FACTORS INFLUENCING ATTITUDES TOWARDS SCIENCE IN PRIMARY AND ELEMENTARY TEACHERS

LARRY EDDY

Factors Influencing Attitudes Towards Science

in Primary and Elementary Teachers

by

Larry Eddy, B.Sc. , B.Ed.

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ABSTRACT

The purpose of this exploratory research was to determine what factors are influencing the attitudes of primary and elementary teachers towards science. The sample consisted of 127 primary and elementary teachers of science in the Province of Newfoundland who responded to a questionnaire that was distributed across the Province.

Based on a review of the literature concerning the attitudes of primary and elementary teachers towards science, an instrument, developed by the Science Council of Canada and modified for this study, was sent to teachers who met the criteria for the study. Through the use of closed form (Likert Scale) items, teachers were asked to assess what factors were influencing their attitudes towards teaching primary and elementary science. According to the research, there were four major factors contributing to primary and elementary teachers attitudes towards teaching science. Theses factors were educational background in science, implementation of process skills, teaching practices and inservice in science. The questionnaire addressed all four of these areas as well as other factors that were perceived by researchers to influence attitudes towards science. This study also tested the hypothesis that there were certain factors such as teacher background, school resources and level of education that lead

teachers into an avoidance of science teaching which in turn influences teaching practice and technique.

After a statistical analysis of the data, a majority of teachers reported the following factors as problematic areas for science teaching in primary and elementary schools: science background, inservice in science, as well as school facilities and equipment.

In testing the hypotheses, only the level of education factor, in particular education in science and training as a science teacher, was found to have a significant effect upon teachers either doing or avoiding science teaching. Further testing of the hypotheses also found that the attitude of wanting to avoid science had a significant effect upon teaching technique. Also, a discriminant function analysis predicted that a majority of primary and elementary teachers would want to teach science if there were adequate school resources and if their background and education in science was adequate. As well, it should be noted that this is an area of research that needs further study.

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CHAPTER I: INTRODUCTION

This project was exploratory in nature and investigated what factors are influencing the teaching of science for primary and elementary teachers. Of particular interest were factors that may cause teachers to avoid teaching science. According to many researchers, there are various factors as to why teachers would want to avoid teaching science. The literature cites four major reasons:

(1) ineffectiveness of inservices
(2) unfavourable teaching practices
(3) inadequate educational background in science
(4) lack of implementation of process skills

In a 1984 national study by the Science Council of Canada, teachers who wished to avoid teaching science most often cited an inadequate background as the major reason. It was found that among teachers who teach science, primary and elementary teachers had the most inadequate background in science and thus avoided science teaching. Many important questions have to be asked. For instance, " is primary and elementary science unattractive to students and are teachers to blame?" Journal articles more often than not point the finger to the primary and elementary teacher; more specifically, their negative attitude towards science teaching.

Science is one of the areas in elementary schools that teachers can either pursue or avoid, unlike areas such as reading or mathematics. One can argue that science is more likely to be avoided by some teachers than other subjects. Thus, one can legitimately argue that their are good reasons for studying the avoidance reasoning of teachers. For instance, according to Duschl (1983), teachers avoid science because of an anxiety that they associate with science. He found the knowledge component both to be very threatening to elementary teachers and to significantly influence their anxiety levels. Duschl claims that experience and contact with science may decrease anxiety levels and permit teachers to not avoid science. Knowing why teachers say they avoid science may help us resolve this problem.

ATTITUDE TOWARD SCIENCE: PRIMARY & ELEMENTARY TEACHERS

> I watched two boys sailing stick boats in a tiny stream the other afternoon. I don't suppose it mattered to them that the water was off color and had a peculiar smell. I don't suppose they were concerned with why the stick floated or why they moved downstream. It is depressingly true that a large number of kids don't know much about the world around them. Even more frightening, they don't care that the water is polluted and are not curious about the sources of the contamination (p. 421).

This introduction to an article by Peggy Tilgner (1990) can lead us to believe that science education in the primary and elementary schools is one of the contributing factors relating to why science may be unattractive to students.

Three obstacles to teaching science most frequently cited by elementary teachers 20 years ago were inadequate science equipment as well as inadequate time and space (Tilgner, 1990). Researchers have found that little has changed. Tilgner, in citing Mittlefehldt (1985), believes that current practices in elementary science education turns off affective and cognitive learning. They blamed inadequate teacher training, lack of equipment, time constraints, under utilization of community resources and over reliance on textbooks.

No doubt, if these statements were true, then students' learning and appreciation of science would be at risk. As educators, we don't want students to develop an aversion for science at an age when they can be inspired the most. It would be detrimental if a course, namely science, that could be most appealing to students, would foster a negative attitude because of how it was delivered by a teacher. Thus, it was the intent of this study to determine if primary and elementary teachers in Newfoundland mistreat science because of certain factors that are affecting their attitudes. A hypothesis was that there are certain factors such as teacher background, school resources and level education that lead teachers into a avoidance of science teaching which in turn influence teaching practice and technique. Reasons for the existence of these attitudes were explored.

STATEMENT OF THE PROBLEM

Background To The Study

Research on attitudes towards science by primary and elementary teachers claim that the negative attitudes by far outweigh the positive ones. As mentioned earlier, there are numerous propositions as to why this is so. Much research claims that inadequate science background leads to poor teaching practices as well as to students lacking process skills and also to a demand for effective inservicing. This can result in both teacher and student negatively viewing science. Therefore, I plan to investigate to see if any of these claims may be true.

To my knowledge, it has been 10 years since Newfoundland science teachers, especially primary and elementary teachers, have been surveyed to determine their attitudes towards science. This particular study was conducted by the Science Council of Canada, was very extensive and yielded provincial and national results. I used this same instrument, with some editing, to measure teacher attitudes towards science in primary and elementary schools. My choice for this instrument was because of its tested high validity. This is extremely important in attitudinal research since a major pitfall of research of this type has been in the instrument itself. The major problem of many attitude instruments is their poor quality, especially their psychometric quality. Most measures do not provide appropriate psychometric evidence of reliability and validity (Munby 1983). Also, the use of this instrument allows a comparison of data with that of a national study by the Science Council of Canada.

Purpose

The purpose of this exploratory study was to determine what factors are influencing the attitudes of primary and elementary science teachers in the Province of Newfoundland. The study attempted to assess whether such factors as educational science background, inservice in science, knowledge of process skills and teaching practices are affecting teacher attitudes toward science as was mentioned in the literature review.

As mentioned above, the study prior to this one concerning Newfoundland teachers' attitudes towards science occurred 10 years ago. This was a national study and concluded that primary and elementary teachers held poor attitudes towards science. My study concentrated on Newfoundland primary and elementary teachers and attempted to see if attitudes have changed and if so, how significant was this change. Thus, the intent was to determine whether or not Newfoundland primary and elementary teachers are similar to other teachers reported in the literature in terms of attitude toward science and to investigate what major factors are influencing these attitudes.

RESEARCH QUESTIONS

The major hypothesis tested in this study was as follows: there are certain factors such as teacher background, school resources and level of education that lead teachers into an avoidance of science teaching, which in turn, influences teaching practice and technique.

Research questions to be answered in this study were as follows:

- What do teachers perceive as the major obstacles that inhibit them from achieving effective science instruction?
- Will the results of this study coincide with the findings in the literature as to what influences teachers attitudes towards science?
- What are teachers' perceptions of the effectiveness of their teaching in enabling students to achieve the various aims of science education?

- What effect do such factors as teacher education, background, and school environment have on attitudes towards science instruction?

- What are the factors, if any, contributing to teaching practice and technique?

DEFINITION OF KEY TERMS

Just what do we mean by attitude? Germann (1988) states that the construct of attitude has been vague, inconsistent and ambiguous. According to Webster's New Collegiate Dictionary, attitude is defined as "a feeling or emotion toward a fact or state." The definition of attitude according to Thurstone is "the affect for or against a psychological object." Germann (1988) claims the concept of attitude is a unidimensional concept as opposed to multidimensional. This view point was promoted by many psychologists who include the components of beliefs and behavioural intentions as well as affect. They believe that beliefs and behavioural intentions are determinants of attitudes.

Having a concise concept of attitude is an integral step when venturing into research on attitudes towards science by primary and elementary teachers. Perhaps even more important is making the distinction between "attitudes towards science" and "scientific attitudes". The terms attitude and science are both somewhat ambiguous, taking on different meanings for different people in different contexts. Schibeci (1984) states that the distinction between cognitively oriented "scientific attitudes" and affectively-oriented "attitudes to science" should be borne firmly in mind. To clarify this issue, Germann cites Gauld (1982), Munby (1983a), Blosser (1984) and Haladyna and Shaughnessy (1982) to offer some guiding descriptions. Attitudes, as it relates to science is divided into two areas - "scientific attitudes" and "attitudes towards science". Scientific attitudes refers to a particular approach a person assumes for solving problems, for assessing ideas and information and for making decisions. It includes such scientific methods and predispositions as objectivity, suspended judgement, critical evaluation and scepticism. "Scientific attitudes" are characterized as thinking as scientists do, that is, acting on evidence in a disciplined way. "Attitudes towards science", on the other hand, may address scientific attitudes, scientists, scientific careers, methods of teaching science, scientific interest, parts of a curriculum, or the subject of science in the classroom. It may refer to beliefs about processes, theoretical products, technological products, or the science - technology relationship (Germann 1988).

"Scientific attitudes" and "attitudes toward science" are different constructs and each contains dimensions that are to some degree, distinct from each other. Attitude research must clearly identify what aspect of attitude is being addressed. While such care will not necessarily eliminate the ambiguity that exists among the constructs and dimensions of attitude, it can foster a resolution of the issue. Attitude is a complex construct that is influenced by a myriad of variables. The attempt is to measure a general attitude toward science without confounding the interpretation by including other dimensions of attitude or science (Germann,1988). If the attempt is successful, then credit has to be given to a theoretical model which shows the relationship of attitudes with other variables.

SIGNIFICANCE OF THE STUDY

In attitudinal research, studies that have good experimental design often report bad news concerning elementary science. The general consensus from the research is that the present state of science teaching is influenced by our culture's sense that it is relatively unimportant for children of elementary - school age to study science. Science is not seen as basic, time is always scarce, many teachers feel unprepared and lack confidence in their ability to teach science, and therefore avoid it. Thus, a fundamental issue for administration, principals, teachers and the community, is, quite simply, that science should be treated more as an important curriculum focus than as a frill. According to the research, science is prescribed within official curriculum, but is not being taught regularly or effectively in many classrooms.

This research is important at this time. The national study ten years ago found that primary, elementary and secondary science teachers in Newfoundland and across the nation had negative attitudes toward science and attributed these attitudes to poor science background. We are at a time in our history when science as well as technology are being promoted more and more in the school and society. It is extremely important that very young students not receive negative experience in science. Thus, it is the responsibility of the primary and elementary teacher to ensure that positive attitudes are developed. It is the teachers attitude that will influence and shape the attitude of the student. Thus, it is of utmost importance that all stakeholders in education know what the attitudes of primary and elementary teachers are towards science in Newfoundland.

CHAPTER II: LITERATURE REVIEW

Literature concerning "attitudes towards science" indicates that this is an area of research that is problematic. Many research journals contain articles that boast the practicality of measuring attitudes towards science. Still, other articles question the validity and reliability of instruments used. A lasting impression from reviewing the literature is that this is an area of science education that is open to question and debate. By examining some of the research on primary and elementary teachers' attitudes towards science, perhaps a clear picture of the major problems will emerge.

NEED FOR PROCESS SKILLS

Raun and McGlathey (1970), as cited by Riley (1979), suggested lack of understanding of the nature of science to be the major reason that elementary school teachers indicate a dislike or fear of science. They further suggested that this lack of understanding was the result of exposure to the products of science and little or no exposure to the process of science. Thus, if a teacher's understanding of and attitude towards science would be improved by proficiency in the process skills, then this would likely result in increased and improved science instruction.

Riley (1979) investigated the effects of hands-on versus non-manipulative training in process skills on preservice teachers' knowledge of process skills, understanding of science, as well as attitudes towards science, science teaching and methods of instruction. These variables were tested using The Science Process Measure for Teachers, Test on Understanding Science, Attitude toward Science and Science Teaching Scales and Attitudes Toward Methods of Instruction Inventory. All of these tests reported Hoyt reliability quotants that were high with the exception of Test on Understanding Science (r=.58). The first three published instruments have established acceptable validity estimates. The investigator developed instruments were judged to have face validity by a panel of experts. The sample consisted of 90 elementary education students, who were randomly assigned to one of three groups; active inquiry, vicarious inquiry and control.

It was concluded from the findings that training in the science process skills by either vicarious - inquiry or an active - inquiry approach can be employed to improve preservice teachers' competence in selected process skills. However, no treatment effect could be discerned on the dependent variables; attitudes toward science and science teaching, understanding science or attitude towards method of instruction. No evidence could be found on any of the criterion measures supporting one inquiry method over the other (Riley 1979).

Kyle, Bonnstetter and Gadsden (1988) studied K-6 teachers who were teaching the Science Curriculum Improvement Study (SCIS) and teachers who were non-SCIS during the 1988-89 academic year. SCIS students learned science theory or process approach while non-SCIS students learned in the traditional science class. Student and teacher version of a Preference and Understandings instrument were used (alpha coefficient =.84)

The data reported that while SCIS and non-SCIS teachers possess similar, often negative perceptions of science; the attitudes of students who have experienced one year of an inquiry - oriented, process approach curriculum were enhanced greatly when compared to students in textbook - oriented science classes. It was interesting to note that the only attitude items for which significance was found on the teacher questionnaire reveals that non-SCIS teachers were more likely to convey the view that being a scientist would make them feel important (p=0.05) (Kyle, Bonnstetter & Gadsden (1988). Perhaps this was a reflection of the low public esteem typically afforded to those individuals in the teaching profession, especially teachers at the elementary school level. On the other hand, the data overwhelmingly supported the fact that students in inquiry - oriented science classes had greatly enhanced attitudes towards science and scientists when compared to students in text-book oriented science classes.

Ginns and Foster (1983) sampled 471 students (321 females, 150 males) and randomly assigned them to two conditions. One group undertook a topics course while another group undertook a lecture course. The topic approach involved the completion of topics or units of work in the physical, earth and biological sciences. This approach was wholly inquiry based. The lecture group were involved in a structured environment with whole group lectures. Pre-test and post-test Science Teacher Attitude Scales were used.

It was found that the topic approach allowed females to achieve a greater positive change in attitude to science and science teaching (Ginns & Foster 1983). Given the predominance of females in most preservice elementary teacher training programs, it seems that the topic approach is a worthwhile strategy to adopt for teaching science. The results suggested that the effects of science courses with high levels of student involvement were mediated by sex - related cognitive style differences in preferred learning styles. The effect reported may arise because females respond positively to the higher levels of personal involvement associated with the topic approach. Thus, this study was in contrast to the previous two studies mentioned in this paper in terms of the effect of process - oriented programs on teacher attitudes.

Hall (1992) studied 159 elementary teacher's attitudes toward science who were enrolled in a Biology for Elementary Teacher Program. The Revised Science Attitude Scale was administered as a pre-test and post-test. This scale was reported to be reasonably valid and reliable. Group scores were then subjected to paired t-test analysis.

All 22 items on the test included a significant increase in attitude. Some statements that generated the highest post-test scores after the activity were; importance of teaching science and teacher excitement of students about science. This study was strictly exploratory and made no attempt to establish causality. The author claimed that it generated evidence to suggest that an activity - centered biology content course was influential in promoting positive attitudes towards science and science teaching (Hall 1992).

Stefanich and Kelsey (1989) studied 318 preservice elementary student teachers, 168 in one university and 150 in another university. Students attending university A were enrolled in education science courses with a common format of lecture - recitation with an optional laboratory component. Students in university B were enrolled in science courses whereby there was frequent utilization of hands-on experiences. The content was analogous to content in elementary science curriculum.

Using the Shrigley Science Attitude Scale for Preservice Elementary Teachers, various interpretations were drawn. Students at School B reflected more positive attitudes toward science content, handling science equipment and teaching science than School A students (Stefanich & Kelsey 1989).

Harty, Anderson and Enoch (1984), noted that one way to improve preservice teacher's attitudes is to design programs with early field experiences. They studied a campus based group of elementary science teachers and a field based group. The campus group received lectures in science; the field base received hands on - activity oriented instruction. Scales used in the study reported high reliability.

The field based group exhibited significantly more positive attitudes towards science than the campus based group. In particular, field based students had significantly more positive attitudes toward the dimension of "responsibility for teaching all science," than did the campus students. This might be accounted for by their greater exposure to an interaction with children (Harty, Anderson and Enochs, 1984).

Lucas and Dooley (1982) claimed there was evidence from various quarters that negative attitudes towards science teaching can be broken down and positive attitudes can be fostered. Negative attitudes toward science, on the other hand, seem to be more resistant to change.

Thirty-three student elementary teachers enrolled in SCS 101 and thirty-four students enrolled in SCS 251 at Kevin Science College were studied. SCS 101 was a content-based unit composing mostly of physical science and earth science. SCS 251 was based on principles of science curriculum construction and included in-depth study of several sets of modern science curriculum materials. The authors wanted to know which unit fostered desirable attitudes. The instrument used was the Attitude Toward Science and Science Teaching Scale (r=.83).

Lucas and Dooley found no significant changes in attitudes either toward science or science teaching as a result of taking the content - based science instruction. Also, there was no significant change in attitude towards science as a result of taking the curriculum - based science instruction. However, a significant improvement in attitude towards the teaching of science followed the completion of the curriculum - based science unit.

EDUCATION BACKGROUND AND KNOWLEDGE

One of the logical points of intervention in addressing attitudes toward science would be in the preparation that elementary education students receive in the content of science as well as in effective pedagogical strategies. However, it should be noted that the relationship between science study and preservice teachers' attitudes about science and teaching science was not clear from the review of literature. So the question remained; "What effect does the influence of college science courses have on prospective primary and elementary teachers?"

Zuzovsky, Tamir and Chen (1989) examined the belief that specialized teachers are more effective in science teaching than are general teachers. The data was based on a sample of 86 science teachers. They taught 86 classes, each in a different school. The ratio was such that half were specialized teachers and half were general teachers, based on teachers self - reports. Teacher and student attitudes were measured and reliability indices for each were quite high.

Specialized and general teacher training were positively correlated with student achievement. This was puzzling as one group was assumed to have received "better" instruction by more qualified teachers. This problem lead to the construction of a causal model. It was found that students taught by specialized teachers and those taught by general teachers had similar achievement scores. Thus, the preparation of teachers and their mode of instruction seem to have no effect on student achievement. However, even though this was an extensive study by these authors, they quickly pointed out that their findings should be viewed with caution. They mentioned that the phenomenon was complicated and that other difficulties cannot be explained on statistical or theoretical grounds and remain unsolved within the framework of the study.

Further literature reviews indicate that much research in this area of science education has been sloppily done and leads one to question the results. King (1991) studied thirteen preservice science teachers who had been student teaching for one to three weeks after completing a Teacher Education Program in science. Students were given a questionnaire and then individually interviewed. He wanted to discern their knowledge and attitude toward history and the philosophy of science.

Problems with the sample used by King was that it is too small (11 students) and individuals were invited, therefore ruling out random sampling. It was therefore difficult to generalize any of his findings. The questionnaire contained 14 questions, of which only 4 dealt with the problem at hand. There was also no mention of reliability and validity. The individual interviews were also conducted early after the students had begun teaching. It is my guess the last thing on pre-service teachers' minds was attitude toward philosophy of science. Lastly, the specific questions in the interview were not listed.

However, the King study did uncover potential problems and try to speculate on their causes and relations. Kings' major finding was that beginning teachers had, for the most part, no knowledge of, or course work in history, or philosophy of science (King, 1991).

Young and Kellogg (1993) studied 96 elementary teacher education students enrolled in elementary mathematics and science methods classes. They compared them to two comparison groups of non-science majors who were randomly selected. Data was collected from a descriptive essay and transcript analysis on their science background.

Over half the elementary science students (55%) described inadequate background preparation in science, with only 10% indicating a rich collection of experiences. Of the 10 students with the highest background rating, all but 1 were found to have a positive attitude toward science. Only 28% of the sample had positive attitudes towards science (Young and Kellogg 1993).

Winnans and Brown (1992) surveyed 151 fourth and fifth grade teachers concerning their attitudes towards using computers in science. The instrument was a questionnaire designed with a combination of open - ended and closed - ended questions using a Likert-type scale. There was no mention of attempts to regulate reliability and validity in their study.

They found two main factors which have constrained implementation of computer use in science. These were teachers' own attitudes towards computers and their feelings about being held accountable for teaching computers. Like other studies, these teachers reported a lack of self - efficacy and confidence in their ability to teach computers. Also their limited knowledge of the scope and sequence of the computer curriculum as it relates to science adds to a negative attitude (Winnans and Brown, 1992).

Harty and Salama (1985) found that teachers with professional educational training exhibited a more desirable set of attitudes towards science than teachers without professional educational training. Significant differences ($p<0.001$) were found between the two groups.

As indicated above, a lack of science training was one of the principal difficulties in teaching science. As teachers "teach" science during their daily routines, research indicates that they need help. One source of help may come from science coordinators and supervisors.

Perrine (1984) studied 29 supervisors and 470 randomly selected elementary teachers using a 32 question, Likert-type instrument. Teachers indicated that they wanted more help that they could use directly for science instruction from supervisors elementary teachers, because of their weakness in science, were looking to the supervisor for more technical assistance and expertise.

Lawrenz and Cohen (1985) studied secondary science education majors and elementary education majors. The claimed that methods courses improved attitudes towards science in elementary teachers only. Their samples were very small, and were not randomly selected. One sample was twice the size of the other and from a different locality. Also, analysis of p-values for pre-test and post-test yield results that tend to be non-significant for a number of items on a Science Attitude Inventory.

EFFECT OF INSERVICE ON ATTITUDES

There were many reasons given by teachers regarding why they feel inservice workshops were of little benefit. Two common complaints were that teachers were expected to learn too much in too little time and that little follow up ever occured. Thus, the inservice seemed insignificant. As a result, teachers attitudes towards science were not improved.

Bitner (1990) tried to address this problem by investigating the effect of a year long inservice science workshop on the attitude of teachers towards science and science teaching. Her sample consisted of 33 K-7 teachers involved in field trips and hands-on science for a full year. The Science Attitude Scale for inservice Elementary Teachers II was administered to the sample as pre and post measures. It measured attitudes toward science and science teaching. A .92 and .94 Cronbach and test-retest reliability was reported. Significant positive increases on background in science, attitude toward using science equipment, doing science laboratory work and discussing science topics were found ($p<.05$). Thus, the year long study appeared to improve teachers attitudes.

Spooner and Simpson (1982) claimed that there was a need for investigations to be designed that shed light on the validity and reliability of instruments used to measure attitudes towards science from inservice. In their study, they employed a pretest and postest design for 52 elementary teachers involved in a five - day inservice workshop. Four instruments, two Likert-type and two semantic differential scales were used with high reliabilities reported.

The results of the treatment on attitude toward teaching science showed a significant positive change in teacher attitude on both the semantic differential and Likert - scales. Spooner and Simpson (1982) claimed that their investigation added evidence to a growing body of knowledge supporting the notion that attitudes of elementary teachers toward science and teaching science could be changed over short periods of time. I agree with their conclusions. The real question, though, is "how long do these new attitudes remain positive?" A follow up study would probably shed some light.

Westerback (1982) made somewhat of an attempt to answer the above question. Two studies of elementary teachers who enrolled in an earth science and biology course encompassing two semesters were conducted. In both studies, attitudes towards teaching science changed in a positive direction. More importantly, the change in attitude appeared to be stable over time. Westerback stated that other studies by Moores (1975) and Bratt (1977) yielded similar trends.

Lawrenz (1985) tested the attitudes of 132 teachers towards science using the pre-postest design with 3 instruments. The inservice classes appeared to have a modest, positive effect on attitudes towards science. However, the instruments in the study yielded low reliability. For example, Beliefs about

Science and Science Education had a reliability of .63. Another instrument, the Curriculum Attitude Survey had pre-post, paired t-tests that showed a general movement toward the negative.

For the most part, inservice programs appear to improve attitudes towards science. For effective instruction to be ongoing in the science classroom, positive attitudes have to be long lasting. Very little of the research literature studied this phenomena, leading one to wonder if anything is gained.

TEACHING PRACTICES

Many factors have been found to influence why and what teachers do when they implement an elementary science program. Some studies support the view that what science teachers do in the classroom does make a difference in student attitudes and achievement. The implication of these results for teachers is that they cannot afford to overlook student attitudes. The science teacher who teaches the subject and lets attitudes fall where they may is doing a disservice to students by making instruction less effective than it could be (Schibeci and Riley, 1986)

A survey of the research literature on science textbook analysis, reading comprehension and content reading indicates that little is known about science reading, especially in the elementary school (Shymansky, Yore and Good, 1991). Yet, textbooks remain an important instructional medium in elementary school science classrooms.

A sample of 522 elementary teachers drawn from the school registry of the National Science Teachers Association of the United States were studied by Shymansky, Yore and Good. The Science and Reading Questionnaire was developed and reported high reliability and validity.

Various insights were found in this extensive study. One finding was that teachers were unwilling to reduce topic coverage in order to increase depth of exploration to achieve conceptual change. Teachers also perceived individual and small-group reports, class discussions, media instructed laboratories, and computer instruction as less effective than science reading for elementary students. Teachers, such as these, were subscribing to traditional teaching practices (Shymansky, Yore and Good, 1991).

Schibeci and Riley (1986), through the use of causal modelling, tested a hypothesis. Their hypothesis was that the influence of student perceptions of science instruction influences student attitudes towards science. They studied two random samples of 350 and 323 students using a Likert scale. The data used to investigate the study came from Book 4 of the 1976-77 National Assessment of Educational Progress.

The findings extended previous research by highlighting the causal inference that perception of instruction influences student attitude. The results of the study supported the view that what science teachers do in the classroom does make a difference in student attitude. Assuming that student perceptions of their instruction were valid indicators, then teachers who exhibited positive instructional behaviour were encouraging students to be creative and were trying to make science more exciting. Also, they were more likely to have a positive influence on student attitudes .

Barrow (1991), found that elementary school teachers see the curriculum as a set of separate and discrete subjects to be taught, rather than as an integrated whole. This leads teachers to adopt traditional methods when teaching science that allow little time for reflection. According to the study, time is a scarce commodity to elementary teachers and influences their teaching in particular ways.

The research literature clearly illustrates that studies of attitudes towards science of primary and elementary teachers were troublesome. The experimental design used in studies reviewed lends itself to instruments that lack conceptual validity. Also, many studies did not even report validity and reliability. Often the sample size was too small and far from being random. Also, items on many scales were measuring cognitive as well as affective domains of science and the researcher was unaware of this.

When studies do have good experimental design, they often report bad news concerning elementary science. The general consensus from the research was that the present state of science teaching was influenced by our culture's sense that it is relatively unimportant for children of elementary-school age to study science. Science was not seen as basic, time was always scarce and many teachers feel unprepared and lack confidence. Thus, a fundamental issue for administration, principals, teachers and the community, is, quite simply, that science is to be treated as an important curriculum focus more so than a little added frill. Although science is prescribed within official curriculum, it is not being taught regularly or effectively in many classrooms.

No doubt, primary and elementary teachers need better science education at the preservice and inservice level. Tilgner (1990) stated that elementary teachers have specific unfulfilled needs limiting their effectiveness as teachers of science. They need to be provided with realistic science experiences which help them develop the basic science skills. They need to be provided with opportunities to develop an understanding of the relationship between science and society if they are to foster such an understanding in their students.

Elementary preservice science teachers themselves are, for the most part, concrete operational. Tilgner claims that Chiappeta (1976) studied the Piagetian operational levels of elementary education majors and found 50% of them to be concrete operational, with another 25% in the transitional stage. Further testing showed that a large percentage of individuals rated at the formal operation level actually functioned at concrete operational levels when tested on their understanding of physical science subject matter. This indicates the need to provide suitable, hands-on experiences for the prospective teachers to help them move from concert to formal operations (Tilgner, 1990).

This paper provided many statistically significant results in teacher attitude change toward science and teaching science. However, we must not forget that a problem in judging practical significance remains. A fundamental question therefore is; "What constitutes a reasonable increase in score on an instrument to be of practical significance?" In other words; "At what point does changing a teacher's attitudes towards science result in observable changes in teacher behaviour?"

Finally, Koballa (1986) produced findings that attempted to answer these questions. Seventy-six preservice teachers who had received instruction regarding how to teach science using hands-on activities were used. A Likert-type Revised Science Attitude Scale was used to measure attitudes towards science (coefficient alpha = .88).

The findings suggested that measuring teacher's attitudes towards science cannot adequately predict nor provide a satisfactory explanation of their science teaching behaviour. Other factors for instance, such as subjective norms have to be considered along with attitudes when trying to predict behaviour.

Everyone would agree that elementary science teachers need to bring more than a science textbook to their classes. They must refrain from relying on traditional teaching practices only. What these teachers do in science will influence the attitudes of their students. We can only hope that teachers are doing hands-on activities.

CHAPTER III: THEORETICAL FRAMEWORK AND METHODOLOGY

LACK OF A THEORETICAL MODEL

According to Schibeci (1984), one problem which plagues attitudinal research is the lack of a theoretical framework. This is true despite the efforts to develop a theoretical basis for attitude, for attitudes in science education, and for attitude change. Schibeci also states that theories of attitude change in science education contexts are limited. Science education researchers in recent years appear to be either unaware of these theories, or, alternatively, do no longer regard them as appropriate for application in educational contexts. To further complicate matters Blosser (1984) states that science education researchers borrow from other disciplines without giving adequate attention to theoretical guidelines.

The theoretical underpinnings that do exist concerning attitudes towards science have come from the realm of social psychology and arise out of the desire to improve the conceptual validity of instruments used to measure attitudes towards science. Munby (1983) called measures of attitudes towards science immature and inadequate. The major problem was that the attitude measuring instruments were of poor psychometric quality. Most measures did not provide appropriate psychometric evidence of reliability and validity.

Munby collected 204 attitude instruments. Fifty-six of these purported to measure attitudes towards science, the remainder measuring scientific attitudes. Only 21 of these were used in more than one study. Of the 56 measures, 21 did not report any reliabilities. Thirty-one of the remaining instruments reported reliabilities greater than 0.7. Only 7 instruments verified their validity by more than one method. Four instruments measured attitudes only and did not include any cognitive items. Munby found no instrument that he did not consider suspect for one reason or another.

According to Schibeci (1984), the results of the large research effort on attitudes towards science have been disappointing. Blosser (1983), in a review of the research literature related to laboratory teaching in science wrote:

> Much of the educational research literature is produced from doctoral studies. Such studies are usually an individual's first attempt at research. Most are single studies with no further follow up of the subjects who were involved. When educational research, focused on instruction, is analysed, much of it is found to be of the comparative variety. Students receiving method A are compared with similar students receiving method B. Frequently, one of these methods is referred to as the "traditional" approach to instruction in science. Readers are often left to their own devices to determine what took place in the traditional approach even if the empirical treatment is described in detail (p. 42).

Gardner (1975) stated that if a scale is to be valid and reliable, there should be a preliminary attempt to specify as clearly as possible the theoretical constructs underlying the scale. Also, items within the scale must be all related to a single attitude object. A disparate collection of items reflecting attitudes towards a wide variety of attitudes objects does not constitute a scale and cannot yield a meaningful score. Gardner further stated that instruments had frequently been constructed which contain two or more logically and psychologically distinct variables. The distinctions were either not perceived or ignored and all the item responses were summed to yield a single score.

Germann (1988) gave an example which reflects the lack of a theoretical construct underlying a scale. He claimed that some investigators did not report internal consistency data at all; others who knew how to perform the necessary calculation seem unaware of how to interpret their results. According to Germann, Harrison (1971) obtained a split - half reliability coefficient of .63 which, considering that there were 50 items in his scale, indicated extremely poor internal consistency. The value was simply presented and allowed to pass without comment.

In general, a first step could be for journal editors to urge their reviewers to be more critical in their reading of attitude scales. There were a number of studies which had been subjected to a blind reviewer system which should not have been published without modification. Studies which report no attempt to gain reliability and validity data about the attitude instrument from one category of studies should be summarily rejected. To change the present situation will require vigilance on the part of journal editors as well as a more professional approach by many researchers.

THEORETICAL MODELS

Although it is true that much research in attitudes towards science has occurred without giving consideration to theory, other studies seem to have a theoretical foundation. Munby (1983), in his review of thirty studies, questioned the conceptual validity of the Scientific Attitude Inventory (S.A.I.), a popular measure for attitudes towards science. He demonstrated that some form of strict and disciplined attention should be given to just what the items were testing. He believed in developing a clue structure out of philosophical distinctions for examining the items. An analytical perspective or clue structure was built which made sensible, useful and well - grounded distinctions among the items in the instrument. This allowed one to see different statements or statement types with a different focus in the item of the instrument.

The clue structure itself was derived from analytical and philosophical distinctions which themselves were conceptually trustworthy. The clue structure for distinguishing items of attitude instruments that measured attitudes to science contained three categories. The categories allowed items to be termed either cognitive (analytical), value (judgement) and attitude (emotional response). Items measuring scientific attitudes gave rise to three more categories in the clue structure. These categories included Test of Possession which involved intellectual skills and Test of Possession involving dispositions and self-report dispositions. Munby also derived a clue structure from considering the philosophy of science. This idea claimed that quite different views of the nature of science were conveyed in the attitude items. He claimed that these instrument items were not measuring attitudes to science but the philosophical view of the nature of science which is cognitive and not attitudinal. Thus, the clue structure had to be expanded further to detect the implicit and/or explicit views of Realism and Instrumentalism that attitude statements of science have. With Realism, scientific theories and explanations were taken to be true descriptions of the world. The scientific construct were thought to have an ontological status similar to that of common sense objects of perceptions. For Instrumentalism, though, scientific theories and explanations were viewed as instruments for ordering perceptions and scientific constructs which were postulated entities (Munby 1983). For instance, consider the following item statement from the Scientific Attitude Inventory:

> "Scientists discover laws which tell us exactly what is going on in nature."

The item was a cognitive item and implicitly conveyed the Realist view that laws are true statements about the world and not subject to change. Similarly, the view of science in the following item was put forward explicitly, though in this case it is Instrumentalist:

"The scientist knows that ideas will change if new facts are found."

The message here was that ideas were not more than ways of conceptualizing facts (Munby 1983). Germann (1988) supports a theoretical framework needed in determining attitudes towards science. He proposed a framework of five commonplaces to classroom education; learner, teacher, curriculum, milieu and governance. According to Germann, the educating process is a school one in which learners and teachers come together to share meaning concerning the concepts and skills of the curriculum. Each of the commonplace brought with it a complex set of causes that directly influences the effort, actions and conduct of an educative event. The governing causes include world views, belief systems, existing knowledge, lifestyles, life goals, needs and drive.

The construct of attitude, according to Germann was that of a general attitude toward science in school. Such a general attitude was the result of a number of narrower classroom attitudes (eg., attitude toward the teacher, the subject, laboratory exercises). This attitude was influenced by a social interaction of a number of variables from the primary governors (learner, teacher and curriculum) and secondary governors (society, home, peers, school) and was one of several other variables that might influence achievements (e.g., social pressures, behaviour options, conflicting beliefs, and values) (Germann 1988).

Some studies have focused on the need for theoretical models on which to base attitude research. One suggested model was built upon reinforcement theory. Martin (1985) claimed that central to this model is the principle that the credibility of the attitude change communicator affects the direction and degree to which an individual's attitude may change. Carl Hovland (1953) as cited by Martin, claimed that communicator credibility is reported to consist of the respondent's perceptions of a communicator's expertise and trustworthiness toward an attitude affect. Contained within the communicator's verbal attitude change message is a "recommended position" toward which the respondent is encouraged to move. Hence, according to Hovland a major effect of persuasive communication lies in stimulating an individual to think of his initial position and the new position recommended in the communication.

Hovland and his associates believed the credibility principle was of central importance to the attitude change process. Their research found that communicators who are perceived as being highly credible and authoritative are more likely to produce greater attitude change, whereas communicators who are perceived to be less credible and authoritative are less likely to produce change. These findings suggest that respondent's attitudes will move toward what they perceive to be the attitude level of the most credible communicator (Martin, 1985).

Shrigley (1983) proposed a model for changing teacher attitudes based on earlier work by Hovland. His paradigm refered to a 3 step process of persuading, mandating, and rewarding the attitudes of teachers toward science. The three stage approach can be found in the literature of social psychologist. As mentioned earlier, teachers could be persuaded to change their attitude if the science supervisor is perceived to be credible. Teachers who cannot be persuaded to modify their negative attitude toward science would be mandated to teach science; minimum conditions would be established as mandatory. From this mandate, teachers who were at first reluctant would be expected to grow to like science (attitude) through the expression of having taught science (behaviour). The final step in the model is teacher reward. This approach suggested that teachers will become more positive toward science teaching when reward is maximized and punishment is minimized. Teachers who were rewarded for teaching science are prone to become more positive in their attitude, which in turn, motivates them to teach science more effectively (Shrigley 1983).

INSTRUMENTATION

There are a variety of instruments that were in use that allow researchers to measure attitudes toward science. Often information collected by these instruments undergoes statistical analysis to determine such things as significance and validity. This paper will only attempt to give a brief description of instruments and scales that are used. Further information on the characteristics of each technique can be found in Gardner (1975).

The most commonly used form of scale was a Likert-type which is a summated rating scale. It consists of a number of opinion statements, each reflecting either a favourable or an unfavourable reaction to the attitude object being studied. Statements reflecting neutral attitudes are often of no value in a Likert scale. Each statement is followed by a set of between two and seven responses, e.g.(Yes/No, Approve / Neutral /Disapprove, Always /Frequently, Sometimes /Never). The five choice Strongly Agree/Agree/Not Sure/ Disagree/Strongly Disagree response pattern is commonly used. Each response is assigned a weight such as 5 for Strongly Agree through to 1 for Strongly Disagree.

A second type of scale, the Differential (Thurstone-type) scale contains a number of opinion statements. These reflect various positions on an attitude continuum. The scale is composed of a large number of items and respondents are asked to select those statements which closely resemble their own beliefs. Each statement has a scale value (unknown to the respondent) and the respondent's score is the mean or median of the scale values of the statements he selects.

Another type of scale is the semantic differential scale. A word or phrase representing an attitude object (e.g. science laboratory, physics lessons) is presented followed by several bipolar adjectives (good/bad, interesting/dull). These adjectives lie on the ends of a 7-point scale and the person responds by marking a position on each scale for each object.

Interest inventories are also used to measure attitudes towards science. They typically contain a list of careers, topics or activities whereby the respondent indicates which one he is interested in.

A final instrument, preference ranking, involves comparisons between the student's enjoyment of science and his enjoyment of other subjects. The student is simply asked to rank the subject he likes in order of preference. Other forms of data gathering methods are clinical and anthropological observations and enrolments (Gardner 1975).

DESIGN OF THE STUDY

The methodology chosen was a systematic and comprehensive survey of primary and elementary teachers attitudes towards science. Data from this survey was combined with data from other components of the study (literature review, Science Council of Canada Study) to provide a composite picture of science education in primary and elementary schools in the Province of Newfoundland.

The instrument used in this study was a modified version of that used by the Science Council of Canada in a national survey of science teacher's attitudes towards science. This instrument had been extensively pre-tested and revised to ensure validity by the Science Council thus reducing any concerns for instrument validity.

The questionnaire was designed to be self-administered. Respondents were directed to circle the appropriate response on a separate answer sheet. This method proved to be quick and easy. The scale for most items was such that,; 1 = No importance, 2 = of little importance, 3 = fairly important and 4 = very important. Also, the questionnaire and accompanying materials were organized into packages and mailed to each respondent. Each respondent was expected to mail their response sheet in a stamped addressed envelope. Also, a letter was addressed to each teacher and school principal outlining the intent of the study. All responses were to be kept confidential and no teacher or school would be identified.

The target population was 127 primary and elementary science teachers in Newfoundland who teach from kindergarten to grade six. The names and location of all schools were obtained from the Newfoundland Department of Education School Board Directory. Also, the principal of each school was contacted by telephone to find out the number of teachers who taught science from kindergarten to grade six in their school. A total of 375 teachers were sent questionnaires as well as a letter concerning the intent of the study.

All data collected using the instrument in this study was analysed using the SPSS computer program. This involved a-nova tests, t-tests and discriminant function analysis.

ETHICS REVIEW

To ensure that proper procedures where undertaken during the research, a copy of the thesis proposal, Questionnaire (See APPENDIX A), Superintendent's Consent Form (See APPENDIX D), Principal's Consent Form (See APPENDIX C), and Teacher's Consent Form (See APPENDIX B) were sent to the Ethics Review Committee in the Faculty of Education at Memorial University, as required in the Graduate Handbook (1993). Permission was granted by the Committee to proceed with the study.

Teachers selected were sent a letter which explained the purpose of the research and which asked them to sign the consent form if they agreed to voluntarily participate in the study.

In keeping with ethical guidelines, it was emphasized that, if at any point in time, they wished to discontinue their involvement in the research they could do so at their discretion. Each teacher was also informed that his or her identity as well as the school would be kept confidential and that the information gathered would be used for research purposes only. As mentioned above, the Superintendents of School Boards as well as the Principal of every school were sent similar consent forms outlining the purpose of the study and its anonymous voluntary aspects.

THE QUESTIONNAIRE

The instrument used in this study was a modified version of an instrument used by the Science Council of Canada in 1984. For the purposes of this research, the instrument was greatly shortened and items slightly modified. This was done because the Science Council study encompassed teachers of science from grades kindergarten to grades twelve throughout the country. This particular thesis, however, was concerned only with primary and elementary teachers of science in the Province of Newfoundland.

The questionnaire was chosen because of its reported high validity and also because of its items which addressed factors that affect primary and elementary teachers attitudes towards science. Those areas, according to the literature review, were related to a need for development of process skills, better educational background and knowledge in science, more effective inservice, and a higher standard of teaching practices.

The questionnaire consisted of two categories which attempted to explore various factors that are possibly contributing to teachers' attitudes towards science teaching. There were a total of 21 questions asked with the majority of items of a Likert - type scale. The next few sections will provide some of the questions that accompanied each category and a brief explanation as to why these questions were chosen. For the complete questionnaire, see APPENDIX A.

CATEGORY I: DEMOGRAPHIC INFORMATION

This section requested personal information from the respondents. It gave an understanding as to who was making the opinions concerning the difficulties with teaching science at the primary and elementary level. The informants were asked to respond to the following questions:

Q.1 What is your age?
Q.2 What is your sex?
Q.3 How many years of overall teaching experience do you have, including the present year?
Q.7 Please indicate the highest level of education you have completed?
Q.8 Please indicate the highest level at which you have studied the following subjects?
Q.20a. Which grades do you teach this year?

CATEGORY II: FACTORS AFFECTING ATTITUDES TOWARDS SCIENCE

This section asked respondents to respond to Likert type items that dealt with factors affecting attitude towards science teaching. As mentioned before, the literature cites four major factors such as poor teaching practice etc. The following will list a sample of some of the questions that addressed each major factor. To view all questions, see questionnaire in Appendix A.

SCIENCE BACKGROUND

These questions attempted to survey the science background of primary and elementary teachers who were responsible for teaching science. Based on the literature review, this area was considered to be the most important contributor to the attitudes of science teachers. The following is a sample of some questions pertaining to this area:

Q.5. Please rate the importance of these areas as representing obstacles to the achievement of your objectives?
b. Background in Science

Q.8. Please indicate the highest level at which you have studied the following subjects?
b. Pure science

Q.10. As preparation for your work as a science teacher, how do you rate the overall quality of
a. Your education in science?

Q.11. How helpful has your post-secondary education been to you as a science teacher in regard to the following areas?
a. Acquiring scientific knowledge
d. Your hands on training as a Science teacher.

INSERVICE

Teachers were not the only stakeholders that are responsible for seeing that students receive an adequate science background. It was the responsibility of other professionals as well to see that primary and elementary teachers foster positive attitudes towards science. The following is a sample of some of the questions that were asked to see if this support has been provided through inservicing.

Q.5. Please rate the importance of these areas as representing obstacles to achievement of your objects?

f. Lack of inservice.

Q.12. How effective is the inservice program provided for science teachers in your school or district?

PROCESS SKILLS

Teachers who have a very limited background in science may also lack a knowledge of the process skills in science. Students of science at any level need to acquire scientific knowledge and skills through active inquiry learning techniques. It is imperative that teachers truely understand the nature of science and how it is practiced. This behaviour must then be modelled to students.

Q.4. How effective do you feel your teaching is at providing for students to achieve each of the following objectives?

c. Developing skills and processes of investigation.

Q.11. How helpful has your post-secondary education been to you as a science teacher in regard to the following areas?

c. Your understanding of the nature of Science.

e. Delivering active-inquiry learning techniques.

Q.14. Please indicate the statement that most closely applies to your situation? In general, I teach my science classes:

a. In a laboratory or specially designed science room.

b In a classroom with occasional access to a laboratory

c. In a classroom with no special facilities for science

TEACHING PRACTICE

There were many reasons why teachers may become frustrated with teaching science, many of which are out of their control. A positive attitude toward science should spill over into the classroom if the proper conditions are in place. The student will only be turned on by science if the teacher exemplifies good science teaching in a proper environment.

Q4. How effective do you feel your teaching is at providing for students to achieve each of the following objectives?
a. Understanding scientific facts concepts, law etc.
b. Developing attitudes appropriate to scientific endeavour.

Q.6. How useful have you found the following types of material to be in your planning?

Q.18. What is your perception of your students' background and abilities to undertake the science courses you teach this year?

Q.19. Which statement most closely describes your teaching situation?

Q.20b. How many different grades do you teach this year altogether?
Q.20c. How many different classes do you teach this year altogether?

As already stated, performing attitudinal research is problematic when there is a lack of a theoretical framework and poor quality of instruments. Often instruments that are used, are not measuring what they purport to measure. With this said, caution was taken in choosing the instrument for this study. This particular instrument, which has been borrowed from the Science Council of

Canada, already has a tested high validity. The instrument intends to measure factors that influence attitudes toward science as opposed to the attitudes that may actually exist. Therefore, responses for each question will be statistically analyzed individually and in groupings to determine if they are factors that influence attitudes towards science. In particular, it was studied to see if questions concerning educational background, inservicing in science, teaching practices and process skills knowledge are factors influencing these attitudes.

CHAPTER IV: RESEARCH RESULTS

The purpose of this research was to determine, through an exploratory study, what factors are influencing primary and elementary teachers attitudes towards the teaching of science. This was accomplished by assessing, through the use of a questionnaire, how Newfoundland primary and elementary teachers thought such factors as inservice in science, teaching practice, educational background in science and process skills affect their attitudes. This study also assessed, more specifically, the hypothesis that there are certain factors such as teacher background, level of education and school resources that would lead teachers into an avoidance of science and which in turn influence teaching practice and technique.

This chapter is divided into three sections. In section 1, demographic information about the teachers themselves is introduced. Section 2 will provide descriptive statistics for the findings from the closed - form Likert scale items. In section 3, an advanced statistical analysis will be presented on the relationship of various factors considered to influence attitudes towards science teaching.

SECTION 1: DEMOGRAPHIC INFORMATION

This section included six questions from the questionnaire, namely #1, #2, #3, #7, #8, #20a. It should be noted here that questions #7, #8 and #20a yield demographic information as well as information concerning factors that influence attitudes towards science teaching. Thus, the original intent of using these questions was not for demographic purposes even though they are discussed in this section. The remainder of this section will provide the actual items from the questionnaire, frequencies and percentages of summarized responses as well as accompanying tables.

Question 1. What is your age? For the One - hundred and twenty-seven teachers that responded to this item, thirty-three (26%) claimed to be over 45 years old, fifty-six (44.1%) were between 36-45 years old and thirty-eight (29.9%) were under 36 years old.

Table 1.1 - Teacher Age

Age	Frequency	Percent
Under 36	38	29.9
36-45	56	44.1
Over 45	33	26.0

Question 2. What is your sex? Thirty-seven (29.1%) of the teachers were male and ninety (70.9%) were female.

Table I.2 - Teacher Gender		
Sex	Frequency	Percent
Male	37	29.1
Female	90	70.9

Question 3. How many years of overall teaching experience do you have, including the present year? Thirty-seven (29.1%) teachers had less than fourteen years experience, ninety (70.9%) teachers had more than fourteen years experience.

Table I.3 - Teacher Experience		
Experience	Frequency	Percent
1 year	4	3.1
2 - 5 years	5	3.9
6 - 9 years	21	16.5
10 - 13 years	7	5.5
14 years or more	90	70.9

Question 7. Please indicate the highest level of education that you have completed? Ninety-seven (76.4%) teachers had completed Bachelor's degrees, twenty-seven (21.1%) had Master's degrees and three (2.4%) of the teachers had Doctoral degrees.

Table 1.4 - Teacher Level of Education

Education Level	Frequency	Percent
Bachelor's degree	97	76.4
Master's degree	27	21.2
Doctoral degree	3	2.4

Question 8. Please indicate the highest level at which you have studied the following subjects?

(a) Mathematics
(b) Pure Science
(c) Education

In 8.a, forty-three (33.9%) of the teachers had not studied any math; eighty-one (63.8%) claimed to have studied math at the Bachelor's level and three (2.4%) studied math at the Masters level. For question 8.b, ninety-one (71.6%) said they had not studied pure science at all; thirty-six (28.4%) said they had completed some pure science university courses. Nobody reported studying science at the Master's level. For question 8.c, ninety-seven(76.4%) teachers claimed they had studied education courses at the Bachelor's level and thirty (23.6%) had completed Master's courses.

Table I.5 - Teacher Enrollment in Math, Science and Education

	Not Studied in University		Bachelor's Degree		Master/Doctoral	
Course	Frequency	Percent	Frequency	Percent	Frequency	Percent
Math	43	33.9	81	63.8	3	2.4
Pure science	91	71.6	36	28.4	0	0
Education	0	0	97	76.4	30	24

Question 20a. Which grades do you teach this year? Thirty-nine (31%) teachers said they teach grades one, two or three and thus these teachers are primary teachers. Eighty-eight (69%) of the teachers were elementary teachers involved with grades four, five or six.

Table I.6 - Number of Primary or Elementary Teachers

Grades	Category	Frequency	Percent
1-3	Primary	39	31
4-6	Elementary	88	69

SECTION 2 - CLOSED FORM LIKERT-SCALE ITEMS

This section included fifteen items which were scored by informants by using a closed formed Likert scale. These questions addressed various factors which influence attitudes towards science teaching.

Question 4. How effective do you feel your teaching is at providing for students to achieve each of the following objectives?

(a) understanding scientific facts, concepts, laws etc.
(b) developing attitudes appropriate to scientific endeavour (curiosity, creativity, scepticism)
(c) developing skills and processes of investigation (observing, classifying, conducting experiments)

Sixty-eight (53.5%) teachers believed their teaching was effective in allowing students to understand scientific facts and concepts. There were fifty-nine (46.5%) teachers that believed their teaching was not effective at accomplishing this objective. With question 4.b, seventy-five (59.1%) teachers reported their teaching to be effective whereas fifty-two (40.9%) claimed to be ineffective. Finally, sixty-five (51.2%) of the respondents said their teaching was effective for developing processes of investigation. Sixty-two (48.8%) thought that they were somewhat ineffective for covering this particular objective.

Table II.1 - Effective Teaching of Objectives

Likert Item	Understanding Scientific Fact		Scientific Endeavour		Process of Investigation	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Very ineffective	12	9.4	17	13.4	13	10.2
Fairly ineffective	47	37.8	35	27.6	49	38.6
Fairly effective	39	30.7	40	31.5	43	33.9
Very effective	29	22.8	35	27.6	22	17.3

Question 5. Please rate the importance of these areas as representing obstacles to the achievement of your objectives?

(a) Curriculum resources (textbooks, computer software)
(b) Background in Science
(c) Physical facilities and equipment
(d) Students' abilities and interests
(e) Institutional arrangements (class size, time allocation)
(f) Lack of inservice

Fifty-three (41.7%) teachers said that curriculum resources were important obstacles when it came to teaching science whereas seventy-four (58.3%) said that curriculum resources were not obstacles. The number of teachers who thought that their background in science was an important obstacle was ninety-five (74.8%). Thirty-two (25.2%) didn't think their science background was an important obstacle. One hundred and three (81.1%) teachers believed facilities and equipment were obstacles with twenty-four (18.9%) saying the opposite. There were ninety-two (72%) teachers saying that student attitudes were not important obstacles and thirty-five (28%) saying they were. Obstacles such as class size and time allocation had thirty (23.6%) teachers feeling these were not important and ninety-seven (76.4%) saying they were important obstacles to the achievement of objectives. Finally, ninety-three (73.2%) teachers claimed that a lack of inservice in science instruction was an important factor that contributed as an obstacle. Thirty-four (26.8%) teachers said that a lack of inservice was not important.

Table II.2 - Obstacles to the Achievement of Objectives

Likert Item	Curriculum Resources		Background in Science		Physical Facilities		Student Attitude		Institutional Arrangement		Lack of Inservice	
	Freq.	Perc.	Freq.	Perc.	Freq.	Perc	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.
No. Importance	42	33.1	7	5.5	2	1.6	62	48.8	9	7.1	9	7.1
Of little Import	32	25.2	25	19.7	22	17.3	30	23.6	21	16.5	25	19.7
Fairly Import.	25	19.7	45	35.4	53	41.7	15	11.8	48	37.8	53	41.7
Very Import.	28	22.0	50	39.4	50	39.4	20	15.7	49	38.6	40	31.5

Question 6. How useful have you found the following types of materials to be in your planning?

(a) Provincially approved texts
(b) Science magazines, journals, newsletters etc.
(c) T.V. or radio programs or tapes
(d) Computer software.

One hundred and ten (86.6%) teachers reported that science textbooks were very important in planning. Seventeen (13.4%) teachers said texts were not very important. Fifty-eight (45.7%) of the respondents claimed that science magazines were not important to planning. Sixty-nine (54.3%) teachers rated such materials as important in planning science lessons. Sixty-five (51.2%) said that T.V. programs were not important whereas sixty-two (48.8%) said they were important for planning. When teachers were asked how useful computer software was for teaching science, eighty-one (63.8%) claimed it wasn't important but forty-six (36.2%) said it was important.

Table II.3 - Materials Useful in Planning

Likert Item	Texts		Science Magazines		T.V.		Computer Software	
	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
No Importance	6	4.7	9	7.1	12	9.4	20	15.7
Of Little Importance	11	8.7	49	38.6	53	41.7	61	48
Fairly Important	50	39.4	48	37.8	40	34.5	34	26.8
Very Important	60	47.2	21	16.5	22	17.3	12	9.4

Question 9. How long has it been since you last took a post-secondary course in each of the following areas?

(a) Mathematics
(b) Pure Science
(c) Education

There were forty (31.5%) teachers who had not studied any mathematics. Fifty-five (43.3%) claimed that it had been more than ten years since they had done a math course. Twenty-one (16.5%) had not completed a math course in 6-10 years; ten (7.9%) had not done math in 1-5 years and only one teacher was currently enrolled in a mathematics course. In pure science, ninety-one (71.6%) teachers said they had never completed a pure science course. The other thirty-six (28.4%) had not done any science in the last ten years. Also, fourty-one (32.1%) of the respondents had not taken an education course in ten years. For thirty-three (26%) teachers, it had been 6-10 years while fifty-one (40.2%) claimed to have not done education in 1-5 years. Only two teachers were currently enrolled.

Table II.4 - Completion of Post-Secondary Courses

Likert Item	Mathematics		Pure Science		Education	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Never Taken	40	31.5	91	71.6	0	0
More Than 10 Years	55	43.3	14	11.0	41	32.1
6-10 Years	21	16.5	13	10.2	33	26.0
1-5 Years	10	7.9	9	7.1	51	40.2
Currently Enrolled	1	.8	0	0	2	1.6

Question 10. As preparation for your work as a science teacher, how do you rate the overall quality of:

(a) Your education in science?
(b) Your training as a teacher?

Ninety-four (74%) teachers rated their education in science to be unsatisfactory. Thirty-three (26%) rated their education in science to be satisfactory. Also, one hundred and five (82.7%) believed their training as a teacher was satisfactory whereas twenty-two (17.3%) said their training was unsatisfactory.

Table II.5 - Quality of Education and Training

Likert Item	Education in Science		Teacher Training	
	Frequency	Percent	Frequency	Percent
Very Unsatisfactory	39	26.8	3	2.4
Fairly Unsatisfactory	60	47.2	19	15.0
Fairly Satisfactory	20	15.7	75	59.0
Very Satisfactory	13	10.2	30	23.6

Question 11. How helpful has your post-secondary education been to you as a science teacher in regard to the following areas?

(a) Acquiring scientific knowledge and skills
(b) Understanding the ways children learn science
(C) Understanding the nature of science
(d) Hands on training as a science teacher
(e) Delivering active - inquiry learning techniques.

Eighty-nine respondents (70.1%) said that their post-secondary education had not been very helpful in acquiring scientific knowledge and skills. Thirty-eight (29.9%) did say that their post-secondary education was helpful. Sixty-seven (52.8%) teachers said their education was very helpful whereas sixty (47.2%) of them believed it wasn't helpful in their understanding the ways children learn science. It was seventy-two (56.7%) teachers who claimed to not understand the nature of science and fifty-five (43.3%) saying that they did understand. In terms of hands-on training as a science teacher, sixty-nine (54.3%) said they did not receive good training whereas fifty-eight (45.6%) said their training was helpful. Finally, for the last item concerning active - inquiry learning techniques, fifty-five (43.3%) respondents claimed that their post-secondary education was not helpful and seventy-two (56.7%) saying it was helpful.

Table II.6 - Post - Secondary Education on Science Teaching

Likert Item	Sci. Knowledge		Children & Sci.		Nature of Sci.		Hands on Train.		Inquiry Tech.	
	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
No Help	31	24.4	9	7.1	17	13.4	27	21.3	17	13.4
Little Help	58	45.7	58	55	55	43.3	42	33.1	38	29.9
Some Help	34	26.8	43	33.9	37	29.1	39	30.7	51	40.2
Much Help	4	3.1	17	13.4	18	14.2	19	15.0	21	16.5

Question 12. How effective is the inservice program provided for science teachers in your school or district?

Fourty-nine(38.6%) teachers claimed that the inservice program provided for science was nonexistent in their district. Another fourty-three(33.8%) teachers said that the inservice program was ineffective. Only thirty-three(27.5%) of the teachers rated their inservicing for science to be effective.

Table II.7 - Effectiveness of inservice

Likert Item	Frequency	Percent
Non - existent	49	38.6
Completely ineffective	15	11.8
Fairly ineffective	28	22
Fairly effective	29	22.8
Very effective	6	4.7

Question 13.(a) If you had a choice, would you avoid teaching science altogether?

Question 13.(b) If "yes", for which of the following reasons.

(a) Lack of resources
(b) Inadequate background
(c) Dislike of science
(d) Working conditions
(e) Student attitudes
(f) inadequate inservice
(g) Poor teaching practices.

Thirty-two (25.2%) teachers said yes; seventy-nine (62%) said they would not avoid teaching science and sixteen (12.6%) claimed they were undecided. For the thirty-two teachers who said they would rather avoid teaching science, twenty-three chose inadequate background as one of their reasons, three said they disliked science, twenty-four chose inadequate inservice and fifteen said it was due to lack of resources. There were no teachers who chose working conditions, student attitudes or poor teaching practice as a reason for avoiding science teaching.

Table II.8 - Reasons for Avoiding Science Teaching

Reasons for Avoiding Science	# of "yes" responses
Lack of Resources	15
Inadequate Background	23
Dislike of Science	3
Working Conditions	0
Student Attitudes	0
Inadequate Inservice	24
Poor Teaching Practice	0

Note: Teachers could choose more than one response

Question 14. Please indicate the statement that most closely applies to your situation? In general, I teach my science classes:

(a) In a laboratory or specially designed science room
(b) In a classroom with occasional access to a laboratory
(c) In a classroom with no special facilities for science

Four (3.1%) teachers said they teach science in a laboratory setting; thirty-eight (29.9%) in a classroom accessing a laboratory and eighty-five (66.9%) from a classroom with no special facilities.

Question 15. Which statements most closely apply to your situation regarding equipment and supplies for teaching science:

(a) There is ample equipment for student use
(b) There is inexpensive, donated, or outdated equipment for student use
(c) There is adequate equipment for demonstration purposes
(d) There is virtually no science equipment at all
(e) There is access to computing facilities
(f) There is adequate audio-visual equipment

Twenty-one teachers (16.5%) said there was ample equipment; sixteen (12.6%) said there was inexpensive, donated equipment and fourty-one (32.2%) teachers reported virtually no science equipment. There were thirty-one (24.4%) teachers who claimed to have adequate equipment; six (4.7%) saying there was access to computing facilities and twelve (9.4%) who had adequate audio - visual equipment.

Question 16. Overall, how do you rate the quality of the facilities and equipment available to you for teaching science?

(a) Very poor
(b) Poor
(c) Good
(d) Excellent

Ninety-three (73%) teachers claimed that the equipment that they had for teaching science was in poor condition and forty-four (34.6%) said that the equipment was in good condition.

Table II.9 - Instructional Setting and Equipment

Equipment/Supplies	Frequency	Percent	Teaching Setting	Frequency	Percent
Ample	21	16.5	Lab Only	3.1	3.1
Inexpensive, donated	16	12.6	Lab & classroom	29.9	29.9
Virtually absent	41	32.2	Classroom only	66.9	66.9
Adequate	31	24.4			
Computing	6	4.7			
Audio-visual	12	9.4			
Poor Quality	93	73			
Good Quality	44	34.6			

Question 17. What is your perception of your students' attitudes toward learning science this year? The majority of my students are:

(a) Indifferent
(b) Fairly motivated
(c) Highly motivated

Six (4.7%) teachers believed their students attitudes were indifferent, ninety (70.9%) thought their students were fairly motivated and another thirty-one (24.4%) teachers rated their students as highly motivated.

Question 18. What is your perception of your students' background and abilities to undertake the science courses you teach this year?

(a) Completely inadequate
(b) Fairly inadequate
(c) Fairly adequate
(d) Completely adequate

One hundred and ten (86.6%) teachers believed their student's abilities were adequate whereas seventeen (13.4%) teachers said that student's abilities were not adequate.

Table II.10 - Teachers Perception of Student Attitude and Ability in Science

Student Ability	Frequency	Percent	Student Attitude	Frequency	Percent
Completely Inadequate	1	.8	Indifferent	6	4.7
Fairly Inadequate	16	12.6	Fairly Motivated	90	70.9
Fairly Adequate	96	75.6	Highly Motivated	31	24.4
Completely Adequate	14	11.0			

Question 19. Which statement most closely describes your teaching situation?

(a) I teach only science subjects
(b) I teach both science and mathematics
(c) I teach a variety of subjects of which science is only one

One teacher said that science was the only subject he/she taught; nine (7.1%) claimed to teach science and mathematics only whereas one hundred and seventeen (92.1%) teachers taught science and a variety of other subjects.

Question 20.b. How many different grades do you teach this year altogether?

(a). 1 only
(b) 2
(c) 3
(d) more than 3

Sixty-six (52%) teachers claimed to teach only the one grade; thirty-one (24.4%) claimed to have two different grades; twelve (9.4%) said they taught three different grades and finally eighteen teachers (14.2%) claimed to teach more than three different grades.

Question 20.c. How many different classes do you teach this year altogether?

(a) 1 only
(b) 2-3
(c) More than 3

The following is a breakdown of the number of different classes being taught: fifty (39.4%) teachers who teach the same class; twenty-nine (22.8%) teachers having two to three different classes and forty-seven (37%) teachers having more than three different classes.

Question 20.d. What is the average number of students in your classes?

(a) 20 or less
(b) 21-25
(c) 26-30
(d) 31-35
(e) over 35

There are thirty-one (24.4%) teachers with less than twenty students per class; fifty-eight (45.7%) with 21-25 students; thirty-one (24.4%) with 26-30 students; two (1.6%) teachers with 31-35 students and five (3.9%) teachers with over 35 students in a class.

Table II.11 - Demographical Information on Science Teaching

Subj. Taught	Freq.	Perc.	Diff. Grades	Freq.	Perc.	Diff. Classes	Freq.	Perc.	# of Students	Freq.	Perc.
Science only	1	.8	One	66	52	one	50	39.4	Less 20	31	24.4
Sci. & Math	9	7.1	Two	31	24.9	Two - three	29	22.8	21-25	58	45.7
Sci & variety	117	92.1	Three	12	9.4	More than 3	47	37	26-30	31	24.4
			Three or more	18	14.2				31-35	2	1.6
									over 35	5	3.9

Question 21.a. How adequate is the amount of time allocated to science (based on your view of its importance relative to the other subjects of the curriculum)?

(a) Inadequate
(b) About right
(c) Adequate

Question 21.b. How much time do you have to cover science courses?

(a) Too little time
(b) Just enough time
(c) More than enough time

Thirty-three (26 %) teachers said that the time allocation was inadequate while fifty-three (41.7%) and forty-one (32.3%) said time allocation was about right and adequate respectively. In terms of time to cover science, fourty-one (32.3%) teachers said there was too little time; seventy-six (59.8%) said there was just enough time and finally ten (7.9%) teachers saying there was more than enough time.

Table II. 12 - Time Allocation for Science

Relative to Other Subjects	Frequency	Percent	Coverage of Science	Frequency	Percent
Inadequate	33	26	Too little time	41	32.3
About right	53	41.7	Just enough time	76	59.8
Adequate	41	32/3	More than enough time	10	7.9

SECTION III: ADVANCED STATISTICAL ANALYSIS

This section provides statistical analysis that tested the hypothesis of the study: there are certain background, education and school factors that would lead to teachers wanting to avoid teaching science and this in turn, influences teaching practice and technique. Based on the hypothesis, statistical relationships and significance for the following model will be considered.

Figure 1: Hypothesis for the study

Teacher Background		Teaching Practice
School Resources	Avoid Science	
Teacher Level of Education		Teaching Technique

Statistical data concerning relationships for the first half of the model will be presented. This part will deal with such factors as the effect of teacher background, school resources and level of education factors towards the attitude of avoiding science teaching. The second part of this section will be concerned with how the attitude of wanting to avoid science influences teaching practices and techniques.

The first variable, namely teacher background, was analysed to determine its effect on teacher's avoidance of science. It should be noted that this variable included such factors as level of education, teaching experience, amount of inservice and teacher age. The factor of age was found to have no significant effect on whether or not teachers would avoid teaching science. When the variables of age and avoiding science were analysed they reported a Spearman correlation value of -.03 and a level of significance of (p= .78).

Table III.1 - Effect of Age on Avoidance of Science

Age	Avoid Science					
	Yes		Undecided		No	
	Frequency	Percent	Frequency	Precent	Frequency	Percent
Under 36	9	23.7	3	7.9	26	68.4
36-45	16	29.1	7	12.7	32	58.2
Over 45	7	21.2	6	18.2	21	63.6

Note: level of significance (p =.78), Spearman correlation= -.03

Another background factor, namely teacher experience, was also found to have no significant influence upon teachers avoiding science teaching. Levels of significance are reported in the tables that follow.

Table III.2 - Effect of Teacher Experience on Avoidance of Science

	Avoid Science					
	Yes		Undecided		No	
Teacher Experience	Frequency	Percent	Frequency	Percent	Frequency	Percent
Less than 14 years	10	27	1	2.7	26	20.3
More than 14 years	22	24.7	15	16.8	53	59.6

Note: level of significance (p= .46), Spearman correlation= -.066

A third background factor, level of education, also had no significant effect upon teachers wanting to avoid science teaching.

Table III.3 - Effect of Teacher Education Level on Avoidance of Science

	Avoidance of Science					
	Yes		Undecided		No	
Level of Education	Frequency	Percent	Frequency	Percent	Frequency	Percent
Bachelor	24	25.3	16	16.8	56	58.9
Masters/Doctoral	8	27.6	-	-	21	72.4

Note:level of significance ($p=.39$), Spearman correlation =.077

A fourth background factor referring to the effect of effective inservice as it relates to the avoidance of science had a significant effect that contributed as to whether teachers would avoid teaching science.

Table III.4 - Effect of Inservice Participation on Avoidance of Science

	Avoid Science					
	Yes		Undecided		No	
Effective Inservice	Frequency	Percent	Frequency	Percent	Frequency	Percent
Non-existent	17	34.7	6	12.2	26	53.1
Ineffective	10	23.3	4	9.3	29	67.4
Effective	5	14.7	6	17.6	24	70.6

Note: level of significance ($p=.05$), Spearman correlation =.17

A second variable including school resources was considered to determine its effect on whether teachers avoid teaching science in primary and elementary grades. The school resources factor included such things as curriculum resources (textbooks), physical facilities and equipment, institutional arrangements and student abilities. All of these factors except one were found not to be significant contributors to teachers avoiding science. The only factor teachers found to be significant in terms of avoiding science was that of using curriculum resources such as science magazines and journals.

Table III.5 - Effect of School Factors on Avoidance of Science

		Avoidance of Science					
		Yes		Undecided		No	
School Factor	Import.	Frequency	Percent	Frequency	Percent	Frequency	Percent
Curriculum Resources	Yes	13	25.0	9	16.2	31	59.6
(textbooks)	No	19	25.7	7	9.5	48	64.9
Physical Facilities and	Yes	26	25.5	14	13.4	63	61.8
Equipment	No	6	25.0	2	8.3	16	66.7
Institutional	Yes	17	24.6	8	14.0	45	65.2
Arrangements (class size)	No	15	26.3	8	14.0	34	59.6
Students Abilities	Yes	27	28.1	13	11.1	57	59.4
	No	5	16.7	3	10.0	22	73.3
Curriculum Resources	Yes	9	14.5	10	15.3	44	71.0
(Science Magazines)	No	20	34.5	5	8.6	33	56.9

Note: Curr. Res.(text) level of significance (p=.69), Spearman correlation= -.04
Phy. Facilities level of significance (p=.73), Spearman correlation= -.03
Inst. Arrange. level of significance (p=.16), Spearman correlation = -.13
Stud. Ability level of significance (p=.59), Spearman correlation =.04
Curr. Res.(Mag) level of significance(p=.04), Spearman correlation =.18

Twenty (34.5%) teachers who said that science magazines and journals were not important in their lesson planning said yes to avoiding to teach science. Nine (14.5%) who said that these materials were important in planning also said yes to avoiding science. Thirty-three (56.9%) teachers who said these materials were not important said they would not avoid science teaching whereas fourty-four (71.0%) teachers who claimed these materials to be important said no to avoiding science. The remaining fifteen (12%) teachers reported to be undecided. (See table III.5)

A third variable called teacher level of education was also tested to study its effect on teachers avoidance of science instruction. This variable included such items as background in science, level of education and training as a science teacher. A background in science was reported by teachers to be not significant in terms of their avoidance of science. Teachers being asked if their background in science was an obstacle to the achievement of their objectives, seemed to have no significant effect on their saying yes to an avoidance of science.

Table III.6 - Effect of Background in Science on Avoidance of Science

	Avoid Science					
	Yes		Undecided		No	
Background in Science	Frequency	Percent	Frequency	Percent	Frequency	Percent
Important	25	26.6	14	2	55	58.5
Not Important	7	21.9	14.9	6.3	24	75

Note:level of significance (p=.17). Spearman correlation= -.12

Another education factor, level of education, was also found to be not significant.

Table III.7 - Effect of Level of Education on Avoidance of Science

	Avoid Science					
	Yes		Undecided		No	
Education Level	Frequency	Percent	Frequency	Percent	Frequency	Percent
Bachelor's Degree	24	24.7	15	15.5	58	59.8
Master's Degree	8	29.6	-	-	19	70.4
Doctoral Degree	-	-	-	-	2	100.0

Note:level of significance (p=.39),Spearman correlation =.08

A third education factor referring to teachers training as a science teacher, in particular, teachers acquiring scientific knowledge, was found to have a significant effect (p=.004) on teachers saying yes to avoidance of science. (Spearman correlation = .25) In particular, for those who said "yes" they would avoid science teaching, twenty-four (34.8%) teachers claimed their training to acquire scientific knowledge was not helpful whereas eight (14%) said their training was helpful. Thirty-six (52.2%) who said no to avoiding science said their training was not helpful whereas fourty-three (75.4%) of those teachers saying no said training was helpful.

Table III.8 - Effect of Teacher Training in Acquiring Scientific Knowledge on Avoidance of Science

	Avoid Science					
	Yes		Undecided		No	
Teacher Training	Frequency	Percent	Frequency	Percent	Frequency	Percent
No Help	24	34.8	9	13	36	52.2
Helpful	8	14.0	7	12.2	43	75.4

Note: level of significance (p=.004), Spearman correlation = .25

Also, in terms of the education factor, teachers were asked to rate their education in science and their training as a science teacher. Both of these areas were found to be significant reasons for teachers avoiding science teaching. Education in science had a significance level of r=.001(Spearman correlation = .29) and training as a science teacher having a p=.04 (Spearman =.18) significance level.

For those teachers saying they would avoid science, twenty-two (36.7%) claimed their education in science was unsatisfactory and ten (15.2%) said it was satisfactory. Teachers who said no to avoiding science were such that twenty-nine (48.3%) were unsatisfied and fifty (75.8%) were satisfied with their education in science. With regards to training as a teacher and for those who said yes to avoiding science, five (22.7%) claimed to be unsatisfied and twenty-seven (26%) satisfied with there training. People who wouldn't avoid science teaching were such that ten (45.5%) were unsatisfied and sixty-nine (66.3%) satisfied with being trained as a science teacher at a post secondary institution.

Table III.9 - Effect of Education in Science and Training as a Teacher on Avoidance of Science

		oid Science					
		Yes		Undecided		No	
Education Factor	Rating	Freq.	Percent	Freq.	Percent	Freq.	Percent
*Training as a Teacher	Unsatisfactory	5	22.7	7	31.8	10	45.5
	Satisfactory	27	26	9	8.7	69	66.3
Education in Science	Unsatisfactory	22	36.7	9	15	29	48.2
	Satisfactory	10	15.2	7	10.6	50	75.8

Note:*level of significance (p=.001),Spearman correlation =.29
level of significance (p=.04), Spearman correlation =.18

The second half of my hypothesis was concerned with if saying yes to an avoidance of science teaching could influence teaching practice and/or teaching technique (delivering process skills). The variable teaching practice referred to such items as perception of effective teaching, perception of students' attitudes towards learning science and teaching situation.

Whether or not teachers would avoid teaching science had no significant effect upon their perception of effective teaching as well as student's attitudes towards learning science.

Table III.10 - Effect of Avoidance of Science on Effective Teaching

		Avoidance of Science					
		Yes		Undecided		No	
Objective		Freq.	Percent	Freq.	Precent	Freq.	Percent
Understanding Sci.	Effective	17	56.9	8	50	43	59.7
facts	Ineffective	13	43.3	8	50	29	40.3
Developing Scientific	Effective	19	63.3	10	66.7	45	59.2
Endeavour	Ineffective	11	36.7	6	33.3	31	40.8
Developing Process	Effective	.5	55.6	11	73.3	38	50.7
Skills	Ineffective	12	44.4	5	26.7	37	49.3

Note: Sci. Facts level of significance (p=.61),Spearman correlation =.05
Sci. End. level of significance (p=.61),Spearman correlation = -.04
Proc. Skill. level of significance (p=.36), Spearman correlation = -.08

Table III.11 - Effect of Avoidance of Science on Student's Attitudes Towards Science

	Avoidance of Science					
	Yes		Undecided		No	
Perception of Student Attitudes	Frequency	Percent	Frequency	Percent	Frequency	Percent
Indifferent	2	6.3	-	-	5	5.1
Fairly Motivated	26	81.3	12	80	51	64.6
Highly Motivated	4	12.5	3	20	24	30.4

Note: level of significance (p=.07), spearman correlation = .16

Also, there was no significant relationship found between avoidance of science and teaching situation referring to the number of different grades and classes being taught by one teacher. For example, the thirty-two (25.4%) teachers who claimed they would avoid teaching science, seventeen (34%)

instructed the same class, nine (32.1%) had two different classes and six (12.8%) teachers were responsible for more than three different classes.

Table III.12 - Effect of Avoidance of Science on Teaching Situation

	Avoidance of Science					
	Yes		Undecided		No	
Different Grades	Frequency	Percent	Frequency	Percent	Frequency	Percent
1 only	21	31.8	5	7.6	40	60.6
2	8	25.8	7	22.6	16	51.6
3	1	8.3	1	8.3	10	83.3
More than 3	2	11.8	2	4.8	13	76.5

Note: level of significance (p=.14), Spearman correlation - .13

The variable teaching technique included such areas as time spent instructing in the laboratory, as well as delivering active - inquiry learning techniques. Whether or not teachers would avoid science had a significant effect upon both of these aspects of teaching technique. For instance, twenty-seven (84.4%) teachers who said yes to avoiding science, taught in a classroom with no special facilities for science. There were no teachers claiming to teach science solely in a laboratory setting.

Table III.13 - Effect of Avoidance of Science on Instructional Setting

	Avoidance of Science					
	Yes		Undecided		No	
Instructional Setting	Frequency	Percent	Frequency	Percent	Frequency	Percent
Lab Only	-	-	-	-	4	5.1
Class and Lab	5	15.6	2	13.3	31	39.2
Classroom Only	27	84.4	13	86.7	44	55.7

Note: level of significance (p=.0007), Spearman correlation = -.30

Also, with regards to delivering active-inquiry learning techniques, nineteen (34.5%) teachers who said they would avoid teaching science also claimed they were not confident in teaching science in this manner. Thirteen (18.3%) teachers of this group felt that their students were actively involved in learning science.

This section also provides a discriminant function analysis for the first half of the hypothesis model. Specifically, an analysis was completed on the factors of teacher background, school resources and level of education as they relate to an avoidance of science. Seventy-four percent of the teachers who indicated a response for the question of avoiding science were categorized based on these three factors. From this seventy-five percent of respondents, the analysis classified ninety-one percent of teachers as those who would respond "no" if asked to avoid teaching science given they had adequate resources, background and education. From the same "no" group eight percent claimed they would avoid science teaching even if they had good resources, background and education in science. For the group of teachers who responded "yes" to avoiding science, fifty-two percent were predicted to say "no" to avoiding science if conditions were good (adequate resources, etc.). Also, fifty percent of the undecided group of teachers were predicted to say "no" to avoiding science if the conditions were good.

Table III.14 - Classification Results for the Discriminant Function Analysis of Teacher Background, School Resources and Level of Education for Avoiding Science

Actual Group		No. of Cases	Predicted Group Membership 1	2	3
Group: Yes Would Avoid	1	29	12 41.4%	2 6.9%	15 51.7%
Group Undecided	2	14	0 0%	7 50.0%	7 50.0%
Group: No Would Teach	3	75	6 8.0%	1 1.3%	68 90.7%

Note: Percent of "grouped" cases correctly classified: 73.73%

Table III.15 - Canonical Discriminant Functions for Table III.14

Fcn	Eigen-Value	Percent of Var.	Cum. Percent	Canonic Corr	After Fcn	Wilks' Lambda	Chi-Square	deg fre	Sig
1*	.2595	64.10	64.10	.4539	0	.693230	39.937	26	.0396
2*	.1453	35.90	100.00	.3562	1	.873101	14.792	12	.2530

Note: *Marks the 2 canonical discriminant functions remaining in the analysis.

Table III.15 provides data on functions that were produced by the discriminant function analysis. These functions can predict which teachers will go into one of two categories; one category referring to teachers who will avoid science, the other category being teachers who will not avoid science. Only one function that was produced was statistically significant with a value of 0.0396. Types of questions involved and correlations for these questions as they relate to an avoidance of science are included in Table III.16.

Table III.16 - Pooled Within - Groups Correlations Between Discriminating Variables and Canonical Discriminant Functions

Item	Function #1	Item	Function #1
Q. 10B	0.61147	LEV.ED	0.31377
Q. 5B	-0.40009	Q. 6B	0.15837
Q. 10A	0.38250	Q. 20D	0.03475
Q. 5C	-0.27034	EXPER	-0.26882
Q. 18	-0.14244	AGE	-0.11561
Q. 9B	0.39531	Q. 5A	-0.11693
Q. 12	0.26209		

Note: Variables ordered by size of correlation within function

Analysis of Table III .16 indicates that if a high score is obtained on this particular function, a teacher is going to want to teach science. However, if a low score is obtained, there is a chance, although it is not certain, that a teacher will want to avoid teaching science.

The following items, from Table III.16, level of education, experience, age, question #9b and question #6b have to do with the background status of the teachers. It was determined that if a teacher was highly educated, young and had less experience, then that teacher was more likely to want to teach science. The experience variable could be given greater consideration as well since this variable had a higher correlation (-.26882).

Analysis of question #9b indicated that teachers who had more recently completed a science course were more likely to teach science. Also, question #6b indicated that teachers who were willing to use resources such as science magazines in their planning were more likely to teach science.

Items #5a, #5b, #5c, #10a and #10b have to do with teachers perceptions of needs for teaching science. Analysis of question #5a indicates that if teachers perceive that curriculum resources are important obstacles to achieving objectives then they are more likely to avoid science. For question #5b, it was determined that teachers who rated a background in science to be important were less likely to want to avoid teaching science. Question #5c indicates that teachers who rate equipment to be important were less likely to teach science as well. Overall, if teachers perceived these three factors as important, they were less likely to want to avoid science. Also, for question #10a and #10b, teachers thought that if their education and training as science teachers was satisfactory, then they were more likely to want to teach science.

Finally, question #12 was concerned with teacher's rating of inservice in science. It was found that if teachers rated inservicing to be effective, they were more likely to be categorized as wanting to teach science.

CHAPTER V: SUMMARY AND RECOMMENDATIONS

This research has explored various factors that are believed to influence the attitudes of primary and elementary science teachers. The study sought to describe, more specifically, the responses of these teachers to factors reported in the research literature such as an inadequate background in science, a lack of knowledge about process skills, ineffective inservicing and poor teaching practice.

The following hypothesis was also tested in this study: there are certain factors such as teacher background, school resources and level of education that lead teachers into an avoidance of science teaching which in turn influences teaching practice and technique. Results concerning the impact of these factors were discussed.

BACKGROUND IN SCIENCE

In doing research for this study, research articles commented more on teacher background in science than any other factor as influencing attitudes towards science. Harty and Salama (1985), claim that poor background in science influences many other factors that result in elementary teachers having problems with science. Ten years ago, the Science Council's national study discovered that over half the elementary teachers had not taken a university-level course in mathematics and nearly three-quarters of them had not taken science. In reporting on attitudes towards science, it appears that teachers' degree of satisfaction with their education in science is roughly proportional to the amount of it they have had. The least satisfied were the elementary teachers and the most satisfied, the senior-years teachers. Also, teachers who wished to avoid teaching science most often cited an inadequate background as the major reason (Orpwood, 1984).

It is mandatory for Newfoundland primary and elementary teachers to complete science 115A and 115B which are education courses. However, a large number of respondents (71.6%) for this study claimed that they had not studied any pure science (chemistry, physics, and biology) courses. As a matter of fact, teachers rated any education that they had received in science to be unsatisfactory. If teachers are so lacking in scientific knowledge, one would logically think this should cause problems in conveying knowledge to students. It was found that a large majority (74.%) of teachers thought that their lack of background in science was an important obstacle to the achievement of objectives in science. It is therefore probably safe to conclude that primary and elementary teachers are weak in science. To what extent this factor affects the quality of science education that students are receiving is not so clear. One can only predict that a lack of knowledge by the teacher would bring about a less desirable set of attitudes and less effective teaching. However, the research literature is vague in reporting on this premise.

Paradoxically, when teachers are asked if given a choice, would they avoid teaching science altogether, only a small minority (25.2%) said yes. For the same group, an inadequate background in science was the main reason chosen for avoiding science. If we consider an avoidance of science to be an attitude toward science, then based on numbers from this study, teachers seem to think positively about wanting to be science teachers. Teachers are claiming that they would teach science when asked to do so but, at the same time, are aware of their own shortcomings with regards to science knowledge. Further research is thus needed in this area.

The hypothesis of this study treated an avoidance of science as an attitude variable. It was tested to see if inadequate science education had a significant effect on this attitude variable. A significant relationship was found in that those teachers who claimed to have inadequate training and education as a science teacher were more likely to want to avoid science teaching. This was the only factor in the model that was significant.

INSERVICE IN SCIENCE

Ten years ago, a large number of elementary teachers reported having had no experience of the many inservice training alternatives. For example, 71.1 percent of elementary teachers reported never having attended a conference or meeting organized by a science teachers' association (Orpwood 1984).

If teachers already in the field are claiming to have an inadequate background in science, then it is only fitting that increased inservice be provided. Significant positive increase on background in science, attitude toward using science equipment, doing science laboratory work and discussing science topics occur when teachers are inserviced with hands-on science activities (Bitner, 1990). In this study, when primary and elementary science teachers were asked about the effectiveness of the inservice program provided in their school or district, 72.4% claimed it was ineffective. Even more disturbing, 38.6% of respondents claimed that inservicing was non-existent (Table II.6). Statistics such as these, claiming the ineffectiveness of inservice, contradict what researchers such as Bitner say about inservicing. However, the research literature also says that a common complaint by teachers is that they are expected to learn so much in so little time and that no follow up occurs. Surely, if this is what's happening to Newfoundland teachers, then attitudes towards science will not improve. Teachers obviously need better inservicing in science since many feel (73.2%) that a lack of inservice is a major factor that prevents them from achieving many objectives in science (Table II.2). Also, when teachers were asked to choose reasons why they would avoid teaching science, the response of inadequate inservice was the most chosen by respondents. It is interesting to note that lack of inservicing was the only significant background factor that resulted in teachers avoiding science for the hypothesis of this study. Teachers need to develop a louder voice to address this problem of ineffective or non-existent inservicing. All stakeholders in education need to realize the importance of this factor as it surely shapes attitudes towards teaching science. No matter what the attitude of a science teacher is, whether it be positive or negative, there is always the potential for inservicing to improve science instruction. For this to happen, inservicing has to be brought into existence and has to be effective.

IMPLEMENTATION OF PROCESS SKILLS

A lack of understanding of the nature of science is the major reason that elementary school teachers indicate a dislike or fear of science (Raun and McGlathey, 1970). If this premise is true, then one can conclude that primary and elementary science teachers are not proficient in process skills. All science teachers need exposure to the processes of science so that it will carry over into the classroom or laboratory. A teacher exhibiting and preaching the importance of process skills will hopefully instill the same behaviour in students. Ten years ago, Canadian primary and elementary teachers believed that objectives such as developing attitudes appropriate to scientific endeavour as well as skills and processes of investigation were very important (Orpwood 1984). This study attempted to determine if Newfoundland teachers understand the nature of science and whether or not the learning environment where science is taking place is conducive to these process skills. Thus, it is important to know what role does such a factor as a lack of process skills have on teacher attitude towards science. Also, such attitudes as an avoidance of science and whether or not they influence teaching technique was tested in the hypothesis of this study.

The results of this study are somewhat puzzling as to where teachers stand for implementing process skills in their classroom. For instance, half of the respondents reported that they were effective teachers for developing process skills in their science classes. From this we can probably conclude that primary and elementary teachers have a good understanding of the nature of science. However, when responding to another item, a majority of teachers claimed to not understand the nature of science and to possess poor hands on training as science teachers.(Table II.6). These teachers blame their post-secondary education for these shortcomings. Teachers also blamed a lack of resources as one of the major reasons for avoiding to teach science. Only 15% of teachers said that there was ample equipment for teaching science in their schools. Eighty-five teachers reported teaching science from a classroom with no special facilities and 81% of teachers reported inadequate facilities and equipment as being obstacles to the achievement of objectives. One may argue that teachers are unlikely to develop the processes of science in their students when they don't even have the basic tools to make a start. If music and computer classes were so deficient in resources and equipment, such programs would probably become non-existent. Yet, science teachers are expected to continue on and miraculously develop the process skills of science solely from a textbook. This could probably be the reason why so many teachers (110) claim to rely on the textbook more than any other resource. According to the literature, research data overwhelmingly supports the fact that teachers who are trained in inquiry-oriented process approaches to science classes have greatly enhanced attitudes towards science when compared to teachers in text-book oriented science classes (Kyle, Bonnstetter and Gadsden, 1988). Thus the apparent message to all stakeholders in education is that Newfoundland primary and elementary science teachers need more training in this area and adequate equipment and supplies for their schools. Finally, with regards to the hypothesis of this study, it was found that teachers who said yes to avoiding science were the same teachers who were teaching in a non-laboratory environment and were unfamiliar with active-learning teaching techniques (process skills in science).

TEACHING PRACTICES

There are many factors that have been found to influence why and what teachers do when they implement an elementary science program.(Schibeci and Riley, 1986). One may argue that such factors as background in science, effectiveness of inservice and degree of knowledge of process skills may influence teaching practices in science. Teaching practices may relate to teachers attitudes towards science. Orpwood's national study found that very few teachers believed that their own teaching practices were reasons for developing an attitude of wanting to avoid science.

According to Shymansky, Yore and Good (1991), textbooks are an important instructional medium in elementary school science classrooms. This agrees with findings of this study where teachers claim to heavily depend on the text. Scholars may argue that reliance on textbooks may suggest that there is very little dynamic teaching occurring in primary and elementary science classes. However, this study reported a majority of teachers believing that their teaching practices were effective in allowing students to understand scientific facts and concepts and also for developing attitudes appropriate to scientific endeavour such as curiosity, creativity and skepticism.

Findings by Schibeci and Riley (1986) support the view that what elementary science teachers do in the classroom makes a difference in student attitude towards science. When teachers for this study were asked to rate the perception of their students' attitudes towards learning science, approximately 95% claimed their students were very motivated. Unless these teachers have the wrong perception, one may conclude that the teachers themselves must have positive attitudes towards science since their students seem to exhibit such an attitude.

According to a study by Barrow (1991), time is a scarce commodity to elementary teachers and influences their teaching in particular ways. Teachers for this particular study believed that the amount of time allocated to science in relation to other subjects was adequate. They also believed that they had plenty of time to cover content material in science courses. Also, teachers for this study who are subscribing to traditional teaching practices seem to believe they are being effective. However, these very same teachers say they do not find other resources such as computer software or T.V. programs etc. important for science classes. Newfoundland primary and elementary teachers supported what the literature indicated. For example, according to Good (1991), teachers perceive media-instructed laboratories and computer instruction as less effective than science reading for elementary students. Finally, it was found that teachers avoidance of science had no significant effect upon their teaching practices. Therefore, this section of my hypothesis can be rejected.

AVOIDANCE OF SCIENCE

Based on a discriminant function analysis, it was easier to predict which teachers would not avoid science; it was harder to predict which teachers would want to avoid science. The analysis predicted ninety-one percent (Table III.14) of teachers who would want to teach science if the conditions were good (adequate resources, education and background in science). For instance, for the group of teachers who claimed they would avoid science, over half of them (51.7%) said they would teach science if conditions were good. Also, fifty percent of undecided teachers were predicted to say "no" to avoiding science. The implications here is that teachers are more likely to avoid teaching science if the school has poor science facilities and if their level of education and background in science is inadequate. Conversely, teachers with a good science education who teach in a school with adequate science resources are more inclined to teach science. This supports findings by the Science Council's national study as well as the literature review concerning factors that influence attitudes towards science. Stakeholders in education must realize that adequate facilities along with a well qualified science teacher should lead to more science instruction in primary and elementary schools. The chances of an "avoidance of science" attitude developing are lessened when teachers are given the tools and training to implement a science program.

Literature reviews concerning research on attitudes towards science claim that primary and elementary teachers have negative attitudes. This exploratory study claims that teachers of primary and elementary science have predominantly positive attitudes. This is not to say that problems don't exist with the instruction of science in elementary schools. However, there is potential for error with data gathered in this particular study. For instance, only 127 out of 375 teachers responded when sent questionnaires. This low response rate (33.9%) causes a weakness in the data and provides a limitation to the study.

RECOMMENDATIONS

1. It is recommended that additional research be conducted to examine what factors are influencing primary and elementary teacher attitudes towards science since this study was only exploratory in nature.

2 It is recommended that in the near future, primary and elementary science students be directly studied. An instrument based on the one used in this research might be used. This would be useful to ascertain from students

themselves what their attitudes are towards science and what factors are influencing these attitudes. This would test the reliability and validity of teacher's perceptions.

3. It is recommended that teachers in junior high and high school be studied to determine what factors are influencing their attitudes towards science, both directly and indirectly.

4. Longitudinal studies need to be conducted on both teachers and students concerning factors influencing attitudes towards science.

5. Further research should be conducted to explore differences between male and female teachers , young and old teachers, and rural and urban teachers.

6. It is recommended that the amount of inservice given to primary and elementary teachers be dramatically increased. Insurances should also be put in place such that inservices are effective.

7. It is recommended that pre-service primary and elementary teachers be required to enrol in more pure science courses at university which will increase their background knowledge in science and understanding of the nature of science.

8. It is recommended that the Newfoundland Department of Education address the problem of inadequate facilities and equipment for primary and elementary science.

9. It is recommended that primary and elementary teaching practices be evaluated and supported by other curriculum specialists in science to ensure that the processes of science are being developed and conveyed to students.

10. It is recommended that more models be developed to determine the significance of other potential factors on attitudes towards science.

11. Further research needs to occur to determine more specifically if primary and elementary teachers possess positive or negative attitudes towards science teaching.

12. It is recommended that all stakeholders in education be aware of recent studies of education conducted provincially, nationally and internationally that have reported a crisis in science education (Science for Every Student, 1984; Towards an Achieving Society, 1989; Project 2061, 1989). The authors of these studies make the claim that students are completing high school scientifically, technologically and environmentally illiterate. They do not possess the essential knowledge and skills needed to make informed choices and critical decisions as adults. These are serious claims. What is the mandate of the primary, elementary and secondary schools. (entry-12) in preparing students to become scientifically literate?

13. It is recommended that the designation of science into various categories should be discouraged at the primary and elementary levels. Barrow(1991), found that elementary school teachers see the curriculum as a set of separate and discrete subjects to be taught, rather than as an integrated whole. This leads teachers to adopt traditional methods when teaching science that allows little time for reflection. According to the study, time is also a scarce commodity to elementary teachers and influences their teaching in particular ways.

14. It is recommended that teachers hired to teach elementary science have an adequate background in science.

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APPENDIX A

A Questionnaire for Teachers of Science

IMPORTANT: We ask that you respond to each item by circling the appropriate number on the response sheet.

1. What is your age?

a.	Under 26	1
b.	26-35	2
c.	36-45	3
d.	46-55	4
e.	over 55	5

2. What is your sex?

a.	Male	1
b.	Female	2

3. How many years of overall teaching experience do you have, including the present year?

a.	1 year (i.e., new teaching this year)	1
b.	2-5 years	2
c.	6-9 years	3
d.	10-13 years	4
e.	14 years or more	5

4. How effective do you feel your teaching is at providing for students to achieve each of the following objectives?

Scale: 1 - Very ineffective 3 - Fairly effective
2 - Fairly ineffective 4 - Very effective

a.	Understanding scientific facts concepts, laws etc...	1	2	3	4
b.	Developing attitudes appropriate to scientific endeavour (e.g., curiosity, creativity, scepticism	1	2	3	4
c.	Developing skills and processes of investigation (e.g. observing, classifying, conducting experiments)	1	2	3	4

5. Please rate the importance of these areas as representing obstacles to the achievement of your objectives.

Scale: 1 - No importance 3 - Fairly important
2 - Of little importance 4 - Very important

a.	Curriculum resources (including textbooks, computer software, etc.)	1	2	3	4
b.	Background in Science	1	2	3	4
c.	Physical facilities and equipment	1	2	3	4
d.	Students' abilities and interests	1	2	3	4
e.	Institutional arrangements (e.g., class size, time allocation)	1	2	3	4
f.	Lack of inservice	1	2	3	4

6. How useful have you found the following types of material to be in your planning?

Scale: 1 - No importance 3 - Fairly important
2 - Of little importance 4 - Very important

a.	Provincially approved texts	1	2	3	4
b.	Science magazines, journals newsletters etc.	1	2	3	4
c.	T.V. or radio programs or tapes	1	2	3	4
d.	Computer software	1	2	3	4

7. Please indicate the highest level of education you have completed.

a.	Bachelor's degree	1
b.	Master's degree	2
c.	Doctoral degree	3

8. Please indicate the highest level at which you have studied the following subjects

Scale 1 - Not studied at university
2 - Bachelor's level
3 - Master's/Doctoral level

a.	Mathematics	1	2	3
b.	Pure science (e.g. Physics Chemistry)	1	2	3
c.	Education	1	2	3

9. How long has it been since you last took a post-secondary course in each of the following areas?

Scale 1 - Never taken
2 - more than 10 years
3 - 6-10 years
4 - 1-5 years
5 - currently enrolled

a.	Mathematics	1	2	3	4	5
b.	Pure science	1	2	3	4	5
c.	Education	1	2	3	4	5

10. As preparation for your work as a science teacher, how do you rate the overall quality of

Scale 1 - Very unsatisfactory
2 - Fairly unsatisfactory
3 - Fairly satisfactory
4 - Very satisfactory

a.	Your education in science?	1	2	3	4
b.	Your training as a teacher?	1	2	3	4

11. How helpful has your post-secondary education been to you as a science teacher in regard to the following areas?

Scale 1 - No help
2 - Little help
3 - Some help
4 - Much help

a.	Acquiring scientific knowledge and skills	1	2	3	4
b.	Understanding the ways children learn science	1	2	3	4
c.	Your understanding of the nature of Science	1	2	3	4
d.	Your hands on training as a Science teacher	1	2	3	4
e.	Delivering active-inquiry learning techniques	1	2	3	4

12. How effective is the in-service program provided for science teachers in your school or district?

a.	Non-existent	1
b.	Completely ineffective	2
c.	Fairly ineffective	3
d.	Fairly effective	4
e.	Very effective	5

13. (a) If you had a choice, would you avoid teaching science altogether?

a.	Yes	1	Please go on to part (b) of this question
b.	No	2	Please go directly to Question 14.
c.	Undecided	3	Please go directly to Question 14.

13. (b) If "Yes", for which of the following reasons

a.	Lack of resources	1
b.	Inadequate background	2
c.	Dislike of science	3
d.	Working conditions	4
e.	Student attitudes	5
f.	Inadequate inservice	6
g.	Poor teaching practices	7

14. Please indicate the statement that most closely applies to your situation. In general, I teach my science classes:

a.	In a laboratory or specially designed science room	1
b.	In a classroom with occasional access to a laboratory	2
c.	In a classroom with no special facilities for science	3

15. Which statements most closely apply to your situation regarding equipment and supplies for teaching science?

a.	There is ample equipment for student use	1
b.	There is inexpensive, donated, or outdated equipment for student use	2
c.	There is virtually no equipment for student use	3
d.	There is adequate equipment for demonstration purposes	4
e.	There is virtually no science equipment at all	5
f.	There is access to computing facilities	6
g.	There is adequate audio-visual equipment	7

16. Overall, how do you rate the quality of the facilities and equipment available to you for teaching science?

a.	Very poor	1
b.	Poor	2
c.	Good	3
d.	Excellent	4

17. What is your perception of your students' attitudes toward learning science this year? The majority of my students are:

a.	Indifferent	1
b.	Fairly motivated	2
c.	Highly motivated	3

18. What is your perception of your students' background and abilities to undertake the science courses you teach this year?

a.	Completely inadequate	1
b.	Fairly inadequate	2
c.	Fairly adequate	3
d.	Completely adequate	4

19. Which statement most closely describes your teaching situation?

a.	I teach only science subjects	1
b.	I teach both science and mathematics	2
c.	I teach a variety of subjects of which science is only one	3

20.

(a) Which grades do you teach this year?

a.	1-3	1
b.	4-6	2

(b) How many different grades do you teach this year altogether?

a.	1 only	1
b.	2	2
c.	3	3
d.	more than 3	4

(c) How many different classes do you teach this year altogether?

a.	1 only	1
b.	2-3	2
c.	more than 3	3

(d) What is the average number of students in your classes?

a.	20 or less	1
b.	21-25	2
c.	26-30	3
d.	31-35	4
e.	over 35	5

21. (a). How adequate is the amount of time allocated to science (based on your view of its importance relative to the other subjects of the curriculum)?

a.	Inadequate	1
b.	About right	2
c.	Adequate	3

(b) How much time do you have to cover science courses?

a.	Too little time	1
b.	Just enough time	2
c.	More than enough time	3

A Questionnaire for Teachers of Science

RESPONSE SHEET

1.	1	2	3	4	5	
2.	1	2				
3.	1	2	3	4	5	
4a.	1	2	3	4		
b.	1	2	3	4		
c.	1	2	3	4		
5a.	1	2	3	4		
b.	1	2	3	4		
c.	1	2	3	4		
d.	1	2	3	4		
e.	1	2	3	4		
f.	1	2	3	4		
6a.	1	2	3	4		
b.	1	2	3	4		
c.	1	2	3	4		
d.	1	2	3	4		
7.	1	2	3			
8a.	1	2	3			
b.	1	2	3			
c.	1	2	3			
9a.	1	2	3	4	5	
b.	1	2	3	4	5	
c.	1	2	3	4	5	
10a.	1	2	3	4		
b.	1	2	3	4		
11a.	1	2	3	4		
b.	1	2	3	4		
c.	1	2	3	4		
d.	1	2	3	4		
e.	1	2	3	4		
12.	1	2	3	4		
13a.	1	2	3			
b.	1	2	3	4	5	6
14.	1	2	3			
15.	1	2	3	4	5	6
16.	1	2	3	4		
17.	1	2	3			
18.	1	2	3	4		
19.	1	2	3			
20a.	1	2				
b.	1	2	3	4		
c.	1	2	3	4		
d.	1	2	3	4	5	
21a.	1	2	3			
b.	1	2	3			

APPENDIX B

TEACHER CONSENT FORM

Dear Primary or Elementary Science Teacher:

I am presently a part time graduate student at Memorial University of Newfoundland. As partial requirement for completion of a Masters of Education Degree in Curriculum and Instruction, I am required to do a research study.

For this study, under the supervision of Dr. Glen Clark, Education Professor at Memorial University, I will be researching primary and elementary teacher attitudes towards science, in particular, those working with your School Board. As a science teacher in either primary or elementary education, you have been chosen to participate in this study.

All information gathered in this study is strictly confidential and at no time will individuals be identified. I am interested in learning about the attitude towards science of primary and elementary teachers with your Board. Participation is voluntary and you may withdraw at any time. Also, this study has received the approval of the Faculty of Education's Ethics Review Committee. The results of my research will be made available to you upon request. If you are willing to participate in this study, please sign this form and return it to me. If you have any questions or concerns, please do not hesitate to contact me at home at 786-0234. Thank you for your consideration of this request.

Yours sincerely,

Larry Eddy

I ___________________________ (teacher) hereby consent to take part in a study involving primary and elementary teacher attitudes towards science undertaken by Mr. Larry Eddy. I understand that participation is voluntary and that I can withdraw permission at any time. All information is strictly confidential and no individual will be identified.

_______________   ___________________________

Date   Teacher Signature

APPENDIX C

PRINCIPAL CONSENT FORM

Dear Principal:

I am presently teaching at Holy Trinity Central High and also a part time graduate student at Memorial University of Newfoundland. As partial requirement for completion of a Masters of Education Degree in Curriculum and Instruction, I am required to do a research study.

For this study, under the supervision of Dr. Glen Clark, Education Professor at Memorial University, I will be researching primary and elementary teacher attitudes towards science, in particular, those working with your School Board. Teachers will be asked to complete a questionnaire concerning their attitudes towards science instruction.

All information gathered in this study is strictly confidential and at no time will individuals be identified. I am interested in learning about the attitude towards science of primary and elementary teachers with your Board. Participation is voluntary and they may withdraw at any time. Also, this study has received the approval of the Faculty of Education's Ethics Review Committee. The results of my research will be made available to you upon request. If you are in agreement with teachers participating in this study, please sign this form and return it to me. If you have any questions or concerns, please do not hesitate to contact me at home at 786-0234. Thank you for your consideration of this request.

Yours sincerely,

Larry Eddy

I ____________________________ (Principal) hereby give permission for teachers at my school to take part in a study involving primary and elementary teacher attitudes towards science undertaken by Mr. Larry Eddy. I understand that their participation is voluntary and that these teachers can withdraw at any time. All information is strictly confidential and no individual will be identified.

________________ ____________________________

Date Principal's Signature

APPENDIX D

SUPERINTENDENT'S CONSENT FORM

Dear Superintendent:

I am presently teaching at Holy Trinity Central High and also a part time graduate student at Memorial University of Newfoundland. As partial requirement for completion of a Masters of Education Degree in Curriculum and Instruction, I am required to do a research study.

For this study, under the supervision of Dr. Glen Clark, Education Professor at Memorial University, I will be researching primary and elementary teacher attitudes towards science, in particular, those working with your School Board. Teachers will be asked to complete a questionnaire concerning their attitudes towards science instruction.

All information gathered in this study is strictly confidential and at no time will individuals be identified. I am interested in learning about the attitude towards science of primary and elementary teachers with your Board. Participation is voluntary and they may withdraw at any time. Also, this study has received the approval of the Faculty of Education's Ethics Review Committee. The results of my research will be made available to you upon request. If you are in agreement with teachers participating in this study, please sign this form and return it to me. If you have any questions or concerns, please do not hesitate to contact me at home at 786-0234. Thank you for your consideration of this request.

Yours sincerely,

Larry Eddy

I ____________________________ (Superintendent) hereby give permission for teachers at my school to take part in a study involving primary and elementary teacher attitudes towards science undertaken by Mr. Larry Eddy. I understand that their participation is voluntary and that these teachers can withdraw at any time. All information is strictly confidential and no individual will be identified.

________________ ____________________________

Date Superintendent's Signature