as personality develops.

Four of the past winners of the Colchester/East Hants Regional Science Fair and subsequent participants at the Canada-Wide Science Fair were interviewed by the researcher and their views on motivation and science projects are, with their permission, shared here. One young lady, Cari MacDonald, recalled that the trigger that piqued her interest in science in general was a family visit to The Ontario Science Centre. Her particular science project idea concerned insulation and stemmed from construction work that took place at her house. She reported receiving lots of encouragement from her family and friends when doing the project. Family involvement, it appears, played a part in this young woman's involvement in science.

Kevin Thomson, whose science interest is (and was) computers revealed that he has been interested in computers for a long time and that he enjoyed the recognition and the competition that science fairs brought. Kevin reported that he wanted to try to rate himself against others in the computer division. Encouragement came from parents and one friend (his science fair partner) and a couple of his teachers.

Duncan and Darren Smith are brothers who both have past experience with science fairs at all levels including the Canada-Wide Science Fair. Their topics, which involve working with wildlife, (turtles and humming birds) stem from their annual summer vacations spent at their cottage on a lake. Parents were supporters of the projects and provided much encouragement and help. Duncan mentioned that winning a trip to different locations in Canada was an incentive to compete.

The ultimate prize (an extrinsic reward) for those who excel at the Colchester/East Hants Regional Science Fair is an all-expenses paid trip to the Canada-Wide Science Fair. Once there students can win cash prizes. The total value of the prizes given out each year, including summer employment, grants, scholarships and trips is in the region of $100,000. At the local level much smaller amounts are given for prizes and certain organizations make prizes available to local fairs. (See Appendices 1 and 2 for a list of prizes at the regional and national levels). Do these prizes increase the motivation to do science fair projects? It certainly provides an incentive for some competitors.

Summary :

Several studies reported a change in the way that children inquired at school with all subject areas. The change appeared to be from a pleasurable, playful experience at elementary school to a more pragmatic and goal oriented one at junior and senior high school. There was a decline with regard to a positive attitude toward school subjects . This decline seemed to be most abrupt between elementary and junior high school. The studies cited also have shown that attitude toward science declined over time. Attitude toward science was linked to other affective attributes such as interest, curiosity and motivation and also to ability and achievement.

Interest in science, like attitude toward science, declined as students progressed through the school system. Although curiosity about science is not dealt with in a separate section in this review, the work of Harty and others (Harty, Samuel & Beall, 1986 ; Harty, Beall & Scharmann, 1985 and Harty, 1985) showed that the affective attributes all have moderate correlations with each other. In other words those who have a positive attitude toward science are likely to be interested in and curious about science.

According to the earlier research, extrinsic motivating factors based on a system of rewards such as grades or marks or, lack of rewards, possibly a failing grade or mark, was not equated with a high level of intrinsic motivation. Intrinsic motivation was cited as the most common influence for participating in science fairs. A high level of intrinsic motivation was corellated with a high level of academic competence. It was also reported that intrinsic motivation in science declined with age.

The student cognitive domain :

Reasoning ability :

It is reasonable to assume that ability in, and enjoyment of a task are related. For instance, an individual who starts participating in a recreational hobby is not likely to derive enjoyment in that activity if no progress is made. There is no reason to believe that doing a science fair project is different. In the previously cited study by Goodlad (1984), students in the survey were asked to rank their school subjects for difficulty and interest. At all three levels of schooling (upper elementary, junior high and senior high school) science as a subject ranked high in difficulty and students reported that science became increasingly more difficult as they progressed through the school system. Math and social studies showed a similiar pattern.

The kind of reasoning ability and thinking skills necessary to plan and engage in a science project may have some influence on students' enthusiasm and willingness for doing one. There is more than one theory that is accepted as an explanation how we as humans progress through the various stages of learning. One of the most widely accepted theories of learning stems from the work of Jean Piaget. Piagetian studies have shown that the acquisition of reasoning ability is dependent on age. More significantly perhaps is that this ability is acquired at different rates and ages and some individuals mature later in terms of reasoning ability.

In a study by Renner, Grant & Sutherland (1978) acquisition of formal reasoning ability was shown to increase slowly from grade 7 where 17% are formal thinkers to grade 12 where 34% of the students were capable of formal thought. Lawsonn, Karplus, and Adi (1978) reported that as age increases so does the ability to solve problems of proportionality and correlation. Chiappetta (1976) reported studies showing that 85% of the population of the United States does not appear to be at the formal level of thought in intellectual development and most adolescents and young adults appeared not to have attained formal operational thought at the cognitive level also. In a description that distinguished concrete-operational thinkers and formal-operational thinkers, Boyle (1969) said that " the child [sic] in the concrete operations phase is concerned with the actual ; the adolescent [sic] in the formal operations phase is concerned with the possible and its relation to the actual" (p.73).

It is generally accepted that as grade twelve (the final year of high school) approaches, and as teachers and schools make an effort to prepare the more qualified students for post-secondary education, academic work is more challenging. Cantu and Herron (1978) noted that much of the high school curriculum in science is based on formal reasoning and formal operational thought but that many students who enroll in high school science courses could not engage in this type of thought process. Ability in general is significantly related to achievement (Fraser, 1985)

In a study that looked at a comparison between gifted/talented children and average children, Piburn and Enyeart (1985) investigated reasoning skills. The authors found that the gifted children were accelerated by two or three grade levels because of their reasoning ability. Barrington and Hendricks (1988) reported that intellectually gifted children had higher opinions of the usefulness of science than students with lower abilities.

Yeany, Kueh & Padilla (1986) in a study on cognitive reasoning and science skills proposed an ordered list of skills that are acquired. The Piagetian skills that the researchers tested involve ones similiar to those required to do a science fair project. According to the authors "the probability of a student being able to formulate a hypothesis before using proportional reasoning skills, before being able to control variables is very low", p.288).

Appendix 3 shows a judging form that is typical of science fairs across Canada. The upper levels of the three different types of projects (experiment, study and innovation) require skills that involve hypothesis forming, variable manipulation and statistical manipulation, especially with the experiment type of project. It is clear that higher level thinking and reasoning skills are necessary to complete a successful project at the junior and senior levels. Many of the science fair projects that are done for the elementary level are studies at an appropriately lower level. Students are encouraged to do experiment type projects in junior and senior high although this is by no means enforced. Daab (1988) described an intervention exercise that was attempted with parents of grade five students. The rate of participation of these students was dropping at the fifth grade due to the fact that these youngsters had to do an experimental project and were not allowed to do a poster or demonstration project. The intervention exercise for parents failed, they were unable to provide the assistance to increase the participation rates.

<u>Summary</u> :

From the work cited above it is clear that the cognitive skills necessary to succeed in science at the senior high level may not be at the disposal of every student, even though the students are cognitively maturing as they get older. It is conceivable that doing a science project is an activity that requires reasoning abilities that are beyond the capabilities of many students at the higher grade levels. If most students lack the necessary reasoning skills then doing a science fair project will be a very challenging experience.

Home and school influence on science :

Classroom environment in general :

In the landmark study by Goodlad (1984) a vast body of research on all aspects of schooling is provided, including the classroom environment. Goodlad identified some generally accepted positive elements found in classrooms. These include exuberance, joy, laughter, praise and corrective support of individual student performance, lack of punitive teacher behaviour and low interpersonal tension. These elements were observed to be in place in the early elementary schools with a noticeable decline reported in these elements in upper elementary school. The decline showed a sharp drop at the junior high school level. In this same study, Goodlad concluded that the teaching of the basic subjects that are required for college admission i.e. the sciences, English, mathematics etc. , is characterized by "a narrow range of instructional activities favouring passive student behaviour". Those are the activities that are "essentially becoming dominant by the fifth or sixth grade." (p.128).

Science classroom environment :

The classroom environment is one of the three spheres of influence on schooling (the other two being the home environment and peer groups). These areas of influence are important in the affective domain. Talton and Simpson (1987), Simpson and Oliver (1990) and Foong (1992) all suggested that the classroom environment has the strongest impact on science attitude. Talton and Simpson (1987) also suggested that the classroom climate, students activities and student interaction were all important factors in having a positive attitude toward science. Myers and Fouts (1992) found that positive attitudes toward science were found in the classroom that had among other characteristics, high levels of student involvement, high levels of teacher support and low levels of teacher control.

Science knowledge is most influenced by the classroom which contrasts with reading ability for instance, which has a large home influence (Zuzofsky and Tamir, 1989). Talton and Simpson (1985) found that the strength of the relationship between peer attitude and individual attitude in science peaks in grade 9. The authors suggest that "perhaps attitude to science is contagious" (p.23) and that the individual attitude may become more like the group attitude.

In an analysis of the NAEP study of 1981-2 , Yager and Penick (1986) found that students' perceptions of science classes changed over their years in school. The results are summarized below in Table 2. In asking about how much fun a subject was at the senior level and at the elementary level, the students are being asked a question that has value attached to it. Students at the senior level may not consider many aspects of high school "fun".

Table 2

NAEP* results on science classroom perceptions

	Grade 3	Grade 7	Grade 11
Science classes are fun	60%	37%	28%
Science classes are interesting	85%	47%	42%
Science classes are exciting	53%	43%	48%
Science classes make me feel uncomfortable	6%	28%	30%
Science classes make me feel sucessfull	57%	38%	28%

Note *Percentages given are for those who answered yes.

The different modes of instruction that students will experience in school in all subject areas seems to have an impact on attitude. The two extremes of these modes can be thought of as entirely teacher-centered to entirely student-centered. In the junior high school classroom, with control of behaviour being perceived as a major issue, Jones et al (1992), in some data from NAEP reported that middle and junior high school classes were subject mostly to lecture/discussion with "hands-on"/lab activities reported as not occurring very often. Hall (1992) suggested that an activity centered biology content course is influential in promoting positive attitudes toward science and science teaching among prospective elementary teachers.

Several studies report that the type of instruction can have an effect on attitude toward science. In a comparison of three different types of instructional approaches in science, Shepardson and Pizzini (1993) found that a "search, solve, create and share" (SSCS) approach was more "fun" than the traditional lab or lecture worksheet in the science classroom. Kyle, Bonnstetter and Gadsden (1988) reported that among elementary students, those in an inquiry-oriented process approach in a science classroom had more enhanced attitudes toward science than those in a textbook oriented classroom.

Independence and initiative toward mathematics were encouraged by teachers with positive attitudes. Teachers with a negative attitude toward mathematics encouraged dependence and passive behaviour (Karp, 1991). Stead et al (1979) made the point in their study that teacher enthusiasm is seen as an important factor in terms of students developing a positive attitude toward science as well as an interest in it. Fouts and Myers (1992) suggested that teachers may contribute toward poor student attitude by the use of inappropriate teaching styles and classroom techniques.

In his paper, Brophy (1986) investigated student motivation to learn and teacher enthusiasm. The author said that, ignoring overtly theatrical performances, "If teachers present topics or assignments with enthusiasm, suggesting that they are interesting, important or worthwhile the students are likely to adopt the same attitude" (p. 25). Further to this Brophy suggested that teachers should "adapt student tasks to their interests .... and give an opportunity for the students to interact with their peers"(p. 25). These suggestions are, the author claims, ways to improve and increase motivation.

Haladanya and Shaughnessy (1982) reported that teacher characteristics were used as a predictor of students attitudes. Teachers who were intrinsically motivated, presumably those who demonstrated a keen interest in their own subject, had influence on students attitudes. Haladanya, Olsen and Shaughnessy (1983) reported different predictor variables for attitude toward science for grades 4, 7 and 11. At grade 4 the top predictor for student attitude was teacher enthusiasm ($r = 0.33$). For grade 7 students, science attitude correlated with teacher enthusiasm for science ($r = 0.54$) and class environment ($r = 0.79$). Grade 11 students rated the following predictors for student attitude toward science ; teacher enthusiasm for science ($r = 0.52$) and teacher attitude toward science ($r = 0.41$). Brophy and Good (1984) reported that for older students, teacher enthusiasm appears to be related to the attainment of affective outcomes toward science.

Family/home involvement in general :

Research findings indicate clearly that family involvement in a child's education has a positive impact. Eastman (1988) allowed that there is a correlation between family involvement with school activities and a child's achievement and interest in school. Further to this, Peterson (1989) also pointed out the correlation between family involvement and long and short term achievement. Family involvement, according to Peterson (1989) can be tutoring, which is reported as the most effective method but tutoring is not possible for all parents given the varying levels of schooling of parents . However, parental attitude and expectations also correlated with higher levels of achievement.

Family/home involvement with science :

The classroom appears to have the greatest influence on attitudes toward science but there are other factors that also play a part. Talton and Simpson (1986) reported that family experiences with science have a strong influence on science attitude. Haladanya, Olsen and Shaughnessy (1983) showed a correlation between science attitude and parental involvement (r = 0.34). Simpson and Troost (1982) also cited family connections with attitude saying that the effect of a home commitment to science with parents and siblings involved correlates with a high science affect.

Students who complete a science fair project do at least some, if not most, of the work outside the classroom. Motivation for, and interest in, doing this work must, in some part, be based on an interest in science. Several studies reported findings showing a link between academic interest and ability. In another field Watkins and Edwards (1992) reported that extracurricular reading had a significant effect on current reading achievement.

Mullis and Jenkins (1986) asked students the following questions about their out-of-school science interests. As can be seen from table 3 below there is a significant decline in the interest in activities involving science outside the classroom as grade level increases, in particular there is a dramatic decrease in the home help received for the senior high students.

Table 3 :

Home experience with science from The Science Report Card (NAEP)

	Grade 3	Grade 7	Grade 11
Does anyone at home ever talk to you about what you are learning in science	78%	77%	35%
Does anyone at home ever talk to you about science projects	64%	59%	31%
Does anyone at home ever help you with your science homework	55%	54%	26%
Does anyone at home read books about science to you/do you ever read books about science at home	59%	33%	19%

Note. Percentage saying yes quoted

Science clubs turn out to be a fertile ground for those with a high ability in science. Eylon et al (1985) found that students who enlisted in extracurricular science activities (for instance, science clubs) had a higher ability in science than those who did not. Students in this study who participated in the extracurricular science activities also saw school science as different from extracurricular science. Extra-curricular science was seen as more important, more interesting and having a higher value than school science.

Another study on the effects of participation in an extracurricular science activity, Hofstein, Maoz and Rishpon (1992) compared participating and non-participating junior and senior high school students in week-long science courses at universities. Students taking part in the extracurricular science activities reported that learning science is more enjoyable, interesting and attractive than those who did not take part. Of note is the finding that when grade eight students to grade eleven students, both of whom had taken part in the extracurricular science program, were compared, science attitudes and interest in science did not decline. This is contrast to studies (Yager & Yager, 1985 ; James & Smith, 1985 ; Mullis and Jenkins, 1986 ; Hofstein & Welch, 1984 and Yager & Penick, 1986) which showed that science attitudes and interest in general did decline over time.

Zuzofsky and Tamir (1989), in a study on elementary school science, reported that science knowledge is more school dependent than reading for instance. Perhaps parents feel more comfortable with reading with their children than doing science with their children. Tamir (1989) reported a significant correlation between the home environment and achievement in science although Gorman and Yu (1990) reported no significant differences between those who did and did not get home help on science achievement. Gorman and Yu however cited a small sample number . Miller (1988) pointed out that the strongest influence on participation in informal science activities (museums, science clubs etc.) for grade 7 and grade 10 students was parental influence or "push".

Summary :

The classroom and the teacher had a strong influence on attitude toward science. The teaching styles and practices of teachers and teachers' levels of enthusiasm for the subject were directly related to a positive attitude in science. Having this positive influence, students may be more inclined to participate in extra-curricular science. As one of the three spheres of influence that students are exposed to, a positive home environment that gave encouragement to students in all academic areas has been shown to enhance attitudes toward science.

The literature tended to support the position that students who engage in science outside the classroom held a more positive view of science in general. The literature also points to the fact that students who had higher ability levels were more likely to engage in science outside the classroom. This suggested that a student who had low ability in any subject was not going to be motivated to doing work outside the classroom in that subject. Nevertheless, extracurricular academic work in any subject appears to increase a positive attitude toward and aptitude for that subject.

Summary of the relevant literature :

Young people's feelings toward many aspects of their lives change over time. Elementary school students reported in general, positive feelings regarding school. The carefree days of elementary school however do not last long. Many attributes experienced a significant decline in the junior high school years. These attributes included interests, attitudes, motivation and curiosity. This trend recovered slightly in senior high school. The junior high school years seemed to be a pivotal and crucial time in the lives of students.

Motivational theory suggested that forcing students to do a science fair project did not increase their intrinsic motivation or interest. Rewards or punishments according to the two conflicting theories either did, or did not increase motivation. However, the science classroom, teacher enthusiasm and an encouraging family environment contributed to a positive science experience.

In addition to the affective domain, the cognitive demands placed on the students increased as they move up through high school and approached post-secondary education. Cognitive abilities and affective attributes were linked in that students who had positive attitudes toward science and were interested in science generally did well at it. Many authors previously cited suggested that the cognitive abilities required to excel in science at high school were not present in many of those students who were enrolled in these courses.

Background information:

This study will examine the low number of participants at the senior level of the Colchester/East Hants Regional Science Fair and the declining rate of participation from a relatively high rate at elemenatry school to a lower participation rate at senior high school. Participation at the Regional Science Fair and at the Canada-Wide Science Fair is divided by age (division) and area of science studied (category, for example life science or physical science). With the exception of the primary to Grade 3 division the Colchester/East Hants Regional Science Fair has age divisions that are the same as the Canada-Wide Science Fair. They are as follows: Elementary: Primary to grade 3, Upper Elementary: Grades 4 - 6, Junior: grades 7 & 8, Intermediate: grades 9 & 10, and Senior: grades 11 & 12.

Tables 4 and 5 summarize the numbers of students participating in the Colchester/East Hants Regional Science Fair over the last seven years. Table 4 shows all participants for the past seven years with percentages for each grade in parentheses. Table 5 shows the same information as table 4 except that the data for the elementary grades has been removed.

Table 4 :

Numbers of participants in the Colchester Regional Science Fair

	1988	1989	1990	1991	1992	1993	1994	1995*
Gr. 4-6	72/ (44%)	49/ (41%)	105/ (55%)	116/ (56%)	103/ (56%)	152/ (61%)	143/ (61%)	142/ (60%)
Gr. 7/8	19/ (12%)	19/ (16%)	47/ (25%)	40/ (19%)	36/ (19%)	55/ (22%)	51/ (22%)	45/ (19%)
Gr. 9/10	57/ (36%)	37/ (31%)	30/ (16%)	40/ (19%)	35/ (19%)	35/ (14%)	34 / (14%)	37/ (15.5%)
Gr. 11/12	14/ (9%)	15/ (12%)	9/ (5%)	12/ (6%)	9/ (5%)	8/ (3%)	7/ (3%)	13/ (5.5%)
Total	162	120	191	208	183	250	235	237

Note . Percentages of the total in parentheses.
* The 1995 data were added after the survey was conducted.

Table 5 :

Number of participants over the past seven years

	1988	1989	1990	1991	1992	1993	1994	1995
Gr. 7/8	19/ (21%)	19/ (27%)	47/ (55%)	40/ (43%)	36/ (45%)	55/ (56%)	51/ (55%)	45/ (47%)
Gr. 9/10	57/ (63%)	37/ (52%)	30/ (35%)	40/ (43%)	35/ (45%)	35/ (36%)	34/ (37%)	37/ (39%)
Gr. 11/12	14/ (15%)	15/ (21%)	9/ (10%)	12/ (14%)	9/ (10%)	8/ (8%)	7/ (8%)	13/ (14%)

Note . Percentages of the totals in parentheses (without elementary grades)

There are forty two schools in the Colchester/East Hants District School Board and these include two high schools, three junior/senior high schools, three junior high schools, two elementary/junior composite schools (Grades P - 9) and thirty elementary schools. For the last ten years the records show that five of the elementary schools have never entered the Regional Science Fair. During some years, schools, for reasons unknown, have not entered projects and in subsequent years have returned with projects. The number of participants that are eligible to enter the Regional Science Fair from each school is based on the enrollment of that school.

The total number of projects that can be accommodated is based on the size of the facility housing the Regional Fair, a high school gymnasium. The maximum number of projects able to be displayed in the gym is two hundred and fifty. (Projects are allowed a width limit of 1.8 metres and a depth limit of 0.8 metres and very few projects challenge the height restrictions of

3.0 metres). However more exhibitors than the maximum number of projects are possible because of a rule that allows the possibility of having two exhibitors per project. The ratio of exhibitors to projects is approximately 1.25 : 1. This means that up to three hundred and twenty students can be involved in the Regional Fair. Project winners consisting of pairs of students gain equal recognition in the awards including the chance to go to the Canada-Wide Science Fair.

Science Fair Projects and Curriculum Requirements :

The curriculum guides for the elementary school science program mentions in the section Methods in Elementary Science that science projects *may* (italics added) be used in class but there is no provision for a mandatory science project nor is there any suggestion that a school science fair be conducted, (Nova Scotia Department of Education, 1978). The appropriate guide for the junior high school science program lists science fairs as an optional topic along with other options. A section of the Curriculum Guide for Junior High School Science is included in Appendix 4.

The secondary school science courses that are listed as honours courses, i.e. Biology 521, Biology 541 and Chemistry 541, require a science project to be done as part of the curriculum. (Nova Scotia Department of Education Curriculum Guide #118). The other science programs which are coded as academic, Biology 421 & 441, Chemistry 431 & 441 and Physics 431 & 441, do not require a science project (Nova Scotia Department of Education Curriculum Guides # 118) but many teachers (particularly teachers of biology) include a science project as part of their program. In fact the Curriculum Guide for Biology has the following to say about science fairs. "Science fairs or science olympics *can* (italics added) be an enriching experience for students especially if the emphasis is on learning and fun rather than competing for prizes" (p.37). Although the science teacher can make the class project mandatory, participation at the Regional Science Fair is optional. This researcher believes however that most students opt to enter the Regional Science Fair. This is a chance to represent their school and to gain recognition for their efforts.

Rationale for this study:

During the past seven years the numbers of senior students (grades 11/12) entering the Colchester/East Hants Regional Science Fair have been declining, (Tables 4 & 5) . There is a very noticeable decline in the participation rates from elementary school through to senior high school as well as a low number of students at the senior high school level taking part. Junior high school and elementary school numbers have been fairly consistent over the years. Many factors could contribute to this low participation rate. This study seeks to determine the reasons for the low participation rates by examining the links between these low rates and the trends in affective and cognitive attributes toward science, motivation toward science and a home/school influence on the science experience to ascertain whether this might relate to the students' willingness for doing science fair projects.

A purposive rather than general sample of students was selected for the following reasons. A general sample would have required a very large number of respondents in order to 'catch' the smaller number of previous participants in the Colchester/East Hants Regional Science Fair and the school science fairs. By a process of competition and selection, this purposive sample represents students with higher level skills and abilities compared to those who did not advance to the Regional Science Fair. This research will focus on individuals who have had science fair experience at a representative level (i.e. the Colchester/East Hants Regional Science Fair) and look at their experiences with science and science fair projects.

These students have all been identified as having previously participated in the Colchester/East Hants Regional Science Fair at the elementary with some having participated at the junior level but not at the senior level. It is to these students with previous science fair experience and with, by implication, past experience with science fair projects, that the research looks for answers to the problem of falling participation rates in the hope that the general student population can benefit from the findings. If any group of students has the potential for entering a science fair at the senior level it should be those who have had previous science fair experience.

CHAPTER 2

Method

Introduction :

This study utilized a retrospective survey that was designed to assess students' cognitive beliefs about science and science fairs as well as some aspects of their classroom and home experiences with science. The survey was designed to look at three different periods of schooling ; elementary, junior high and senior high.

Subjects :

One hundred and six students were identified, from past records of participants in the Colchester /East Hants Regional Science Fair in grades 4, 5 and 6 in 1988 and 1989. In a follow-up search it was found that they did not participate in the Regional Fair at the senior high level several years later when they would have been eligible. Seventy eight out of a possible one hundred and six students identified completed the survey. This represents seventy four percent of the total. The seventy eight students are presently in grades 10, 11 or 12 in the Colchester/East Hants District School Board at five different high schools.

Instrument :

The instrument used in this research contains informational items to which the answers are yes or no and two open-ended questions at the end. (See appendix 5 and results section). Questions 18 - 24 of the instrument were taken from the National Assessment of Educational Progress (NAEP) survey carried out in the United States. These questions are listed in Yager and Penick (1986).

Procedure :

Permission to administer the survey was granted by the Superintendent of Schools of the Colchester/East Hants District School Board. Each principal of the participating schools provided their individual permissions. The survey was administered at two of the high schools personally by the researcher, this number of surveys gathered (approximately 75%) represented the majority of the students. The large high school in the Colchester/East Hants District was visited twice over a period of two weeks so as to avoid the disruption of removing 60 students from the classroom. At the other three high schools, volunteer teachers administered the survey. All survey participants were taken out of class to a quiet room. The students had no previous knowledge that the survey was going to be administired. The participants were given the option of declining to participate before the survey started. None chose that option. The whole exercise took about twenty minutes after which the students returned to class.

<u>Data analysis</u> :

The data was analysed using analysis of variance (ANOVA) to determine if any significant differences exist between elementary, junior high and senior high school. F values are reported for significant differences.

CHAPTER 3

Results

Respondents to the survey answered yes or no to all the questions. Table 6 shows the results of the survey (Appendix 5). Included in the table are the percentage of answers that were "yes". The responses from the survey were treated in the following way. Yes and no responses were categorised and an analysis of variance (ANOVA) was carried out on a comparison of the matching questions for elementary, junior high and senior high schools. A result indicating a significant difference between school levels will be one where "F" and "t" values are given.

Table 6 :

Survey results (percentages are given for "yes" answers)

Survey Question	**% yes for elem/ junior/senior**	**Elem. vs. jun.**	**Jun. vs. sen.**	**Elem. vs. sen.**
(1) In school I did a science fair project for class	100 / 80.5 / 45	N/A	N/A	N/A
(2) The project was mandatory	80.3 / 73.2 /67.6	NSD	NSD	NSD
(3) The project was marked and was part of my science mark	89.3 / 83.3 /78.1	NSD	NSD	NSD
(4) If I had been given a choice I would have chosen to do a science fair project	66.2 / 42.4 /46.8	F=12.7 p=.0007	NSD	F=5.07 p=.032
(5)I received encouragement when doing this project from my teacher	90.9 / 83.1 /93.1	NSD	NSD	NSD
(6)I received encouragement when doing this project from my parents	89.6 / 76.5 /77.8	NSD	NSD	NSD
(7)I received encouragement when doing this project from my friends	38.1 / 23.4 /46.1	NSD	F=5.17 p=.032	NSD
(8)I received encouragement when doing this project from my classmates	33.8 / 20.3 /29.6	NSD	NSD	NSD

Survey Question	**% yes for elem/ junior/senior**	**Elem. vs. jun.**	**Jun. vs. sen.**	**Elem. vs. sen.**
(9) In school my teacher was enthusiastic about Science Fairs	84.0 / 65.3 / 64.7	F=8.27 p=0.01	NSD	F=5.98 p=.018
(10) The kind of thought processes required to do a science fair project came easily to me	77.9 / 56.8 / 44.2	F=9.17 t= 0.012	NSD	F=27.6 $t=10^{-4}$
(11) The science fair project was done in class time only	4.0 / 2.0 / 2.0	N/A	N/A	N/A
(12) The science fair project was done wholly at home	35 / 58 / 81	N/A	N/A	N/A
(13) The science fair project was done at home and school	51.3 / 40.0 / 16	N/A	N/A	N/A
(14) I was selected for the Regional Science Fair (held at CEC)	100 / 14.0 / 4.0*	N/A	N/A	N/A
(15) (If no to q. 14) I would have liked to have been chosen for the Regional Fair	-- / 44.0 / 38	N/A	N/A	N/A
(16) I used to be/am interested in doing the following activities outside school more than occasionally : watch science programs on TV	53.9 / 43.1 / 47.8	NSD	NSD	NSD
(17) I used to be/am interested in doing the following activities outside school more than occasionally : read books about science	36.8 / 26.0 / 41.2	NSD	NSD	NSD
(18) At school the topic of science was/is fun	68.9 / 42.9 / 50.8	F=11.9 p=0.005	NSD	F=5.49 p=.022
(19) At school the topic of science was/is interesting	82.7 / 78.9 / 71.4	NSD	NSD	NSD
(20) At school the topic of science made/makes me feel successful	48.0 / 43.1 / 53.3	NSD	NSD	NSD
(21) At school the topic of science made/makes me feel curious	83.3 / 72.6 / 79.4	F=4.36 p=0.04	NSD	NSD

Survey Question	% yes for elem/ junior/senior	Elem. vs.jun.	Jun. vs. sen.	Elem. vs. sen.
(22) At school the topic of science made/makes me feel uncomfortable	5.2 / 13.7 / 19.4	NSD	NSD	F=5.05 p=0.03
(23) At school other subjects were/are, on the whole, fun	56.8 / 40.8 / 42.0	NSD	NSD	F=4.72 p=0.03
(24) At school other subjects were/are on the whole interesting	71.0 / 71.4 / 85.3	NSD	F=4.08 p=0.05	NSD

Notes. NSD = no significant data
N/A = not applicable to ANOVA treatment
*The entry marked thus is erroneous, this entry should have been zero
Elem. = elementary school, jun. = junior high school, sen. = senior high school

The second part of the survey asked the respondents to complete two open-ended statements. Question 40 a) asked for completion of the statement "one good reason why I would not do a science fair project is ...". The results are shown below in Table 7.

Table 7:

Student responses to question 40a

Reasons given**	Percentage of total
too much work/time involved	67*
can't find a topic	14
science fairs are too hard	8
no interest in science fairs	7

Notes *Percentages calculated from the number of responses for reasons given compared to the total number of reasons
**Some students provided more than one reason. All reasons given were tallied to provide total number of reasons

Question 40 b) asked the students to complete the statement "I would do a science fair project in high school if ...". The results of the responses are given in the table below.

Table 8 :

Student responses to question 40b

Reasons given**	Percentage of total
if an interesting topic could be found	33*
if the project is mandatory	30
if the project was part of the students'evaluation or if the project would elevate the students' mark	11
if prizes were given out	8

Notes *Percentages calculated from the number of responses for reasons given compared to the total number of reasons.
**Some students provided more than one reason. All reasons given were tallied to provide total number of reasons.

Since this research used a retrospective approach to data collection, the answers to the open questions are the opinions of students at the senior level. In other words when they are asked the questions regarding doing science fair projects, their answers apply to projects at the senior level. The results indicate almost 50% of the responses on the reasons for doing a project involved some sort of reward for participation or threat for non-participation. Past participants in the Colchester/East Hants sample have reported that as they move through the school system, the science fair project becomes a more challenging prospect. This trend includes the statistically significant difference between elementary school and junior high school.

Colchester/East Hants vs. National Assessment of Educational Progress data

It is appropriate here to comment on the two samples being compared as part of this research. The NAEP information was collected from respondents at the various ages reported. The Colchester Hants sample collected retrospective data from respondents who were recollecting information from previous years. The senior high school comparison (between NAEP and Colchester/East Hants) is a valid one but a caveat is necessary concerning the comparisons of elementary and junior high school. Care should be taken in comparing the NAEP elementary school results with the Colchester/East Hants elementary school results and similiarly for the junior high results as the information was collected differently for each sample. This comparison is less than ideal but under the circumstances all that could be achieved in this study.

Seven of the questions on this survey were taken from the NAEP studies in order to compare the two samples. This allowed the researcher to examine the trends with respect to a general and a purposive sample. Although a recognisable instrument that measures attitude was not used in this present research for the Colchester/East Hants sample, an indicator of attitude toward science that the researcher would like the reader to accept is the students' willingness to read books about science. (Table 9) A comparison between the two samples at the elementary level would be invalid here because the questions asked were worded slightly differently.

Many comparisons are made in this research between the results of the NAEP studies and the Colchester/East Hants sample. The reader should bear in mind the following. The age divisions in the NAEP studies are either grades 3, 7 and 11 or grades 4, 8 and 12. For the purposes of this research, when comparisons are made to the Colchester/East Hants sample, grades 3 and 4 from the NAEP studies will be deemed as equivalent to the elementary division in the Colchester/East Hants sample (actually grades 4-6) Similiarly, grades 7 and 8 (NAEP) are equivalent to the junior division (actually grades 7 & 8) and grades 11 and 12 are equivalent to the senior division (actually grades 10-12). There is no equivalent age division for NAEP that coincides with grades 9 and 10 in the Colchester/East Hants sample.

Table 9

NAEP vs Colchester/East Hants data for science activities

	Elem.	Elem.	Jun.	Jun.	Sen.	Sen.
	NAEP	CEHRS	NAEP	CEHRS	NAEP	CEHRS
Do you ever read books about science	-----	-----	35%	26%	19%	41%

Notes. NAEP : National Assessment of Educational Progress data
CEHRS : Colchester/East Hants Regional Science Fair data

The students in the Colchester/East Hants sample are more favourably disposed toward this previously mentioned indicator on science attitude than the NAEP sample at the junior and senior high level. The difference between the senior levels is greater than the difference between the junior levels. These numbers for the Colchester/East Hants sample are in fairly close agreement with the numbers of respondents who are keen on science fair projects with the exception of book reading at junior high school.

Classroom climate for the Colchester/East Hants sample was measured in terms of "fun" and "interest" and a comparison was made with the NAEP sample. There was a statistically significant drop in the responses to the question on "fun"for the Colchester/East Hants sample. Although there are no F values given for the NAEP results there is a big decline in the yes responses to the question on "fun", Table 10.

Table 10

NAEP data vs Colchester /East Hants data for science classroom attributes

	Elementary		Junior High		Senior High	
	NAEP	CEHRS	NAEP	CEHRS	NAEP	CEHRS
Science classes are fun	64%	69%	40%	43%	25%	51%
Science classes are interesting	84%	83%	51%	79%	46%	71%

Note. NAEP = National Assessment of Educational Progress data (1984)
CEHRS = Colchester/East Hants Regional Science Fair data
Percentage numbers are for "yes" responses.

The Colchester/East Hants elementary school sample compares closely with the NAEP results for the elementary school sample but after that level the samples differ. This confirms that the students in the Colchester/East Hants sample are more favourably disposed toward the topic of science as a classroom pursuit than were participants in the NAEP sample. The Colchester/East Hants students also report being more uncomfortable with academic science as they move through the school system. (Table 11) This indicator seems to agree with the acknowledgement by the students in the Colchester/East Hants sample that their academic work in science is becoming more of a challenge. The levels of discomfort for the Colchester/East Hants sample however are not as high as the NAEP sample. The NAEP data is taken from Yager and Penick (1986).

Table 11

NAEP vs. CEHRS results for successfull and uncomfortable feelings in science class

	Elementary		Junior High		Senior High	
	NAEP	CEHRS	NAEP	CEHRS	NAEP	CEHRS
Science classes make me feel successfull	59%	48%	40%	43%	30%	53%
Science classes make me feel uncomfortable	6%	5%	22%	14%	20%	19%

Note. NAEP = National Assessment of Educational Progress sample (1984)
Percentage numbers are "yes" responses.
CEHRS = Colchester/East Hants Regional Science Fair sample

CHAPTER 4

Discussion

Introduction :

This study has examined trends concerning many aspects of the science experience. It has investigated the differences in the science experience that students have encountered during their elementary, junior high and senior high school years. The discussion will attempt to explain and rationalise the phenomenon of waning interest as the students got older for those students who have had experience with science fairs at a young age . The various affective and cognitive attributes that the respondents in the Colchester/East Hants sample reported will be compared to two other trends.

First of all the Colchester/East Hants sample's responses and trends will be compared where possible to the NAEP responses and trends for curricular science and science outside the classroom. The reason for this comparison is that the Colchester/East Hants sample is a purposive one which is being compared to a random sample of students (the NAEP sample) to determine the similiarity between samples. Secondly the Colchester/East Hants sample's results for the cognitive and affective attributes with science and the same sample's home and school experiences concerning science will be compared to the respondents' motivation toward science fair projects. The reason for this is to try to establish a relationship (not strictly a correlation) between the cognitive/affective attributes, the home/school influence *and* the motivation for engaging in science fair projects. The results will be discussed following the same order as the literature review.

The student affective domain :

Attitudes toward and interest in science and science fairs :

Interest and attitude are closely related, to most people they are perceived to be the same. At an early age, for example, early elementary school, attitude and interest are indistinguishable and are corellated signigicantly, (Harty, Andersen and Enochs, 1984). Many of the studies cited in the literature review reported a decline in affective attributes toward science spanning the three levels of schooling, (James & Smith, 1985 ; Mullis & Jenkins, 1986 ; Hofstein & Welch, 1984 and Simpson & Oliver, 1990). Yager and Penick, 1986 and Goodlad, 1984 indicated a similiar downward trend in student interest in/attitude toward science.

For the senior high respondents in the Colchester/East Hants sample doing a science fair project and reading science books, which is an out-of-school activitiy, generated similiar levels of interest. Therefore an attitude toward science outside the classroom appears to be similiar to an attitude toward science fairs for senior high students. This attitude toward science is likely one that reflects their interest/attitude in extracurricular science rather than their classroom science experience. Students in the Colchester/East Hants sample show no significant differences in attitude toward/interest in classroom science across school levels. In fact there is a statistically insignificant increase in interest/attitude toward science at the senior high level compared to the junior high level.

From the results, less than half of the Colchester/East Hants sample wanted to be selected for the Regional Science Fair at the junior and senior high level. Attitude toward science fairs, as measured by students' indication of their intent in doing a science project, declined significantly between elementary school and junior high school. There was no significant difference between junior high and senior high.

For the comparison of interest in/attitude toward classroom science and science fairs between elementary and junior high school the statistically significant decline in inclination to participate in the science fair is not matched with the trend of interest in/attitude toward science, which is not significant. Therefore, lack of interest in science fair participation at the junior high school level is not a function of a declining interest in/attitude toward science.

The reader should make note that as already alluded to in the results section comparison of the two samples on identical questions (taken from the NAEP material) is less than ideal.

<u>Student motivation for doing a science project:</u>

The literature suggests that extrinsic reward decrease intrinsic motivation (Deci, 1975 ; Greene and Lepper, 1974 and Bandura, 1977). Harter's (1981) research finds a decline in motivation across the grade levels. This is in agreement with the results of the Colchester/East Hants survey where students show a decline in motivation to do a science fair project across grade levels. More than half of the students in the Colchester/East Hants sample did not want to do a science fair project at the junior high and senior high level. Caruso's (1985) work concludes that intrinsic rather than extrinsic motivation influences junior high students to participate in science fairs. Mandatory science fair projects have not created an intrinsic student interest in science fairs.

An interesting dilema seems to be emerging here. In order to increase the intrinsic enjoyment of students toward science and science fairs, teachers must not force their students to do a project. The later meta-analytic study by Cameron and Pierce (1994) indicates that extrinsic rewards do not decrease intrinsic motivation or task willingness. The latter group of authors make no mention of punishment or lack of reward as an extrinsic incentive. By implication, forcing a student to do a science fair project will not make that individual like science projects more. With attitude toward and achievement in science correlated to motivation in science it is clear that students must have the mind-set to engage in science fairs. It seems that the desire must come from the heart, from a genuine interest in science.

There would appear to be two extremes in terms of reasons for students doing science fair projects for presentation in class and for possible participation in the Colchester/East Hants Regional Science Fair. At one extreme some students will have a genuine, intrinsic interest in science . At the other extreme some students will be forced by their teachers to do a project with the threat that it is to be part of their evaluation and refusal to do a project will result in loss of marks. There could be a middle ground where a student may be reluctant to do a science fair project but once involved in the activity will begin to enjoy it. These two extremes could be thought of as a continuum .

It appears that most of the students from the Colchester/East Hants sample especially at the junior high and senior high school level did a project not because of a profound interest in science but only because it was mandatory. The incentive for most of them was that the project was part of their overall evaluation and the threat of a lower grade due to non-participation was enough to force them to participate. This is hardly a case of inspired interest in science but rather, for many, a response to a threat. Although teachers' opinions are not part of the research, their reasons for requiring students to do a piece of research would be interesting to know. Speculation on the researcher's part suggests that at the junior high level, science fair projects are assigned by teachers to try to foster an interest in science itself. Many senior high teachers feel that independent research is part of the scienctific process and that students at that level should be able to demonstrate this process.

According to the survey two thirds of the responses cite the amount of time and work involved as the main reason for not doing a science fair project. Since the question asked about science fairs in the senior years, most students would have to do these projects outside classtime. The survey in essence, is really asking students the following: Would you use up some of your free time outside school to engage in a science project because you are genuinely interested in science and motivated enough to give up other activities like part-time employment, sports and other interests? In all probablility only a minority of students would answer yes to this question.

In addition to the extracurricular activities, conscientious students are keeping themselves busy with schoolwork. In fact two of the young people mentioned earlier as previous Canada-Wide Science Fair participants who are now in grade 11 have decided to take a year off from the Colchester/East Hants Regional Science Fair because of a heavy academic load. Many students in grade twelve at the academic level are at some time during that year, planning post secondary education of some sort. For these students, who are concerned with high marks, scholarships and entry deadlines etc., the last thing many of them will want to think about is a time-consuming science project that they would have to do on their own time and on their own initiative.

The student cognitive domain :

Reasoning ability in science and participation in science fairs :

Academic subjects according to the literature are more challenging as one moves from junior high to senior high (Cantu and Herron, 1978). Much of the high school science curriculum requires a higher level of reasoning skills. Certain aspects of science fair projects as previously alluded to, require participants to use higher level reasoning skills (Yeany , Kueh and Padilla, 1986). Also, many studies have shown that formal reasoning skills are not present in all students at high school, even less so in junior high schools. (Renner, Grant and Sutherland, 1978 ; Chiapetta, 1976). Past participants in the Colchester/East Hants sample have reported that as they move through the school system, both their academic work and the work that would have to be done on a science fair project become more challenging . More than half of the respondents said that doing the science fair project would be a difficult task for them.

Appendix 3 shows the judging forms for science fair projects. A lot is expected of students who do a science project in their junior and senior high school years. On the judging forms, "scientific thought" is clearly a portion of the project evaluation that is highly valued. It may be that when students realise the level of reasoning required to do a quality science project, many will stay away from it. Given the perceived level of knowledge required, the amount of work involved to complete a science fair project at the senior level and the fact that 80% of senior students report that the science fair projects had to be done at home only, it is not surprising that many students opt not to do a science fair project given the choice.

Cognitive ability in secondary school science and ability to do a science project both require concrete and formal operational reasoning. Students at the junior high and senior high level may not be functioning at the required reasoning level to successfully undertake a science fair project. If the competition in the classroom and at the school science fair is keen then students with a higher ability in science, i.e. those who are able to use formal reasoning skills will outperform those in the science fair than who can't and those who can't, may drop the idea of doing a science project.

An apparent anomaly exists with the ability to undertake a science project at a higher grade and acquisition of formal reasoning skills. It would be reasonable to assume that as a larger number of students acquire formal reasoning skills, progressing from elementary school through to senior high school, more would be interested in or at least capable of doing a science fair project. Interest in science fairs, as previously reported however, declines. Speculation on the part of the researcher suggests that the perceived level of difficulty of a senior project is high.

Selecting a topic for a science fair project is a difficult task for most students and even though many students show an interest in a particular branch of science, choosing a topic is a challenging task. Once a topic has been selected the formalisation of the project idea into reality involves formulating hypotheses, planning an investigation and working with variables. This requires students to be operating with quite a high level of reasoning.

Science teachers at the start of every calendar year are often inundated with requests from students for science fair project topics and ideas. Until quite recently resources for project topic ideas were scarce. Recently, books and lists of project ideas have become available at local libraries and many schools now keep science fair "how to" books on their shelves. There are however, to the researcher's knowedge, significantly far more books on elementary school and junior high school science fairs than there are for senior high school projects.

There are other resources that can be sought and found and many volunteers give up their time to help students to come up with ideas. For some of the senior high students that do a science fair project, the Nova Scotia Agricultural College in Truro is a valuable resource for help and assistance. For many teachers, especially elementary teachers who might traditionally have a weak science background, finding a topic for some students in the class can be quite a challenge. From this researcher's personal experience many students at the high school level will, having been assigned a science fair project, go back to their teachers with a topic in mind and will subsequently not know how to proceed or they will have some general ideas but still require suggestions and a fair amount of assistance at various stages of the project.

Home and school influence on science and science fairs:

Classroom influence :

The classroom is generally thought of as teacher-centred and is described by Goodlad's (1984) study. These narrow range of instructional activities favouring "passive student behaviour" are activities that are "essentially becoming dominant by the fifth or sixth grade." (p.128). Students in the Colchester/East Hants sample however found their science classes more fun and interesting than their counterparts in the NAEP sample. In fact there is no significant difference among the three levels of schooling in the Colchester/East Hants sample regarding science classes with a high level of interest.

That students at the senior level find their science classes interesting presumably is a compliment to their teachers. This interest in classroom science does not translate into a desire by senior students to participate in science fairs though. The results of the survey show a significant difference between interest in/attitude toward classroom science and attitude toward science fairs in junior and senior high school. There seems to be a distinction here between two types of science interaction. This may have to do with the students' enthusiasm for engaging in an activity that is of their own initiative outside school compared to that of regular classroom science activities.

The individual science fair project is a student-centred activity where the students have an active role, i.e. an active pursuit. A passive pursuit, albeit one that generates student interest, might be sitting in a science classroom with the teacher as the director and initiator of the classroom activities. The active pursuit does not seem to be as popular as the passive one for the Colchester/East Hants sample. The literature suggests students adopt a more passive role as they move up through the school system, (Goodlad, 1984).

<u>Teacher enthusiasism :</u>

Teacher enthusiasm toward science has been shown to improve student attitude toward science (Stead et al, 1979 ; Brophy, 1986) and by implication (on this researcher's part) science fairs . Haladanya & Shaughnessy (1982) and Haladanya, Olsen and Shaughnessy (1983) lend support to the previous position with their research in saying that teacher characteristics can be used as a predictor of student attitudes. There is a significant decline in perceived teacher enthusiasm for science fairs in the

Colchester/East Hants sample comparing the elementary and junior high school responses and this may well be linked to a declining student attitude toward and interest in science fairs. This report of low teacher enthusiasm continues into the senior high years.

The question regarding teacher enthusiasm concerning science fairs is not necessarily an indictment of teachers' lack of enthusiasm in general nor is it a judgement on teachers' performance. Since the inclusion of a science fair project in elementary school and junior high school is optional, it is the teacher who makes the choice as to whether or not the members of a class will do a science fair project. For most teachers, taking a whole class through the science fair process is time consuming and often involves after- school hours for the teacher. Some teachers teach between one hundred and fifty and two hundred students, especially at the junior high level. Elementary school teachers who are with their students most of the time may have up to thirty students . This last fact together with the revelation by the Colchester East/Hants sample that half of the students were able to do *some* of the work on their science fair projects in school makes it easier on the teacher. However this still requires a lot of time and energy on the teacher's part.

The teachers who were the subject of the students' opinions may have in fact been enthusiastic about curricular science but not enthusiastic about science fairs (an optional part of the curriculum for elementary school, junior high school and most of senior high school). Students in the Colchester/East Hants sample report a high level of interest in classroom science, which must be a feather in the cap of their teachers. Enthusiasm for science fairs, however, declines significantly between elementary and junior high school, although it is still moderate.

Family involvement and science outside the classroom :

Previously cited literature, (Talton & Simpson, 1987 ; Haladanya, Olson & Shaughnessy, 1983 ; Simpson & Troost, 1982 ; Tamir, 1989 and Miller, 1988), indicates that a high science affect is possible with family involvement. Many studies have shown that for school-based academic subjects that might be found on the curriculum at any level , extracurricular activity in that subject area is correlated to an increase in ability and attitude, (Watkins & Edwards, 1992 ; Eylon et al, 1985 and Hofstein, Maoz & Rishpon, 1992). Parental encouragement for their children toward science fairs after project assignment was reported as being high for the Colchester/East Hants sample.

With science fair projects becoming a more dificult prospect as the students get older, parental help (as opposed to parental encouragement) will likely decrease and fewer students will be able to cope with the higher academic demands of a science fair project at the senior high school level. They will also be less able to rely on their parents for help and this may mean that students' enthusiasm for science fairs will decline. The four past participants of the Canada-Wide Science Fairs whose interview results were reported in the introduction section all cite parental involvement with their science experiences. The home influence, again with much written on it is a very important source of influence on children.

Other influences :

Encouragement by friends and classmates is reported as much lower than that of family and teachers at all levels of schooling. Social relationships for students at all levels of schooling are not usually on an academic basis but based more on friendship. The exception might be in the act of helping each other rather than encouraging each other. The transition between elementary school and junior high school is regarded as quite a traumatic experience for many youngsters. In the Colchester/East Hants District School Board, as with many other school boards many of the elementary schools are small. They then feed into a smaller number of larger junior high schools. therefore students have to cope with this change of environment.

Science projects and time involved :

A very small percentage of the science fair projects in the Colchester/East Hants sample were done wholly during class time at all levels. Students in the Colchester /East Hants sample claim that they have a shortage of time for any extra activities (this claim reflects their opinion for time for senior projects). At the junior high level 60% of survey respondents completed their project at home. Junior high students are not as likely to have part time employment and other large time commitments. Students at the high school level are more likely to be increasing their social committments as they mature and so their claim that they have little time for science fairs is probably genuine. It could be claimed though that if they were genuinely interested in science they would find the time for selection of and engagement in a science fair project.

Conclusions, implications and recommendations

Conclusions:

In summation of the discussion points the following broad conclusions can be drawn:

- The students in the Colchester/East Hants sample are having, or have had, a positive experience with science in the classroom, that is they find it or have found it interesting, but that does not or did not necessarily translate into an interest in a science fair project. This is especially true for the junior high and senior high school students.

- The levels of interest in/attitude toward science activities outside the classroom and interest/attitude in science fair projects for senior high students are similiar. For the Colchester/East Hants sample this was a moderate level of interest.

- A significant decline in attitude toward science fairs between elementary school and junior high school is not accompanied by a decline in attitude toward science therefore low participiton rates in science fairs at the junior high level cannot adequately be explained by interest in/attitude toward classroom science.

- Mandatory science fair projects do not encourage students to take an interest in science fairs.

• This study suggests that there is a correlation between a family committment to science/science fair projects and an interest in doing science fair projects.

• Many indicators concerning the science experience in general (choice in doing a science fair project, teacher enthusiasm for science projects, thought processes required to do a science fair project, "science is fun" and a curiosity for science) show a statistically significant drop at the junior high level with some recovery at the senior high level.

• Teacher enthusiasm and student enthusiasm for science fair projects follow the same patterns.

• As the perceived level of difficulty of science fair projects increases as the students move through the school system, the students willingness to do a science fair project decreases.

• The two samples of students that were compared (Colchester/East Hants and NAEP) are different.

<u>Implications</u>

In a study on extracurricular science activities Hofstein, Maoz & Rishpon (1992) reported that interest in and attitude toward science did not decline in students who took part in extracurricular science activities. One wonders if students should be exposed to more science outside the classroom as an intervention strategy . This is a tall order for most teachers but perhaps outside science, that is, science that is not out of a textbook, could be brought into the classroom. Extracurricular science in the classroom itself might be a possibility although time would have to made for such activities.

There are for instance many programs on television that deal with many areas of science and so the extracurricular activity does not have to be dealt with by a 'live' person. Although all students will not be reached by any intervention strategy a more positive attitude toward science might be possible with more student exposure to different science activities at the junior high and senior high levels. Upon hearing this all teachers may complain that there is barely enough time to cover the curriculum that they are supposed to.

The new curriculum that is being introduced for chemistry has associated with the regular units that are part of the 'core' curriculum, other units which incorporate the concept of science, technology and society. Students then are afforded the opportunity to integrate the 'core' material into a societal context. In other words the students apply in-class science to the real world. This in turn may provoke an increased interest in the idea of independent research.

The point has already been made that children mature cognitively at different rates and so teachers who are using science fairs in the classrooms should be aware that not all of their students will be able to do a project that involves higher level thinking. The science fair project should still be a positive experience for these children if teachers want to retain the idea of science fairs. The child who has not matured as fast as some other children, may have, with the negative experience of difficulty with the project, an indifferent attitude toward science fairs.

Teachers at any level can make the science experience for children more positive and there is a vast body of research dating back many years that advocates a more 'hands on' approach to science. This type of teaching style is reported as being more effective in promoting a healthy attitude toward science, (Shepardson & Pizzini ,1993 ; Kyle, Bonnstetter & Gadsden ,1988 ; Fouts and Myers, 1992 and Myers and Fouts ,1992). Perhaps by having the right atmosphere in the classroom and by having a classroom that is involved with practical, interesting science, students might develop an interest ib science fairs. Without publishing a set of guidelines that tells teachers what to do, that is a 'how to' manual, there are many approaches to teaching science that can promote and maintain a healthy student attitude toward science. This could include science projects and other related activities.

Teachers should have a solid background in science and an appreciation for the way that science is applied to the world outside the classroom. To quote Brophy (1986) again : "If teachers present topics or assignments with enthusiasm, suggesting that they are interesting, important or worthwhile the students are likely to adopt the same attitude" p. (25). This could be extended to science fair projects. Enthusiasm cannot be mandated but the importance of its effects can be imparted to teachers in an effort to help stimulate interest in a variety of topics. Many resources, particularly at the elementary and junior high level are available for teachers where activities are described that are designed to be more practically oriented than just textbook learning.

Limitations of the study

Sampling

Purposive as opposed to random sampling was chosen for this study. Reasons for this decision were disclosed in the introduction section. Because random sampling was not chosen however, the results can only strictly be generalised to those who have competed in a science fair. It is the position of the researcher that students who have competed in the science fair previously are of a higher ability than many of their contemporaries. The reader is being asked here to accept that the results of the research can be generalised to the student population in general.

All researchers would probably like to have larger sample sizes but given the limitations of time and access to schools it was possible only to look at a small number of students. In particular it would have been beneficial to have had access to a larger number of senior high students, this group being the one that seems to be at risk as far as interest in and participation in science fairs is concerned. A researcher with the good fortune to have full-time study available would probably be able to survey students in other school districts and pool all the Nova Scotia results together.

Recommendations for further research :

Teachers

The literature reveals that the classroom and the teacher are the biggest influences on science interest and ability. The fact that any of the students do a science project at all is almost all due to their teachers and yet this research focussed only on the students' perspective. To gain some insight into another aspect of science fairs it would be beneficial for future research if the teachers could be asked the same questions about attitudes, interests and comfort levels concerning science fairs. Just as students complained that they did not have enough time for science fairs, teachers could make the same claim. Many teachers are involved in after-school extracurricular activities that take up a lot of their time. Coaching, drama production and driver education are just a few of the varied activities that teachers find themselves participating in.

In a related study in the field of participation in sports, Gill (1986), suggests that developing positive attitudes toward sports may increase subsequent participation. Teachers should, according to Riddle (1980) focus on convincing non-participants in sports for instance of the positive effects and refute the negative effects. This is a way to increase participation in exercise programs. The same could presumably be done for science fairs.

Parents

The role of parents and their children with homework/schoolwork has been well documented but a parents' perspective on science fairs in particular would round out the picture. In particular, their comfort level in being able to give help to their children would be useful information. It is clear that parents with a higher educational background would be of more assistance to their children with science fairs as their children get older and the academic demands of the science project increased.

Dept. of Education

While curricula are not constantly being updated, changes are made every few years that are usually a result of changes in philosophies. The latest curricula to be affected are the senior high science curricula (chemistry, physics and biology). Since the Nova Scotia Department of Education does not advocate mandatory science fair projects for all students, there would seem to be no incentive to undertake any sort of intervention on science fairs. The Department of Education offers and mandates many new programs and does a lot of in-servicing of teachers. It seems likely that science fair in-servicing of teachers would be effective if the Department of Education chose to make science fairs a priority since their other initiatives in science are usually well received and effective.

Research in general

To the knowledge of the researcher and according to the literature, there have been no large scale information gathering surveys on science fairs. As has been previously stated, the Colchester/East Hants sample was a purposive one and the perspective of the general student population would be of interest. A corellational study yielding results that were more mathematically concrete than this present research yielded would be of interest to the researcher. Also as part of a larger study, an intervention exercise that attempted to increase the particiaption rates of the seniors in the district would be of interest to the researcher.

Miscellaneous Issues

Semestering

Traditionally the science fair project is done during the months of January and February with most of the judging for the class fairs taking place at the end of February/beginning of March. This schedule is maintained so that the counties/regions can have their regional science fairs at the end of March. Canada-Wide Science Fair participants are chosen at the regional fairs and the process of registering the students and chaperones for this event has to be done early so the Canada-Wide Science Fair committee can organise their event. For that reason the regional science fairs have traditionally been in March, as near to the end of the school year as possible for school systems that have had a regular (i.e. a non-semstered school year). Many school districts are now introducing or have introduced semestering at the junior and senior high levels.

The effect that this will have on scheduling science fairs is undetermined at the moment but consider the consequences. With such a long gap between the first semester ending (end of January) and the regional science fairs taking place, students who schedule their science courses for the first semester may lose interest in competing in the science fair in March. In addition to this, teachers might like as much curricular work as possible covered in class so that students have a theoretical base of knowledge to rely on before doing science investigations. With most regional fairs taking place at the end of March and with class fairs having to take place prior to the March break holiday, time is short for these students who want to do a science fair project and who opt to schedule their science course/s for the second semester. This is equivalent to barely two months regular work prior to the fair.

Science Olympics

For the past ten years or so the Science Olympics program has been in place and many teachers, especially at the junior high level involve their students in this program as an alternative to science fairs. The Science Olympics are just as the name suggests, a competition between or within schools . Students work in teams toward solving a single problem or sometimes multiple problems in science and technology. The students are challenged and this can be an enjoyable activity that has a practical use. The Science Olympics encourages teamwork and cooperation and is not quite as individualistic as the science fair is. The big advantage from the students' point of view is that the time spent on the preparation for this event is very little. For teachers the challenge is increased and preparation time would be moderate. The Science Olympics are being used by some teachers as an alternative to science fair projects.

Type of project

At various times in the recent history of science fairs, it was considered that the best projects were the ones that followed the scientific method and that students should be encouraged to do this type of project. This experiment type project involved a hypothesis and manipulation of variables, in other words 'true science'. The difficulty with this type of project for the younger students has already been alluded to in the section on reasoning abilities. Many projects at the elementary level are not experiments but innovations and studies which are appropriate at that level. At the junior and senior levels, it is the opinion of this researcher that an experimental project will receive a higher ranking than a project that is a study or an innovation assuming that the projects are of the same calibre.

Resources

One of the biggest problems for students at the beginning of the science fair 'season' has already been alluded to and that is finding a topic to study for a project. This was an answer that represented 33% of the responses to the open question at the end of the survey, (Table 7). From the researcher's experience with science fairs at the local, regional and national level the source of student project ideas varies. Some students will do a project that stems from work that has been done in class while other students will have a genuine interest in an area of science and explore that. In the researcher's own experience with science fairs students who excel at the various levels of competition, the best projects are those that are not based on the students' current academic work from the curriculum but based on a science experience outside school or at least outside the curriculum.

For students at the high school level the problem resource personnel other than the teacher potentially could be addressed by persuading resource persons or guides to donate their time and effort. Many of the top projects at the Canada-Wide Science Fair each year acknowledge the help and support of the scientific community with their projects. Students living in a metropolitan area have a distinct advantage with universities and industries being a potential source of resource personnel. A recent advertisement in the Halifax Chronicle Herald offered science supplies specifically for science fair projects. The advertisement was quoted with the words science fair clearly stated and therefore this is one resource.

Non-competitive science fairs

Many parents and teachers do not consider competition between students, particularly for younger students, a necessary part of their school experience. There are quite a number of references to non-competitive science fairs in the literature where the concept of competition is replaced with exhibition. The researcher offers no personal opinion at this time on this idea of non-competitive science fairs but leaves the reader with this. Recognition by ones peers and teachers and qualifying for regional and the Canada-Wide Science Fairs would not be possible without competition and selection of winners. This idea of non-competitive science fairs may encourage more students to enter science fairs however.

Adolescence

To say that much has been written on the subject of adolescence is a grievous understatement. Since the 1950's there has not been a more studied group in psychology and sociology. This period in a young adult's life can be turbulent and traumatic and this present research will not deal with adolescence as such. There is however a pattern to many of the trends investigated having to do with science and science fairs. Suffice to say that the academic climate and outcomes in junior and senior high probably suffer at the hands of the changing world of adolescence.

Why science fairs ?

If science fairs and all that goes with them just faded away, would anybody care? Students would still have their needs met by the curriculum, they would still do practical science in labs as they have always done. Many would still go on to university and graduate. Being forced to do a science fair project may well have turned some students off science for the rest of their lives. It seems that the majority of students in the present sample found science interesting, yet more than half would not be willing to do a science fair project.

Society though is being overwhelmed with the message that we are becoming a more technology-based world and that more scientists, technicians and engineers will be required in the future. Science , we are told is going to allow all worlds (first, second and third) to continue to prosper into the twenty first century and beyond but where are our scientists going to come from. It is the opinion of the researcher that science fairs are one way to expose young people of all ages to science. If this activity increases the interest of young people and helps to steer some who would otherwise not consider science as a career , then science fairs and science projects and all that go with them are indeed a worthwhile exercise.

During the 1995 Canada-Wide Science Fair, held in Guelph, Ontario at which the researcher was privileged to attend as a delegate/chaperone, a famous person of science spoke to the participants and delegates as a guest. This was indeed an honour to listen to a fascinating account of space travel by an individual who was also a previous participant at the Canada-Wide Science Fair in the mid-1960's. Dr. Roberta Bondar was the first Canadian female astronaut.

Chapter 5

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Appendix 1

Prizes available from the
Canada-Wide Science Fair

AWARDS

Special Awards

Instructions for self-nomination

To self-nominate for a Special Award write the 4-character code appearing by the Special Award description into section B of FORM A — CWSF Participant Registration. See page 4 for complete instructions.

Codes ending in:

1 are for juniors
2 are for intermediates
3 are for seniors
0 are open to anyone
9 cannot be classified, so read the descriptions carefully

Each participant can self-nominate for 7 awards.

Please ensure that you do not nominate yourself for an award for which you are not eligible. Verify your selections with your Regional Science Fair representative or Chief Judge.

A single project means that it is a one-person project, a team project means that it is a two-person project. Do not nominate yourself for a single-project award when you are a team.

IMPORTANT
Be sure to talk over the timing and location of the trips with your parents. If you do not want to be considered for a trip, or any other award, please do **not nominate yourself.**

SUBJECT AREA	CODE	AWARD DESCRIPTION
Acoustics	CAA0	Criteria: Outstanding project related to acoustics Award: $400 cash Sponsor: Canadian Acoustical Association
Agriculture M	AIC1 AIC2 AIC3	Criteria: Outstanding junior project depicting agricultural science Outstanding intermediate project depicting agricultural science Outstanding senior project depicting agricultural science Award: $100 cash (junior), $100 cash (intermediate), $300 cash (senior) Sponsor: Agricultural Institute of Canada
Atmosphere	ATM3	Criteria: Outstanding senior project related to atmospheric chemistry Award: $300 cash Sponsor: Canadian Institute for Research in Atmospheric Chemistry
Biological & Medical Sciences	BMS2	Criteria: Outstanding intermediate project showing excellence in planning and design of a biomedical experiment, innovation or study of diagnostic relevance in the area of laboratory science Award: $250 cash Sponsor: Canadian Society of Laboratory Technologists
Chemistry	CHM2 CHM3	Criteria: Outstanding intermediate project related to chemistry Outstanding senior project related to chemistry Award: $250 cash (intermediate), $500 cash (senior) Sponsor: The Chemical Institute of Canada

JUDGING PROCESS

Screening

Projects are classified by division, category and type. These classifications are decided before judging begins to assist in matching judges to exhibits.

When registering for the CWSF, the exhibitor, with the help of their delegate, will decide on division placement.

Before the CWSF, the Chief Judge will examine each project summary and will determine if the project has been properly placed. If the Chief Judge feels an error has been made regarding division placement, he/she will make a recommendation to the exhibitor and the delegate.

National Youth Science Awards Program

CWSF Awards 1995

1. Grand Awards Judging
The concept of Grand Awards is reletively new and responds to YSF Canada's need to identify a pool of the best science projects in Canada, as represented at the CWSF, to fulfil a growing need for national recognition and international competition.

Grand Award recipients are selected by a special panel of YSF Canada judges headed by the National Judge-in-Chief. Eligibility will be determined by a number of factors including: rigorous scientific merit, medal standing as determined by the CWSF '95 Chief Judge / Judging Subcommittee, age and project criteria, as specified.

Certain Grand Awards involve international travel and commitments which will require the recipient(s) to be absent from school/university for up to two weeks. This commitment will be determined by self-nomination. Students wishing to self-nominate for these awards should do so with parental approval.

2. Division Awards Judging
A judging team will evaluate a specific group of projects in the same division and category on an individual basis. Judging is a two-step process. First, judges will read project summaries and view the exhibit without students being present. In the second part of judging, students are present at their exhibit. The interviews are the most important part of the process and approximately 30 minutes will be allocated for each one. Plan to describe your project in about 10-15 minutes and be prepared for the judges to ask questions. All judges then submit the scores to the Chief Judge or Division Chairperson. The ranking in each division and category will then be determined on the basis of these scores and subjective interaction among the judges. Medals and cash prizes will be allocated according to current YSF Canada policy, based on merit and at the discretion of the CWSF '95 Awards Committee.

The divisions are:
- Physical Sciences
- Life Sciences
- Engineering
- Computer Technology

Each division will be divided into three categories:
- Junior (Grades 7-8; Secondary I & II in Quebec)
- Intermediate (Grades 9-10; Secondary III & IV in Quebec)
- Senior (Grades 11-12 and OAC; Secondary V, CÉGEP I in Quebec)

In each division and category, the following guide is used:

2 exhibits	Gold	\$400.00 + Certificate
3 exhibits	Silver	\$300.00 + Certificate
4 exhibits	Bronze	\$200.00 + Certificate
10 exhibits	Honourable Mention	Certificate

3. Special Awards Judging
Special Awards are based strictly on criteria established by the sponsor. Students must self-nominate for these awards when registering for the CWSF. Special Awards judges (usually appointed by the sponsor) will spend approximately 10 minutes with your project. Plan to tell him/her what you did and why you deserve the award in about 5 minutes to leave some time for questions.

SUBJECT AREA	CODE	AWARD DESCRIPTION
Chemical Process	DPC0	Criteria: Outstanding project with a creative approach to chemical processes Award: $1,000 cash Sponsor: DuPont Canada Inc.
Computer Technology	IBM0	Criteria: Project deemed to have used computer technology to the best advantage Award: IBM personal computers will be awarded to the winning student(s) and to the school(s) of the winning student(s) Sponsor: IBM Canada Limited
Development	DVL0	Criteria: Outstanding projects related to an issue or problem relevant to developing countries. **Note:** Children of IDRC employees or of those whose work is partially funded by the IDRC are not eligible for this award Award: $500 cash (best), $300 cash (second best) Sponsor: International Development Research Centre (IDRC)
Earth Sciences	~~GAC0~~	Criteria: Outstanding project related to earth sciences Award: $750 cash Sponsor: Geological Association of Canada
Energy	AEC0	Criteria: Outstanding projects related to energy and the environment (this award is also listed under environment) Award: Three $1,500 cash prizes Sponsor: AECL Research
	TCP3	Criteria: Outstanding senior project involving energy and the environment Award: $500 cash Sponsor: TransCanada Pipelines
Engineering	AIR3	Criteria: Outstanding single senior engineering project Award: Two return hospitality service tickets to any destination served by Air Canada worldwide (some exceptions may apply) Sponsor: Air Canada
	CPE1 CPE2 CPE3	Criteria: Outstanding junior project related to engineering Outstanding intermediate project related to engineering Outstanding senior project related to engineering Award: $200 cash (junior), $300 cash (intermediate), $500 cash (senior) Sponsor: Canadian Council of Professional Engineers
	CTT2	Criteria: Outstanding intermediate project related to engineering Award: $500 cash & plaque for winner, plaque for his/her school Sponsor: Canadian Council of Technicians and Technologists

SUBJECT AREA	CODE	AWARD DESCRIPTION
Engineering (continued)	EIC1	Criteria: Outstanding junior engineering projects Award: $300 cash (best), $150 cash (second best) Sponsor: Engineering Institute of Canada - Life Members' Organization
	QUE0	Criteria: Outstanding project displaying the most practical approach to the solution of an engineering problem Award: $300 cash Sponsor: Queen's University - Faculty of Applied Science
Environment	AEC0	Criteria: Outstanding projects related to energy and the environment (this award is also listed under energy) Award: Three $1,500 cash prizes Sponsor: AECL Research
	SHL3	Criteria: Outstanding senior project that best exemplifies sustainable development Award: Winner will receive an expense-paid trip to the London International Youth Science Forum (July 26 - Aug. 9, 1995) and a $500 scholarship Sponsor: Shell Canada Limited
Innovation	MAN3	Criteria: Outstanding senior innovation projects Award: Eight projects will each receive a $500 cash award. Each project will then be considered a semi-finalist for the $4,000 Young Canadian Awards, which will be awarded later to four Manning Innovation Achievement Award winners . Sponsor: The Manning Awards
Life Sciences K	CFB2	Criteria: Outstanding intermediate projects related to life sciences Award: $300 cash (best), $200 cash (second best) Sponsor: Canadian Federation of Biological Societies
Microbiology K	CSM0	Criteria: Outstanding project relating to microbiology Award: $200 cash Sponsor: Canadian Society of Microbiologists
Miscellaneous	WZM9	Criteria: Outstanding single senior projects. The student must be in his/her final year of high school (OAC in Ontario and CEGEP I in Quebec) Award: *The Joseph Kerbel Scholarship & The Arthur Beatrice Minden Scholarship* Two trips for a four-week summer science program at the Weizmann Institute in Israel, July 12 - August 11, 1995 Sponsor: Canadian Society for the Weizmann Institute of Science
K J M	DOW9	Criteria: Best-communicated junior or intermediate projects Award: Ten prizes of $500 to the student and $500 to the sponsoring region for travel to future CWSFs Sponsor: Dow Chemical Canada Inc.

SUBJECT AREA	CODE	AWARD DESCRIPTION
Miscellaneous (continued)	GUL0	Criteria: None Award: Two $500 scholarships Sponsor: Gulf Canada Resources Limited
	IMT0	Criteria: Outstanding single project for student showing greatest potential as a researcher Award: $250 cash Sponsor: Intra Madison Travel
	XRX3	Criteria: Outstanding senior project Award: $500 scholarship Sponsor: Xerox Canada Inc.
Physics	PHY1 PHY2 PHY3	Criteria: Outstanding junior project related to physics Outstanding intermediate project related to physics Outstanding senior project related to physics Award: $250 cash (junior), $250 cash (intermediate), $250 cash (senior) Sponsor: Canadian Association of Physicists
Plant Science	CBA0	Criteria: Outstanding plant science exhibit Award: $250 cash Sponsor: Canadian Botanical Association
Psychology	PSY1 PSY2 PSY3	Criteria: Outstanding junior project related to psychology Outstanding intermediate project related to psychology Outstanding senior project related to psychology Award: $150 cash (junior), $200 cash (intermediate), $300 cash (senior) Sponsor: Canadian Psychological Association
Pulp & Paper	PPA0	Criteria: Outstanding project related to the pulp and paper industry Award: $250 cash Sponsor: Canadian Pulp and Paper Association
Telecommunications	TCP1	Criteria: Outstanding junior project utilizing computers and/or telecommunications Award: $500 cash Sponsor: TransCanada Pipelines

NOTE: If the project is completed by two students, prize money will be shared. Scholarships are paid to the winner's university upon receipt of proof of registration.

Grand Awards

Grand Awards recognize the best of the best. Winners of the Best Junior, Intermediate and Senior Projects in the Fair are chosen from among the gold medallists. They receive a \$1,000 scholarship from prize sponsor Rockwell International of Canada Ltd. One of these projects is then named Best Overall Project in the Fair. The award is a \$2,000 scholarship sponsored by YSF Canada. No **self-nomination is required.**

Other Grand Awards involve travel and a significant time commitment. If you meet the criteria described and would like to be considered for Team Canada or the trips to Japan and Stockholm, self-nominate by writing the 4-character code appearing by the Grand Award description into section B of FORM A — CWSF Participant Registration.
Please note that Grand Awards will be selected from among the Bronze, Silver and Gold medallists.

NAME	CODE	AWARD DESCRIPTION
Team Canada — Science '96	TCAN	Criteria: 1. Be a high school student registered in Grade 9 to O.A.C. (or Secondary III to CÉGEP I in Quebec) in May 1996. 2. Be between the ages of 12 and 21 in May 1996. 3. Commit to prepare and exhibit as a member of Team Canada at U.S.-based International Science and Engineering Fair (ISEF), if selected. 4. The project must have the potential to be further developed in a second phase. Award: An expense-paid trip to ISEF '96 in Tucson, Arizona (May 1996). Participants will be eligible for ISEF '96 Grand Awards, Special Awards and scholarships with an estimated value of \$1,000,000. Sponsor: Youth Science Foundation Canada Note: Team Canada–Science '96 members will not be eligible to attend CWSF '96.
Stockholm International Youth Science Seminar	SIYS	Criteria: 1. Be between the ages of 18 and 24 as of December 4, 1995. 2. Candidates who have previously attended the Seminar will not be considered. Award: Registration and attendance at the 20th Stockholm International Youth Science Seminar, Stockholm, Sweden, December 4-11, 1995. Seminar held in connection with the Nobel Prize Ceremony and Festivities. Sponsor: Shell Canada Limited
Canada-Japan Science and Technology Award	JAPN	Criteria: 1. Be in the Intermediate and Senior categories (grade 9 or higher). 2. Be available to spend one to two weeks in Japan in early November 1995. 3. Be prepared to take your project with you to Japan. Award: Three expense-paid trips to Japan to showcase Canadian science and technology excellence and to study Japanese science and technology achievements first hand. Sponsor: Government of Canada *Selection Process:* Projects from all four divisions are eligible, however special attention will be given to those that focus on any one of the following areas: advanced materials and biomaterials; biotechnology and biosciences; oceanography and ocean engineering; space science, technology and cosmology; advanced manufacturing, microelectronics, communications and photonics; or sustainable development and environmental management.

Appendix 2

Prizes available from the
Colchester/East Hants Science Fair

Categories are:
- **Junior** (Grades 7-8, Secondary I and II in Quebec)
- **Intermediate** (Grades 9-10, Secondary III and IV in Quebec)
- **Senior** (Grades 11-13, Secondary V and CÉGEP I in Quebec)

AWARDS AND SPONSORS

AECL RESEARCH AWARD
(Sponsored by AECL Research)
- **Criteria:** To be awarded to a student or students who will be representing their regional science fair at the Canada-Wide Science Fair.
- **Eligible Categories:** Junior, Intermediate or Senior
- 1 prize per region, 1 or 2 students per project

Award: Certificate plus $100 (where the project is completed by two students, money will be shared)

SCIENCE AND DEVELOPMENT AWARD
(Sponsored by the International Development Research Centre)
- **Criteria:** The project should relate to an issue or problem relevant to developing countries.
- **Eligible Categories:** Junior, Intermediate or Senior
- 1 prize per region, 1 or 2 students per project

Award: Certificate plus a hand-crafted gift from a developing country

Special Note: Children of IDRC employees or of those whose work is partially funded by the IDRC are not eligible for this award.

IBM COMPUTER TECHNOLOGY AWARD
(Sponsored by IBM Canada Ltd.)
- **Criteria:** The best application of computer technology to support a project *or* the best computer hardware/software design innovation.
- **Eligible Categories:** Junior, Intermediate or Senior
- 1 prize per region, 1 or 2 students per project

Award: Trophy plus a software package

PEACE FROM SCIENCE AWARD
(Sponsored by Science for Peace)
- **Criteria:** The project should demonstrate relief of world tensions through an application of science.
- **Eligible Categories:** Junior, Intermediate or Senior
- 1 prize per region, 1 or 2 students per project

Award: Certificate plus book

THE CHEMICAL INSTITUTE OF CANADA AWARD
(Sponsored by the Chemical Institute of Canada)
- **Criteria:** The project should deal with a chemical topic or process.
- **Eligible Categories:** Junior, Intermediate or Senior
- 1 prize per region, 1 or 2 students per project

Award: Certificate plus subscription to magazine

ENERGY CONSERVATION AND RENEWABLE ENERGY AWARD
(Sponsored by the Solar Energy Society of Canada Inc.)
- **Criteria:** Best overall project on energy conservation, active or passive solar, photovoltaic, wind and earth energy.
- **Eligible Categories:** Junior, Intermediate or Senior
- 1 prize per region, 1 or 2 students per project

Award: Certificate plus subscription to magazine and membership to the Solar Energy Society of Canada

THE EDISON SOCIETY STUDENT ACHIEVEMENT AWARDS
(Sponsored by the Edison Society)
- **Criteria:** Four outstanding projects in each of the four divisions: Life Sciences, Physical Sciences, Engineering and Computer Technology.
- **Eligible Categories:** Junior, Intermediate or Senior
- 16 prizes per region, 1 or 2 students per project

Awards:

1st	Plaque
2nd	Medallion
3rd	Silver Medal
4th	Bookmark

Appendix 3

Sample judging forms for science fairs

CANADA WIDE SCIENCE FAIR

MAY 13-19, 1990

University of Windsor

JUDGING FORM

____

TOTAL MARK

PROJECT #:____ LANGUAGE:___
ENTRANT:________________________
PARTNER:________________________
CATEGORY:___ DIVISION:____ TYPE:____
PROJECT TITLE:__________________
JUDGE:__________________________

"EXPERIMENT TYPE OF PROJECT" - An investigation undertaken to test a specific hypothesis using experiments. Experimental variables, if identified, are controlled to some extent.

PART A: SCIENTIFIC THOUGHT (Maximum 45 marks)

Level 1 - Duplicating of a known experiment to confirm the hypothesis. The hypothesis is totally predictable.

5 MARKS MANDATORY (Maximum 15/45)

\+ 0 1 2 3 4 5 6 7 8 9 10

Level 2 - Extend a known experiment through modification of procedures, data gathering and application.

15 MARKS MANDATORY (Maximum 25/45)

\+ 0 1 2 3 4 5 6 7 8 9 10

Level 3 - Devise and carry out an original experiment with controls. Variables are identified. Some significant variables are controlled. Data analysis includes graphic representation with simple statistics.

25 MARKS MANDATORY (Maximum 35/45)

\+ 0 1 2 3 4 5 6 7 8 9 10

Level 4 - Devise and carry out original experimental research which attempts to control or investigate most significant variables. Data analysis includes statistical analysis.

35 MARKS MANDATORY (Maximum 45/45)

\+ 0 1 2 3 4 5 6 7 8 9 10

PART B: ORIGINAL CREATIVITY (Maximum 25 marks)

1. Topic originality	5	4	3	2	1	0
2. Originality in approach	5	4	3	2	1	0
3. Resourceful use of equipment and information services	5	4	3	2	1	0
4. Creativity in interpretation of data	5	4	3	2	1	0
5. Judge's discretion	5	4	3	2	1	0

PART C: SKILL (Maximum 10 marks)

1. Necessary scientific skill shown	3	2	1	0
2. Exhibit well constructed	3	2	1	0
3. Material prepared independently		2	1	0
4. Judge's discretion		2	1	0

PART D: DRAMATIC VALUE (Maximum 10 marks)

1. Layout logical and self-explanatory	3	2	1	0
2. Exhibit attractive	3	2	1	0
3. Presentation by student clear, logical and enthusiastic	3	2	1	0
4. Judge's discretion			1	0

PART E: PROJECT SUMMARY (Maximum 10 marks)

1. Has all the required information been provided?	3	2	1	0
2. Is the information in the specified format?			1	0
3. Is the information presented clearly with continuity?		2	1	0
4. Does the summary accurately reflect the actual project?		2	1	0
5. Presentation (Neatness, grammar spelling in report)		2	1	0

A GUIDELINE FOR SCIENTIFIC THOUGHT JUDGING (MAXIMUM 45 MARKS)

EXPERIMENT TYPE OF PROJECT	STUDY TYPE OF PROJECT	INNOVATION TYPE OF PROJECT
DEFINITION: An investigation undertaken to test a specific hypothesis using experiments. Experimental variables, if identified, are controlled to some extent.	DEFINITION: A collection and analysis of data to reveal evidence of a fact, situation or pattern of scientific interest. It could include a study of cause and effect relationships or theoretical investigations of scientific data. Variables, if identified, are by their nature not feasible to control, but an effort to make meaningful correlations is encouraged.	DEFINITION: Involving the development and evaluation of innovative devices, models or techniques or approaches in fields such as technology, engineering, or computers (both hardware and software).
EXPERIMENT Level 1	**STUDY Level 1**	**INNOVATION Level 1**
Duplicating of a known experiment to confirm the hypothesis. Hypothesis is totally predictable.	Study of existing printed material related to the basic issue.	Building models (devices) to duplicate existing technology.
5 + 1,2,3,4,5,6,7,8,9 or 10	5 + 1,2,3,4,5,6,7,8,9 or 10	5 + 1,2,3,4,5,6,7,8,9 or 10
EXPERIMENT Level 2	**STUDY Level 2**	**INNOVATION Level 2**
Extend a known experiment through modification of procedures, data gathering and application.	Study of material collected through compilation of existing data and through personal observations. Display attempts to address a specific issue.	Make improvements to, or demonstrate new applications for existing technological systems or equipment and be able to justify them.
15 + 1,2,3,4,5,6,7,8,9 or 10	15 + 1,2,3,4,5,6,7,8,9 or 10	15 + 1,2,3,4,5,6,7,8,9 or 10
EXPERIMENT Level 3	**STUDY Level 3**	**INNOVATION Level 3**
Devise and carry out an experiment with an original approach or design. Variables are identified. Some significant variables are controlled. Data analysis includes graphic presentation with simple statistics.	Study based on observations and literary research illustrating various options for dealing with a relevant issue. Appropriate arithmetic, graphical or statistical analysis in relation to some significant variable(s).	Design and build innovative technology or provide adaptations to existing technology that will have economic applications and/or human benefit.
25 + 1,2,3,4,5,6,7,8,9 or 10	25 + 1,2,3,4,5,6,7,8,9 or 10	25 + 1,2,3,4,5,6,7,8,9 or 10
EXPERIMENT Level 4	**STUDY Level 4**	**INNOVATION Level 4**
Devise and carry out original experimental research which attempts to control or investigate most significant variables. Data analysis includes statistical analysis.	Study correlating information from a variety of significant sources which may illustrate cause and effect or original solutions to current problems through synthesis. Significant variable(s) identified with in-depth statistical analysis of data.	Integrate several technologies, inventions or designs and construct an innovative technological system that will have commercial and/or human benefit. Testing where applicable with statistical analysis.
35 + 1,2,3,4,5,6,7,8,9 or 10	35 + 1,2,3,4,5,6,7,8,9 or 10	35 + 1,2,3,4,5,6,7,8,9 or 10

SCIENTIFIC THOUGHT MARK: (MAXIMUM 45) ____

CANADA WIDE SCIENCE FAIR

MAY 18-19, 1990

University of Windsor

JUDGING FORM
STUDY

TOTAL MARK

PROJECT #:_____ LANGUAGE:___
ENTRANT:____________________________
PARTNER:____________________________
CATEGORY:__ DIVISION:_____ TYPE:_____
PROJECT TITLE:____________________________
JUDGE:____________________________

"STUDY" - A collection and analysis of data to reveal evidence of a fact or a situation of scientific interest. It could include a study of cause and effect relationships involving ecological, social, political or economic considerations; in depth studies; theoretical investigations. Variables, if identified, are by their nature not feasible to control.

PART A: SCIENTIFIC THOUGHT (Maximum 45 marks)

Level 1 - Study of existing printed material related to the basic issue.

5 MARKS MANDATORY (Maximum 15/45)

+ 0 1 2 3 4 5 6 7 8 9 10

Level 2 - Study of material collected through compilation of existing data and through personal observations. Display attempts to address a specific issue.

15 MARKS MANDATORY (Maximum 25/45)

+ 0 1 2 3 4 5 6 7 8 9 10

Level 3 - Study based on observations and literary research illustrating various options for dealing with a relevant issue. Appropriate arithmetic, graphical or statistical analysis in relation to some significant variable(s).

25 MARKS MANDATORY (Maximum 35/45)

+ 0 1 2 3 4 5 6 7 8 9 10

Level 4 - Study correlating information from a variety of significant sources which may illustrate cause and effect or original solutions to current problems through synthesis. Significant variable(s) identified with in-depth statistical analysis of data.

35 MARKS MANDATORY (Maximum 45/45)

+ 0 1 2 3 4 5 6 7 8 9 10

PART B: ORIGINAL CREATIVITY (Maximum 25 marks)

1. Topic originality	5	4	3	2	1	0
2. Originality in approach	5	4	3	2	1	0
3. Resourceful use of equipment and information services	5	4	3	2	1	0
4. Creativity in interpretation of data	5	4	3	2	1	0
5. Judge's discretion	5	4	3	2	1	0

PART C: SKILL (Maximum 10 marks)

1. Necessary scientific skill shown	3	2	1	0
2. Exhibit well constructed	3	2	1	0
3. Material prepared independently		2	1	0
4. Judge's discretion		2	1	0

PART D: DRAMATIC VALUE (Maximum 10 marks)

1. Layout logical and self-explanatory	3	2	1	0
2. Exhibit attractive	3	2	1	0
3. Presentation by student clear, logical and enthusiastic	3	2	1	0
4. Judge's discretion			1	0

PART E: PROJECT SUMMARY (Maximum 10 marks)

1. Has all the required information been provided?	3	2	1	0
2. Is the information in the required format?			1	0
3. Is the information presented clearly with continuity?		2	1	0
4. Does the summary accurately reflect the actual project?		2	1	0
5. Presentation (Neatness, grammer spelling in report)		2	1	0

JUD 6-11-90

CANADA WIDE SCIENCE FAIR

MAY 18-19, 1990

University of Windsor

JUDGING FORM

INNOVATION

TOTAL MARK

PROJECT #:____ LANGUAGE:___
ENTRANT:______________________________
PARTNER:______________________________
CATEGORY:__ DIVISION:_____ TYPE:_____
PROJECT TITLE:________________________
JUDGE:________________________________

"INNOVATION" – Involving the development and evaluation of innovative devices, models or techniques or approaches in fields such as technology, engineering, or computers (both hardware and software).

PART A: SCIENTIFIC THOUGHT (Maximum 45 marks)

Level 1 – Building models (devices) to duplicate existing technology.

5 MARKS MANDATORY (Maximum 15/45)

+ 0 1 2 3 4 5 6 7 8 9 10

Level 2 – Make improvements to, or demonstrate new applications for existing technological systems or equipment and be able to justify them.

15 MARKS MANDATORY (Maximum 25/45)

+ 0 1 2 3 4 5 6 7 8 9 10

Level 3 – Design and build innovative technology or provide adaptations to existing technology that will have economic applications and/or human benefit.

25 MARKS MANDATORY (Maximum 35/45)

+ 0 1 2 3 4 5 6 7 8 9 10

Level 4 – Integrate several technologies, inventions or designs and construct an innovative technological system that will have commercial and/or human benefit.

35 MARKS MANDATORY (Maximum 45/45)

+ 0 1 2 3 4 5 6 7 8 9 10

PART B: ORIGINAL CREATIVITY (Maximum 25 marks)

1. Topic originality	5	4	3	2	1	0
2. Originality in approach	5	4	3	2	1	0
3. Resourceful use of equipment and information services	5	4	3	2	1	0
4. Creativity in interpretation of data	5	4	3	2	1	0
5. Judge's discretion	5	4	3	2	1	0

PART C: SKILL (Maximum 10 marks)

1. Necessary scientific skill shown	3	2	1	0
2. Exhibit well constructed	3	2	1	0
3. Material prepared independently		2	1	0
4. Judge's discretion		2	1	0

PART D: DRAMATIC VALUE (Maximum 10 marks)

1. Layout logical and self-explanatory	3	2	1	0
2. Exhibit attractive	3	2	1	0
3. Presentation by student clear, logical and enthusiastic	3	2	1	0
4. Judge's discretion			1	0

PART E: PROJECT SUMMARY (Maximum 10 marks)

1. Has all the required information been provided?	3	2	1	0
2. Is the information in the specified format?			1	0
3. Is the information presented clearly with continuity?		2	1	0
4. Does the summary accurately reflect the actual project?		2	1	0
5. Presentation (Neatness, grammar spelling in report)		2	1	0

JUD 6-12-90

<u>Appendix 4</u>

Excerpt from the Nova Scotia
Department of Education Curriculum
Guide for Junior High Science

Optional Topic 7:5

SCIENCE FAIR

INTRODUCTION

A science fair or annual project is unlike other projects that a student has completed. It combines as many skills as possible in its development over an extended time period. The results of the project probably will not be as important as the steps that the student took to complete the science investigation. This is a creative experience for the student and it will take time for the growth and development to occur. The role of the teacher is one of promoting creativity, self-confidence, co-operation, honesty and responsibility in investigations, and appreciation of the process of scientific investigations.

Learning Outcomes

The student will be able to:

- develop enthusiasm for science investigations;
- understand that creativity is part of the scientific process;
- improve their level of self-confidence;
- appreciate the need for co-operation in scientific investigations;
- realize that challenges exist and appropriate rewards are there for individual work;
- understand the need for honesty and responsibility when performing an investigation;
- plan and carry out a logical approach to solving a problem;
- use science skills and processes in a safe manner;
- use daily experiences to show application of scientific principles;
- describe the progress of an investigation using proper recording methods;
- define and use scientific terms such as variable and control;
- develop oral communication skills

Planning a Science Fair

There are three phases of planning a science fair: Project Definition; Research; and Presentation. Careful planning is essential. Teacher support and encouragement are required at each stage.

Project Definition:

1. Decide at what depth the science fair will be conducted: small

group, class, classes, school. As a rule, start small and progress to something larger. Formal judging may not be required for a first effort.

2. Secure the reference materials which are available from the Youth Science Foundation and check to see that appropriate resource books are available in the library. A library display of suitable references for science fairs is recommended.

3. Choose the fair date and the date on which the students should complete each phase. Be sure that students are well aware of these dates and what must be submitted on each of them.

4. Spend some time introducing a list of potential ideas for science fair projects. Maintain a growing list of science fair topics as the year progresses. Relate science fair topics to the subjects being studied. Lists of projects from other fairs, resource books, filmstrips, and videos are all helpful. Using students' hobbies, their parents' occupations and local resource persons may be also be helpful.

5. A sample project should be demonstrated so that students will be familiar with the end goal. Using an investigative approach should be encouraged. A student who is enthusiastic and successful in science fairs may be available to describe a project to less experienced students.

6. A list of the processes and skills needed should be highlighted and taught if necessary. This would include: hypothesizing (a statement which will describe the project); experimenting (collecting the data by reading and doing activities); presentation (includes making inferences and organizing them so that they can be clearly presented).

7. The judging criteria which will be used should be provided to students. A typical "Judge's Tally Sheet" is provided on page 45. This may need to be adapted if students are not familiar with science fairs. Note the several aspects of the project: submitted report; thought; ability; skills oral presentation; and construction of project.

8. Inform parents by means of a letter or though a parents' night presentation so that they will know what is expected of the students and how they may assist.

9. A brief report should be presented by each student at the end of this phase, which would include the project title, hypothesis, and an outline of the research to be undertaken.

Research Phase

1. During the research phase, the original hypothesis may have to be revised. Students need to be reminded that in scientific research most of the time (90+%) is spent in experimenting that

is unsuccessful. Good projects are usually those that are based on a simple hypothesis, careful reading of background material, and simple experiments.

2. During this phase, teachers will be needed to provide equipment and may need to supplement laboratory time. There should be formal and informal discussio so that "dead ends" can be avoided. Encouragement when projects are not proceeding smoothly may be needed.

3. A submitted report should be required at the end of this phase.

Presentation Stage

1. Usually a table top, free standing display unit is used to present the project (See references for ideas and specifications.)

2. Students can gain experience by presenting their project first to their peers before the judging takes place.

3. Encouraging criticism should be provided as necessary to ensure that students speak clearly and concisely, have the background necessary to answer questions and present themselves with confidence.

Judging

Judges should be secured from interested members of the science community: meterologists, medical workers, research scientists and teachers from universities and schools. Parents and acquaintances of parents are often available.

Clear instructions should be provided for the judges: the criteria to be used, the assigned projects and where to find them, and the prize list. A room should be provided where final decisions can be made.

Non-Investigative Projects

Science fair projects are expected to be investigative in nature: a problem which the student defines, researches both in the literature and in the laboratory, and which is then reported as a demonstration with poster backup. These are the only projects which are expected to win regional fairs and which can be exhibited at Canada-Wide Science Fairs.

Non-investigative projects which report, in poster form, or demonstrate, well known science concepts are frequently useful in encouraging students to develop an interest in science and to enable students to receive many of the learning outcomes of science fairs. While this type of project should probably not be encouraged by being given awards, it has become a significant part of most local science fairs.

One of the Regional Science Fairs has solved the problem of awards by dividing all entries into "Investigative" and "Non-investigative" categories and awarding prizes for both groups. Only winners in the "Investigative"category are eligible for the Canada-Wide Fair.

Financial Support

Financial support for science fairs is required for the program, prizes and promotion. It is usually solicited from local businesses, the local of the Nova Scotia Teachers Union, the school board, and the school student council. Grants are available from the Association of Science Teachers for both local and regional fairs.

Time Schedule

Suggested time schedule for a science fair in which students will be proceeding to a Regional Fair:

December - Report on "Project Definition"
February - Report on "Research Phase"
March - Local Science Fair
April - Regional Science Fair
May - Canada Wide Science Fair

Other Activities tc Encourage Participation in Science

Some teachers may not wish to organize a full-fledged science fair and would like a less rigorous beginning to reach this goal. Science Olympics or Science Safari may be the answer and are in themselves very worthwhile activities.

Science Olympics are projects which are set up competitively in a classroom, school or district. They are often held at science fairs and may be part of a teaching unit. For example, at the end of a unit on "Forces" you may challenge students to see who can build the strongest bridge made from toothpicks and glue, 30 cm in length. The Association of Science Teachers Conference has had such a competition, and also one based on flying paper airplanes.

OPTIONAL TOPICS - GRADE 7

Science Safari is a series of activities described in several resource books for which national awards are available. These are sponsored by the Youth Science Foundation (address below).

The Invention Convention provides an opportunity for pupils to practise problem solving skills, creative thinking and experimenting (address below).

Either an Olympics or the Safari is excellent preparation for students for later participation in science fairs.

Resources

1. Other science fairs and their organizers.

2. Youth Science Foundation,
   Suite 805,
   151 Slater Street,
   Ottawa, Ontario,
   K1P 5H3
   (613) 2380-1671

   A series of pamphlets:

   Science Fair Organization
   Science Fair Judging
   Science Fair Regulations
   Science Fair Project Ideas
   Science Clubs
   Science Olympics - Organization & Events, Volumes I and II
   Science Fair Certificates for Schools

3. Nuts and Bolts. B. VanDeman and E. McDonald, The Science Man Press, Harwood Heights, Illinois, 60056.

4. Videos - Media Services, Nova Scotia Department of Education

5. The Invention Convention; Valentine, c.; Silver Burdett; 1984.

JUDGE'S TALLY SHEET - This tally sheet is the type used for regional and national fairs and can be adapted for local use. Note that it is heavily weighted for investigative projects.

Exhibit Title: ____________________ Exhibit Number: __________

Exhibitors: (1) ____________________ (2) ____________________

Scientific Thought	Level 5: An attempt to design and conduct an experiment or study with all important variables controled.	Level 4: Similar to 5, with one or more variables tested, but with inadequate control of significant variables.	Level 3: A working model based on an understanding of a scientific principle.	Level 2: A chart, model, collection, specimen, or report based on first hand investigations.	Level 1: A diagram, copy, illustration, or other display of information already available.
30	30 29 28 27 26	25 24 23 22 21	20 19 18 17 16	15 14 13 12 11	10
Creative Ability	Imaginative, resource-ful, novel approach, creative design, and use of equipment.	Standard approach and good treatment of current topic.	Incomplete and unimaginative use of resources.	Lack of creativity in both topic and resources.	
20	20 19 18	17 16 15	14 13 12	11 10 9	
Student Skill	Excellent quality and workmanship.	Good quality and work-manship.	Average quality and workmanship.	Below average quality and workmanship.	Poor quality and workmanship.
5	5	4	3	2	1
Dramatic Value	Excellent use of all media to focus attention.	Good use of all media to focus attention.	Poor use of media to focus attention on topic.	Some material used here.	
5	5 4	3	2	1	
Oral Presentation	Excellent flow of thought and presenta-tion. Judge feels wel-come and well informed after presentation.	Comfortable even flow, good summary of pro-ject, good response to judge's questions.	Uncomfortable, uneven flow, poor response to judge's questions.	Poor presentation, very uneven flow of logic. Unable to respond to judge's questions.	Reading of report and poor responses to judge's questions.
15	15 14 13	12 11 10	9 8	7 6	5

SUBMITTED REPORT: Teacher will mark this section (25).

Appendix 5

Survey instrument

SCIENCE FAIR SURVEY

The following survey is one that asks you about your participation in science fairs in past years. Please use a checkmark to answer YES or NO at the end of each line. Questions 1-13 inclusive deal with your science fair experiences in elementary school only. You will be asked about your experiences in junior high school and senior high school later in the survey. Several of the questions in each section have several parts. Please answer all the parts for each question. If you don't know the answer to the question write in "don't know" on the dotted line. IF A QUESTION DOES NOT APPLY TO YOU (ie you are in grade 10 and you are looking at the senior high section) THEN ANSWER "N/A"

GRADE PRESENTLY IN ________

ELEMENTARY SCHOOL SECTION

1. In elementary school I did a science fair project for class.................................... YES ___ NO ___
2. The project was mandatory.. YES ___ NO ___
3. The project was marked and was part of my science mark .... YES ___ NO ___
4. If I had been given a choice I would have chosen to do science fair project .... YES ___ NO ___
5. I received encouragement when doing this project from my
   - a) Teacher .... YES ___ NO ___
   - b) Parents .... YES ___ NO ___
   - c) Friends .... YES ___ NO ___
   - d) Classmates .... YES ___ NO ___
   - e) Other (specify) .... ______________
6. In elementary school my teacher was enthusiastic about Science Fairs...................... YES ___ NO ___
7. The kinds of thought processes required to do a science fair project at elementary school came easily to me .... YES ___ NO ___
8. The science fair project was done (answer a or b or c)
   - a) in class time only .... YES ___ NO ___
   - b) wholly at home .... YES ___ NO ___
   - c) at home and school .... YES ___ NO ___
9. I was selected for the Regional Science Fair (held at CEC) .... YES ___ NO ___

9a. (If no to q. 9) I would have liked to have been chosen for the Regional Fair .... YES ___ NO ___

10. In elemenatry school I used to be interested in doing the following activities outside school more than occasionally
    - a) watch science programs on TV .... YES ___ NO ___
    - b) read books about science .... YES ___ NO ___
11. At elementary school the topic of science was,
    - a) fun .... YES ___ NO ___
    - b) interesting .... YES ___ NO ___
    - c) other (specify) .... ______________
12. At elementary school the topic of science made me feel
    - a) successful .... YES ___ NO ___
    - b) curious .... YES ___ NO ___
    - c) uncomfortable .... YES ___ NO ___
13. At elementary school other subjects were, on the whole
    - a) fun .... YES ___ NO ___
    - b) interesting .... YES ___ NO ___
    - c) other (specify)........_____ ________

JUNIOR HIGH SCHOOL SECTION

Answer questions 14 - 26 on your experiences with science fairs in junior high school

14. In junior high school I did a science fair project for class (any science class)............. YES ___ NO ___
15. The project was mandatory.. YES ___ NO ___
16. The project was marked and was part of my science mark .... YES ___ NO ___
17. In junior high school if I had been given a choice I <u>would</u> have chosen to do a science fair project .... YES ___ NO ___
18. I received encouragement when doing this project from my
    - a) Teacher .... YES ___ NO ___
    - b) Parents .... YES ___ NO ___
    - c) Friends .... YES ___ NO ___
    - d) Classmates .... YES ___ NO ___
    - e) Other (specify) .... _______________

19. In junior high school my teacher was enthusiastic about Science Fairs........ .... YES ___ NO ___
20. The kinds of thought processes required to do a science fair project at junior high school came easily to me .... YES ___ NO ___
21. The science fair project was done (answer a or b or c)
    - a) in class time only .... YES ___ NO ___
    - b) wholly at home .... YES ___ NO ___
    - c) at home and school .... YES ___ NO ___
22. I was selected for the Regional Science Fair (held at CEC) .... YES ___ NO ___

22a. (If no to q. 22) I would have liked to have been chosen for the Regional Fair .... YES ___ NO ___

23. In junior high school I used to be interested in doing the following activities outside school more than occasionally
    - a) watch science programs on TV .... YES ___ NO ___
    - b) read books about science .... YES ___ NO ___
24. At junior high school the topic of science was,
    - a) fun .... YES ___ NO ___
    - b) interesting .... YES ___ NO ___
    - c) other (specify) .... ____________________
25. At junior high school the topic of science made me feel
    - a) successful .... YES ___ NO ___
    - b) curious .... YES ___ NO ___
    - c) uncomfortable .... YES ___ NO ___
26. At junior high school other subjects were, on the whole
    - a) fun .... YES ___ NO ___
    - b) interesting .... YES ___ NO ___
    - c) other (specify)........_______ _______

SENIOR HIGH SCHOOL SECTION

Answer questions 27 - 40 on your experiences with science fairs in senior high. Answer only those questions that are appropriate. (Students presently in grade 10 can answer only those that are appropriate)

27. In senior high school I did a science fair project for one of my science classes (biology, chemistry or physics) .... YES ___ NO ___
28. The project was mandatory.. YES ___ NO ___
29. The project was marked and was part of my science mark .... YES ___ NO ___
30. Given a choice I would choose to do a science fair project in high school.............. YES ___ NO ___
31. I received encouragement when doing this project from my
    a) Teacher .... YES ___ NO ___
    b) Parents .... YES ___ NO ___
    c) Friends .... YES ___ NO ___
    d) Classmates .... YES ___ NO ___
    e) Other (specify) .... ________________

32. In senior high school my teacher was/is enthusiastic about Science Fairs................ YES ___ NO ___
33. The kinds of thought processes required to do a science fair project at senior high school came easily to me .... YES ___ NO ___
34. The science fair project was done a) in class time only .... YES ___ NO ___
    b) wholly at home .... YES ___ NO ___
    c) at home and school .... YES ___ NO ___
35. I was selected for the Regional Science Fair (held at CEC) .... YES ___ NO ___
35a. (If no to q.35) I would have liked to have been chosen for the Regional Fair .... YES ___ NO ___

36. In senior high school I am interested in doing the following activities outside school more than occasionally
    a) watch science programs on TV .... YES ___ NO ___
    b) read books about science .... YES ___ NO ___

37. At senior high school the sciences in general (physics, chemistry & biology) are
    a) fun .... YES ___ NO ___
    b) interesting .... YES ___ NO ___
    c) other (specify) .... ________________

38. At senior high school the topic of science makes me feel a) successful .... YES ___ NO ___
    b) curious .... YES ___ NO ___
    c) uncomfortable .... YES ___ NO ___
39. At senior high school other subjects are, on the whole a) fun .... YES ___ NO ___
    b) interesting .... YES ___ NO ___
    c) other (specify)........________________

40. Please complete the following statement on science fairs in high school

a) One good reason that I would not do a science fair project is ______________________________

____

b) I would do a science fair project in high school if ______________________________

____

THANK YOU FOR YOUR COOPERATION