PROPOSED SCIENCE, TECHNOLOGY AND SOCIETY COURSE FOR SECONDARY SCHOOLS IN NEWFOUNDLAND AND LABRADOR: TEACHERS' PERCEPTIONS AND CONCERNS

BRUCE W. VEY, B.Sc., B.Ed.

Proposed Science, Technology and Society Course For Secondary Schools in Newfoundland and Labrador: Teachers' Perceptions and Concerns.

© Bruce W. Vey

B.Sc., B.Ed.

A Thesis Submitted in
Partial Fulfillment of the Requirements
For the Degree
of
Master of Education
(Curriculum and Instruction)
Memorial University of Newfoundland
March 1992

St. John's Newfoundland

ISBN 0-315-73328-4

Abstract

This thesis explored secondary science teachers' perceptions of and concerns about the development and implementation of a proposed Science, Technology and Society course in the schools of Newfoundland and Labrador.

The importance of the STS theme in science education has been recognized in the reports, Science for Every Student (Report 36 of the Science Council of Canada, 1984) and Towards an Achieving Society, (Task Force on Mathematics and Science in Newfoundland and Labrador, 1989). In an attempt to address this need, the Department of Education in Newfoundland and Labrador has developed a course description for the STS course.

Secondary science teachers were asked to complete an STS questionnaire, composed of eight parts based on the draft course description - the nature of the course, course content, instructional time and strategies, role of the teacher, instructional resources, evaluation strategies, preservice and inservice requirements, and personal data.

The results indicated that although the majority of science teachers felt that STS issues should be taught as a separate course, teachers were concerned about the development and implementation of such a course. These concerns included the nature of the proposed STS course, resource materials, evaluation strategies and teacher inservice. Most teachers felt that the course should be a two credit course, offered to all students, preferably those students in Level II.

A large percentage of the teachers surveyed agreed with the proposed STS course content. However, many teachers felt that other topics - marine technology, global climate,

endangered species, nutrition, environmental issues and human population should be included.

This study provided insight into how science teachers perceive STS topics in the curriculum and gave teachers an opportunity to have input into the development of the STS course and the nature of the inservice required. It is hoped that the results of this study will influence the selection of topics and that the proposed STS course will include topics that reflect teachers' concerns about the course and their perceptions of what will be required to successfully implement an STS course at the secondary level.

Acknowledgements

A special thank you to Dr. Ruby Gough, my thesis supervisor, for her continued support and encouragement throughout the writing of this thesis. I gratefully appreciate her support and without that support this endeavor would not have been possible.

To my wife, Beverley, for her patience and understanding over the past six years.

Also, I would like to thank Dr. Wayne Oakley, Harry Elliot, Barry LeDrew and Wendy Coffin of the Department of Education for their help in developing the questionnaire and for their assistance in mailing out the STS questionnaire.

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CHAPTER 1

THE PROBLEM

Introduction to the Problem

Curriculum implementation is strongly influenced by the beliefs and perceptions of classroom teachers. This is supported by Aikenhead's (1985) finding that the value and belief system of teachers often does not allow for new approaches such as Science, Technology and Society curricula. Many of these innovations are inconsistent with teachers' current beliefs and values. He suggests that only by gaining an understanding of the system of thought that teachers bring to their work will curriculum specialists understand the key factors in implementing innovations.

The goals of science education are changing and the need for change has been expressed nationally in Canada and internationally, for example, in Australia, Britain and the United States (Aikenhead, 1980; Bybee, 1987; NSTA, 1985; Solomon, 1988). Science educators from both the educational and scientific communities have failed to consider the relationships among science, technology, and society (Hurd, 1985). To achieve this change will require the teaching of science in a social context, supported by a curriculum that has scientific, technological and social relevance (The Science Council of Canada, 1984). The Science Council of Canada recommends that our future citizens need to understand science and technology and the impact of both of these on society.

The Department of Education of Newfoundland and Labrador is currently developing a new Science, Technology, and Society course. The proposed Science, Technology and Society course will be different from traditional secondary science courses. Whereas traditional science courses utilize a textbook as the primary resource, this course is designed to utilize multiple resources. The teaching of Science, Technology and Society issues will involve two distinct processes: the inquiry process and the decision-making process. The inquiry process will involve exploring an issue by expanding upon the various points of view, while the decision-making process will involve using strategies to determine an appropriate course of action. Consequently, secondary science teachers will be faced with a different philosophy of science instruction, controversial course content, varied instructional strategies and non-traditional evaluation practices. By working cooperatively with classroom teachers, new ideologies can be translated into practice and curriculum developers can gain a better understanding of the change process (Aikenhead, 1985). Without that understanding and cooperation innovations are often ignored. The present study focuses on secondary science teachers' perceptions and concerns about the implementation of the proposed secondary Science, Technology and Society course.

Need for the Study

There is a world-wide need for a redefinition of science education to establish new goals, design programs, rethink policies and to discuss changes in current teaching practice (Zoller, 1991). It is recognized that science courses must endeavor to address social issues and make science more relevant and therefore meaningful to students' "real life" problems and concerns. The reports, **Science for Every Student** (Report 36 of the Science Council of Canada, 1984) and **Towards an Achieving Society**, (Task Force on Mathematics and Science Education in Newfoundland and Labrador, 1989) both recognize the significance and importance of the Science Technology and Society theme in science education. **Towards an Achieving Society** recommends that a one credit secondary Science, Technology and Society course be developed for the Newfoundland and Labrador science curriculum.

In an attempt to address this need, the Department of Education in Newfoundland and Labrador has formed a provincial working group to develop a Science, Technology and Society course for secondary level students. The course will focus on current societal and technological issues within a local, national, and global context. Secondary science teachers who will be teaching this new course will be faced with a non-traditional science course. For example, instructional strategies would include discussions, both formal and informal; role playing; exercises in problem solving and critical thinking; and decision-making. Also, most educators in this province are unfamiliar with the proposed Science Technology and Society course, particularly its objectives, content, instructional strategies and evaluation techniques, and there is a need to inform teachers of the nature of the course. Rhoton (1990) notes that there is a need for more research on the attitudes and perceptions of science teachers and their role in implementing the Science, Technology and Society theme in the science curriculum. Given that the proposed Science, Technology and Society course is a new science course with a unique philosophy of instruction, it is necessary to determine teachers' perceptions of the course and their concerns about implementing such a course.

The Purpose of the Study

The purpose of this study was to identify the perceptions and concerns of secondary science teachers about teaching the proposed Science, Technology and Society course and to use this information to develop guidelines for an implementation plan. A secondary purpose was to provide secondary teachers with an opportunity to have input into the development and implementation of the proposed Science, Technology and Society course. The ultimate goal is to use the collected data to provide the Department of Education, school boards, and science program co-ordinators with information that will assist them in developing an implementation plan that will take into account teachers' perceptions and concerns.

Research Questions

1. What are teachers' perceptions of their role in implementing the proposed secondary Science Technology and Society course?
2. What are teachers' concerns about implementing the proposed secondary Science Technology and Society course?

Scope and Limitations of the Study

The research in this study was directed at secondary science teachers in the province of Newfoundland and Labrador. Limitations of the study were as follows:

1. A limitation of this study was the possibility of a low response to the questionnaire. However, every effort was made to ensure a high response rate, including a follow-up letter and the mailing of additional questionnaires to teachers.
2. Since the study was restricted to secondary science teachers, it is possible that the results may not be applicable to science teachers whose major teaching assignment is at the junior high level.
3. Teachers' lack of knowledge of the Science, Technology and Society movement in science education may have influenced their responses.

Definitions of Terms

1. **STS** refers to Science, Technology and Society

2. **Secondary Science Teachers** refers to teachers who teach science at one or more of Levels I, II and III.

3. **STS Course Description** refers to the draft of the Science, Technology and Society course description which has been compiled by the Department of Education, Program Development Division, June 1990.

4. **STS Course** refers to the Science, Technology and Society course that will be implemented beginning September, 1992 in high schools of Newfoundland and Labrador.

Summary and Overview

The importance of identifying teachers' perceptions and concerns about teaching the proposed secondary Science, Technology and Society course has been presented. This study will reveal the perceptions and concerns of teachers who will be teaching the proposed Science, Technology and Society course and provide them an opportunity for input into the nature of the course. Also, science teachers will have an opportunity to recommend learning resources and the inservice required in the implementation phase. It is hoped that from this study guidelines will evolve for an implementation plan.

CHAPTER 2

REVIEW OF THE LITERATURE

Introduction

The field of study that has focused on issues related to the interactions of Science, Technology and Society (STS) is relatively new to science education. However, in a short period of time the inclusion of STS issues has become an international trend in science education and is changing science curricula around the world. The STS movement is an attempt to broaden the scope of science education by stressing the nature of science, the nature of technology and the interactions of science, technology and society. Science, Technology and Society education has been one of the most significant developments in the field of science education during the 1980's (Wraga & Hlebowitsh, 1991). The purpose of this chapter is to review the literature relating to STS curriculum and instruction, with attention to trends in science education, the evolution of the STS movement, the need for STS in the science curriculum, students' beliefs, STS programs, and teachers' views on the nature of the Science, Technology and Society emphasis and its implications for instruction.

Trends in Science Education

To provide an accurate account of the development of programs related to STS and the impetus for this movement in science education it is necessary to examine the changing goals of science education over the past three decades. An historical approach will trace the evolution of STS issues within the larger framework. Programs related to science, technology and society will be reviewed, as well as students' beliefs about the importance of this emphasis and teachers' concerns about the implementation of science, technology and society curricula.

During the 1960s, science education followed a two stage design known as the center-periphery model (Hart & Robottom, 1990). The goals for science education were developed at the "center" by scientists while program development and implementation would occur at the "periphery", usually by teachers. Among the outcomes of this model were negative reactions by teachers to the new programs because they were often not involved in the development of the new science courses.

Also, science courses were academically oriented and focused on preparing students for post secondary institutions. Personal, social and career goals of students were de-emphasized, with the result that students learned mainly the content of textbooks as a means of passing the course and as preparation for the next science course. According to Hart and Robottom (1990) this emphasis was the primary reason for students' perceptions of

The recommendations of the Science Council of Canada clearly represented the goals of science education for the 1980s and 1990s. Among the discussion papers commissioned for the Science Council of Canada study was Glen Aikenhead's paper entitled Science in Social Issues (1980) in which he expressed concern that decisions were being made on science-related issues by those who do not understand science. Canadians are making decisions on such issues as nuclear energy, acid rain and pollution.

Aikenhead states:

> If Canada is to deal effectively with its future, then a citizenry able to comprehend science issues is a necessity. This goal will be possible if our present and future scientists are critically aware of the impact their research and teaching can have on Canadian society, and only if the general population understands the important relationship between science and technology. (p.11)

The general public and scientists need to understand the interaction between science and society if science-related problems are to be effectively addressed. Aikenhead (1980) also recognizes the need to rethink the goals of science education. He recommends that students should learn the following:

1. The characteristics of science, its aims, values and strategies for decision making.
2. The limitations of scientific knowledge, including scientific values, examination of the boundaries between science and politics and science and society.

3. The characteristics of science and its place in Canadian society. (p.13)

Aikenhead presents a more practical view of science education which focuses on the characteristics of science in society and the limits of science in a man-made society.

The National Science Teachers Association in the United States (NSTA, 1982) presented the position that the "goal of science education during the 1980s is to develop scientifically literate individuals who understand how science, technology and society influence one another and individuals who are able to use knowledge in everyday decision-making" (p.20).

Summary

The trends in science education have been presented and the recent calls to redefine science education have been seen to have a common central theme, the need to rethink the goals of science education and to include issues related to STS in science curriculum and instruction. The next section examines the changes in science education over the past thirty years and the growth of the STS movement.

The Evolution of the STS Movement

Just over three decades ago the American science education system underwent the greatest reform in its history (Bybee, Harms, Ward, & Yager, 1980). The launching of Sputnik initiated a science curriculum oriented towards the pure sciences. Courses such as chemistry and physics were designed to prepare students for post-secondary institutions. Scientists were needed to re-establish American space supremacy. These changes in science education were largely directed towards curriculum development, teacher training and improving science laboratory facilities.

During the 1960s the task of reforming the science curriculum was placed in the hands of research scientists. This reform was sparked partially by the knowledge explosion and new developments in learning theories (Munby, 1982). The science programs developed during this period emphasized the nature of inquiry and scientific processes. This led to such courses as Biological Science Curriculum Study (BSCS) and Physical Science Study Committee (PSSC). Later, these courses became known as the alphabet courses. The alphabet courses were based on the principle that science education should be taught in the form of separate disciplines. These courses were designed to present science in its purest form through the science disciplines -- physics, chemistry, biology and earth science -- while societal issues and technological developments were largely ignored. The alphabet courses were expected to change the nature of science education in schools

(Hart and Robottom, 1990). The scientists assumed that "if students understood science the way scientists know science it would be inherently interesting" (Hurd, 1986, p. 12). The science programs were written by scientists and science education researchers, and classroom teachers were not involved in the change process. This movement in science education was not accepted by science teachers, perhaps because teachers were not involved in the change process. As Fullan (1987) states, there is a vast difference between what is intended to happen in curriculum change and what actually takes place in curriculum change, and he takes the position that teacher involvement is a critical factor in the process.

As described in the previous section, the goals for science education during the 1970s and 1980s were beginning to change. Early symptoms of a growing discontent with science education in Canada and the United States were evident in a "decline in interest in science at all levels, the modification of programs to make them reachable by more students, increased dropout rates, low participation in high school and university science, and low achievement in national and international achievement tests in mathematics and science" (Gough,1990, p.6).

Also, researchers in science education began to address problems identified by society. This appears to have evolved as a result of public pressure. During the 1970s there was no "Sputnik" to stimulate change in the science curriculum. However, Canadians and Americans were faced with a large number of complex problems, both local and global, and the public expected science to solve these problems. Because of the nature of these complex problems scientists and science education researchers realized that such societal problems and their solution would require a rethinking of the goals of science education (Aikenhead, 1980; Bybee, 1985).

In the early 1970s the pressures for reform in science education were occurring from various sources. The National Science Foundation recommended that science education should focus on content that relates science to society and technology. Hurd (1986) emphasized the need for "science students to appreciate the role of science and to have the desire and ability to use science in the solution of broader problems of society" (p.22). This led to the development of such courses as The Man-Made World, Physics - A Human Endeavour, and the Intermediate Science Curriculum Study. Although these courses made significant contributions to the science curriculum, they were not accepted by the majority of classroom science teachers. Classroom teachers considered the courses too difficult for most students. Also, most teachers either did not understand or refused to adopt the philosophy of instruction for these new courses. Most teachers did not accept the inquiry method of teaching that was essential for the success of these courses. Because of the lack of acceptance, numerous science related programs including health science, oceanography, natural science and drug education were introduced in schools. These courses evolved in an attempt to integrate science into other disciplines and thereby make science more relevant to real life.

Robert Yager has defined science education as the science and society interface (Yager, 1985). According to Yager, this definition broadens the domain for science education and science education researchers. It focuses on what scientists do and how they interact with one another and society. Yager states that the science/society interface also suggests "a vital role for science education that has been ignored in the past" (p. 144).

Kromhout and Good (1983) oppose STS education and favor a discipline-centered approach to science teaching. They imply that the discipline-centered approach is more effective and is value-free when compared with STS education. Also, Good, Herron, Lawson and Renner (1985) disagree with Yager's definition of science education because the definition overemphasizes the sociological and political aspects of science education and de-emphasizes the importance of its psychological aspects. "Science education should focus on discovering, developing, evaluating methods and materials to teach science and not science defined by sociological and/or political influences" (p.140).

In general, most science education researchers tend to support Yager's linkage of science and society as essential components of science education. Good et al. (1985) and Bybee (1987) have difficulty accepting Yager's definition of science education. They agree that science education must respond to societal issues and these societal issues must be reflected in the science curriculum. Bybee (1987) states that "the goals of science education must be reformulated to include the personal and social dimensions that have been ignored for over two decades" (p.378). Bybee supports the basic idea that schooling should serve individuals, and ultimately society's needs for maintenance and development.

The science curriculum should reinstate the personal and social goals that were eliminated during the curriculum reform of the 1960s and 1970s. Bybee (1987) suggests that this would require more research and development in the following areas:

1. Presentation of science knowledge skills, and understanding in a personal/social context.
2. Inclusion in the curriculum of knowledge, skills and understandings relative to technology.
3. Extension of the inquiry goal to include decision making.
4. Clarification of knowledge, skills and understanding relative to the Science, Technology and Society theme that are appropriate to different ages and stages of development.
5. Identification of the most effective means of incorporating Science, Technology and Society issues into existing science programs.

6. Implementation of Science, Technology and Society programs into school systems. (p. 679)

Summary

Changes in science education over the past thirty years have been reviewed in this section. It is clear that many individuals and organizations are demanding that science education address societal issues in the curriculum. The researcher will examine the position statements about STS education from organizations such as National Science Teachers Association, the Science Council of Canada and the International Organization for Science and Technology.

The Need for STS in the Science Curriculum

Scientific and technological advances alone should warrant a serious examination of science programs and practices. As changes are occurring in science and technology there is considerable pressure from various organizations and individuals for educational reform in general. In science education, the development of science, technology and society courses is one of the products of this educational reform.

The National Science Teachers Association (NSTA) adopted a position statement about the STS movement for the 1980s. The NSTA (1982) emphasized the influence of science and technology on almost all aspects of life and the need for appropriate science education for all citizens. Recently, the NSTA has amended its position statement on science, technology and society to include the following:

> There are no concepts and/or processes unique to STS; instead STS provides a setting and a reason for considering basic science and technology concepts and processes. STS means determining ways that these basic ideas and skills can be seen as useful. STS means focusing on real-world problems instead of starting with concepts and processes which teachers and curriculum developers profess to be useful to students. (NSTA, 1982, p.2)

In 1984, the Science Council of Canada published a report entitled Science for Every Student: Educating Canadians for Tomorrow's World. The Science Council examined science curricula in each province and territory, analyzed thirty science textbooks, surveyed teachers' opinions, and commissioned eight case studies of science teaching across the country. The Council concluded that STS issues are not presented in Canadian science education to the degree they should be, and recommended that more emphasis should be placed on STS issues in the science curriculum. Science, Technology and Society was regarded as a top priority in science education.

The International Organization for Science and Technology Education (IOSTE) met in 1987, and this symposium focused on the science, technology and society movement. During this symposium, STS was defined as "teaching science content in the authentic context of its technological and social milieu. Students integrate their understanding of the natural world (science content) with both the man-made world (technology) and the social world of the students' day-to-day experience (society)" (Solomon, 1988, p.379).

Most science education researchers would agree that in today's society, students should be exposed to science programs that are broad in nature and prepare students to make rational decisions on societal issues (Aikenhead,1980; Bybee,1987; Jenkins,1990). In a curriculum support document entitled STS Science Education, Jenkins (1990) states that "all students, including future scientists, engineers and technicians are citizens. However, not all students will become scientists, engineers or technicians"(p.2). These citizens will be expected to make one or more decisions on STS related issues during their lives. To make rational and scientific decisions citizens will need to become scientifically and technologically literate. The main reason for making STS an essential component of science education is to make students aware of the effects of science and technology on society. In the Alberta curriculum support document, Jenkins used the term, "unifying the goals of science education" to refer to the STS movement as a vehicle to unify many of the concepts previously taught in science education. (p.1) Studies about STS issues will provide an opportunity to organize and present all the goals of science education. He suggested that "when the STS science education concept is combined with the concept of curriculum emphasis, we have a systematic and logical method of presenting the STS goals over the total science program". (p. 6) This view of science education can not only serve those students who go on to finish study in the sciences but the total population of students who ultimately become members of society. Several organizations including the Science Council of Canada, The National Science Teachers Association (NSTA) and the International Organization of Science and Technology (IOSTE) also support Jenkins' view of science education.

Summary

The goals for science education and the evolution of the STS movement have been presented. The recommendations from the Science Council of Canada, the National Science Teachers Association and the International Organization of Science and Technology strongly suggest that STS issues are an essential part of science education. The next section will examine students' beliefs and naive conceptions about STS issues.

Students' Beliefs: Science, Technology and Society

Many schools deal only with concepts and principles, and the teaching of nature of science and scientific literacy is often ignored (Aikenhead, 1973). To promote scientific literacy, Aikenhead states that "scientifically literate adolescents ... need to learn science with respect to conceptual development, technology, nature of society, humanities and ethics". (p. 540)

More recently Aikenhead, Fleming and Ryan (1987) studied secondary school graduates' beliefs about STS and developed their own instrument, Views on Science, Technology and Society (VOSTS). Aikenhead et al., (1987) note that instruments commonly used to assess students' understanding of science and social issues suffer from a critical flaw. These instruments assume that both the student and assessor perceive the same meaning in the item. Aikenhead, Fleming and Ryan (1987) surveyed 10,800 high school students using their instrument VOSTS. Students were asked to react to a statement concerning an STS topic by stating whether they agreed, disagreed or couldn't tell and to give an explanation for their answer in paragraph form. The instrument was designed in this format to address what Munby (1982) coined "the doctrine of immaculate perception" (p.15). When students respond to an objectively scored item they subjectively make their own meaning out of the item. To the assessor the instrument is objective but it may turn out to be subjective to the student. One of the findings of this study was that students have naive conceptions about science, technology and society. They think that there is little difference between science and technology, that science and technology have little to offer in solving social problems, and that scientific research is predominantly medical research. It was also found that about 77% of students' sources for ideas about scientists came from mass media. Students made little reference to their high school science courses or visits to scientific museums. These results seem to indicate that the social and technological context of science is being ignored in many classrooms (Science Council of Canada, 1984; Bybee, 1985; Hurd, 1986). Also, these results indicate that teachers place little emphasis on science, technology and society in secondary science courses.

Fleming (1987) used the data from the VOSTS survey to examine further students' beliefs about science, technology and society. He found that students were unable to distinguish between science and technology. Also, Fleming noted that students confused the roles of scientific and technological research. When asked for a choice between science and technology in improving the quality of life, the majority of students responded that science and technology are interdependent but viewed science as having a greater role in improving the quality of life.

Summary

In designing new STS curricula it is important to consider students' beliefs and their naive conceptions of science. In addition, several researchers (Aikenhead, Fleming and Ryan, 1987; and Fleming, 1987) have suggested that science in a social context is often being ignored in science curriculum and instruction. In the next section the researcher will examine STS programs presently in use in Canada, Britain, and the United States.

Science, Technology and Society Programs

A number of programs have been developed and are in various stages of implementation. Among these are Logical Reasoning in Science and Technology (LORST), Energy and Use, Science in a Social Context (SISCON), and Science and Technology 11.

Logical Reasoning in Science and Technology (LORST)

Glen Aikenhead developed an STS course entitled **Logical Reasoning in Science and Technology (LORST).** This course, designed for Saskatchewan's Grade Ten students of average academic ability teaches scientific facts, principles, and critical thinking. The course is designed so that the science instruction takes place within the social context of drinking and driving and within the technological context of the Borkenstein breathalyser (Aikenhead, 1989). LORST requires approximately eighty hours of instruction and is flexible in course content and instruction. The ultimate goal of LORST is to improve the scientific and technological literacy of students.

Energy and Use

At Kelly Walsh School, Casper, Wyoming students use an STS program, **Energy and Use**. This activity-centered program focuses on energy-related issues, particularly alternative energy, source applications, consumer energy consumptions and land use (Penick, 1985). Students are required to formulate their own questions and then attempt to answer these questions by working as researchers in the community. Some students are helping to make their community more energy aware and in the process they are becoming more energy conscious themselves.

Science in a Social Context

In Britain, **Science in a Social Context** (SisCON) has been in use for more than 15 years. **Science in a Social Context**, an STS course, is used to supplement the traditional science curriculum. The course was designed for 17-year old students as a means of preparing them to become informed citizens. This STS course contains eight units, each presented in book form (Solomon, 1983).

Science and Technology 11

The Ministry of Education in British Columbia has developed a secondary level STS course: **Science and Technology 11**. This course is based on the following goals:

- to develop an appreciation of the interactive nature of science, technology and society.
- to gain knowledge of technologies as applications of science.

- to develop the ability to respond critically to technological issues.

Zoller et al. (1990) examined the **Science and Technology 11** course offered by the Ministry of Education, British Columbia. The purpose of this study was to determine whether STS courses actually work. A questionnaire consisting of four statements from Aikenhead's Views On Science Technology and Society (VOSTS) inventory form was administered to secondary students (Aikenhead, Fleming & Ryan, 1987). An experimental group consisted of 101 randomly selected students who had taken the **Science and Technology 11** course in the previous school year. The control group consisted of randomly selected students from the same schools who had not taken the **Science and Society 11** course.

Zoller et al. (1990) found that **Science and Technology 11** had an impact on students' beliefs and attitudes related to STS issues. For example, the experimental group favored public decisions on social issues, whereas the control group believed that scientists and engineers should decide on such issues. The experimental group strongly believed that scientists should be held accountable for discoveries that might harm the public while the control group felt that scientists should not be responsible for their discoveries.

Summary

In this section the researcher has reviewed a number of STS programs being used in different countries. Although each program is different in content and format, they are all STS courses and each course is activity-oriented, designed to promote scientific literacy and real life skills.

Although the findings of Zoller et al. (1990) are not conclusive, they do indicate that the **Science and Technology 11** course influences students' beliefs and problem solving abilities. This study is significant for the Department of Education in Newfoundland and Labrador and the provincial STS working group in light of the proposed STS course. The students' reaction in British Columbia is also important to the province of Newfoundland and Labrador because the course developed by the provincial working group has been strongly influenced by the success of British Columbia's **Science and Technology 11** course.

Teachers' Views on the Nature of STS Courses

Bybee has completed several surveys in the field of STS education. Bybee (1985) sent 100 questionnaires to secondary science teachers in the United States.

The following questions were asked:

1. Which Science, Technology and Society problems are important?

2. How will these Science, Technology and Society problems change by the year 2000?

3. How much do science educators know about Science, Technology and Society problems?

4. Who should take courses in which Science, Technology and Society problems are presented?

5. How should Science, Technology and Society courses be presented?

6. How much emphasis should be placed on Science, Technology and Society problems?

Seventy-seven percent of science teachers surveyed completed the questionnaires. He found that secondary science educators ranked population growth, water resources, world hunger, air quality and atmosphere and war technology as the highest in priority. Fifty-two percent of the respondents indicated that problems of human health and disease will be improved by the year 2000. The science teachers were least knowledgeable about mineral resources, war technology, hazardous substances, extinction of plants and animals, and nuclear reactors. Ninety percent of the respondents indicated that STS issues are very important and should be a core requirement for all students. Respondents indicated that about 10% of instructional time is necessary for elementary grades, about 15-20% for intermediate grades and approximately 20% or more for secondary grades.

Bybee and Mau (1986) conducted an international survey of science teachers on science and technology related global problems. Two hundred and sixty two educators, representing an 80% response rate from 41 countries, completed the survey. As a result of this survey, Bybee and Mau found that world hunger and food resources, population growth, air quality and atmosphere, water resources, war technology and human health and disease were the top six concerns identified. Also, an integrated approach was preferred and it was felt that the study of global issues should be a requirement of all students.

In the report, **Science For Every Student: Educating Canadians for Tomorrow's World**, the Science Council of Canada recommended the following instructional time for STS content in the present science curriculum:

Early years (to grade 6)	50 percent
Intermediate grades (7-9)	33 percent
Senior grades (10-12)	25 percent

Mitchener and Anderson (1989) examined secondary science teachers' perceptions of developing and implementing an STS curriculum. They investigated why a quality program **Topics in Applied Science** was receiving less than complete acceptance by all teachers exposed to the course. The potential for teachers' rejection of an STS program was highlighted in this study.

Mitchener and Anderson investigated science teachers' perceptions of **Topics in Applied Science** in two intermediate schools. Fourteen teachers with varying experience were involved in the study. The clinical interview technique, classroom observation and document analysis were used to gather data.

Of the fourteen participating teachers, only four teachers accepted **Topics in Applied Science**. Although these teachers accepted the Science, Technology and Society course, they adapted the curriculum to their classroom environments and were reluctant to accept the program in its original form.

Five teachers altered Topics in Applied Science and found the course time consuming and energy draining to teach. These five teachers did not accept the idea of creating a separate Science, Technology and Society course but thought Science, Technology and Society should be part of every traditional science course. In addition, these five teachers often abandoned the new teaching strategies recommended for **Topics in Applied Science** in favor of the traditional expository teaching technique. Teachers felt more comfortable with the traditional role of the science teacher as the expert in his/her field.

The remaining five teachers rejected the **Topics in Applied Science** philosophy and did not want to be involved in any way with the course. These teachers stated that **Topics in Applied Science** lacked science content and they disagreed with its social studies focus and activity-oriented approach. Also, teachers noted that discipline and time on task were problems because of the emphasis on formal and informal discussions. Evaluation was also a concern when compared with the evaluation in traditional science courses.

The findings showed that teachers varied in reaction to **Topics in Applied Science** and this study emphasizes the importance of the classroom teacher as the key figure in determining the successful implementation of any Science, Technology and Society course. It also supports the need for significant attention to teachers' beliefs and perceptions.

Time constraints were also identified as a deterrent to successful implementation of STS courses in the Science Council of Canada study. As a result of the four year study conducted by The Science Council of Canada (1984), it was found that 90 percent of teachers recognize the importance of showing the connection between science and technology, while only 65 percent think they attain this objective effectively. The study indicates that the main obstacle to teaching such courses is that of time constraints. Also, teachers say that they are pressured by examinations and by school boards to cover the course content. Teachers feel their own lack of training and inservice is also a major factor. Given these findings, the objectives of an STS course are usually neglected.

Summary

Teachers' views on the nature of STS courses have been presented. Teachers are concerned about such factors as time on task, discipline, evaluation of students, training, inservice, and curriculum implementation.

Chapter Summary

The purpose of this chapter was to review the literature as it relates to the present study. This was accomplished by reviewing the trends in science education, the evolution of the STS movement, the need for STS in the science curriculum, students' beliefs about STS, science, technology and society programs and teachers' views on the nature of STS courses and concerns about implementation. This chapter supports the need for the present study and provides the theoretical and practical background necessary to carry out the study.

CHAPTER 3

METHODOLOGY

Introduction

This chapter provides a description of the research methodology used in this study, and it includes a description of the population studied, the instruments used, the method and purpose of the pilot study, and descriptions of the techniques used to collect and analyze data. The overall objective of this study was to obtain information on teachers' perceptions of the proposed STS course and concerns about implementing the proposed secondary science course.

Research Questions

The research questions in this study were as follows:

1. What are teachers' perceptions of the proposed secondary Science, Technology and Society course?
2. What are teachers' concerns about implementing the proposed secondary Science, Technology and Society course?

Pilot Study

The validation of the instrument was conducted during the third week of September 1991. Six science experts were asked to examine the instrument on its science content, readability, and clarity, and to suggest possible improvements.

A pilot study was incorporated into the design as a means of refining the questionnaire. The pilot study was conducted during the first week of October, 1991. Fifteen secondary science teachers from three separate schools boards in the province of Newfoundland and Labrador were chosen. The teachers' package for the pilot study consisted of an introductory letter, a copy of the questionnaire, the draft STS course description and a large envelope with a return address to hold all completed questionnaires. Questionnaires were mailed to science program co-ordinators for distribution and collection.

The participants were asked to read the draft Science, Technology and Society course description and to complete the questionnaire by October 7, 1991. The primary purpose of the pilot study was to improve the draft questionnaire. The pilot study would help remove any ambiguities within the questionnaire, ensure that the questionnaire was suitable, and determine the questionnaire's reliability (Borg and Gall, 1983). An analysis was conducted during the third week of October to determine whether or not the items were reliable. The pilot study was given an overall .42 alpha coefficient.

Several items received a negative alpha reading and hence were deleted from the questionnaire.

Procedure

The population for the survey consisted of 417 secondary science teachers who were surveyed throughout the province of Newfoundland and Labrador. Seven of the questionnaires were spoiled, leaving a total population of 410. A covering letter outlining the purpose of the study was mailed to school board superintendents to ask for their permission to conduct the field study. A list of secondary science teachers was compiled by asking science program co-ordinators for a listing of all secondary science teachers within their respective districts.

The draft Science, Technology and Society Course Description and the questionnaire were mailed to 417 secondary science teachers. Of the total population of 417, seven questionnaires were spoiled and 183 were completed and returned to the researcher. Science teachers were asked to read the draft Science, Technology and Society Course Description and to complete and place the questionnaires in stamped envelopes by November 8, 1991.

A reminder letter was sent to all non-respondents on November 15, 1991 as a means of increasing the total number of completed questionnaires. Also, the researcher faxed a reminder letter to all science program coordinators in the province of Newfoundland and Labrador on November 24,

1991. Program coordinators were asked to contact the science teachers within their districts and to encourage teachers to complete and return the questionnaire. Also, the researcher telephoned approximately thirty schools as an additional means of increasing the number of completed questionnaires. In summary, every reasonable effort was made to encourage science teachers to complete and return the STS questionnaire. As shown in Figure 1, the responses to the questionnaire adequately sample the school boards throughout the province of Newfoundland and Labrador. Although the returned number of questionnaires represents approximately 45% of the total sample, all school boards are sampled in this study. In addition, the returned questionnaires do sample such variables as small schools and large urban schools, all-grade schools and schools with only high school subjects.

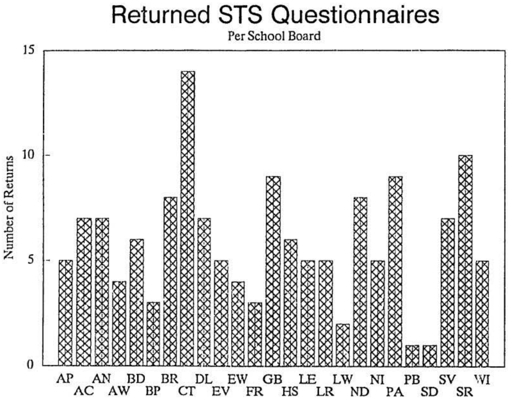

Figure 1: Distribution of STS Questionnaires per school board

Legend

AP - APPALACHIA R.C.
AV - AVALON NORTH INT.
AC - AVALON CONSOLIDATED
AW - AVALON WEST
BD - BAY D'ESPOIR INT.
BP - BURIN PENSINSULA INT.
BR - BURIN R.C.
CT - CLARENVILLE-TRINITY
DL - DEER LAKE -ST. BARBE SOUTH
EV - EXPLOITS VALLEY INT.
EW - EXPLOITS -WHITE BAY R.C.
FR - FERRYLAND R.C.

GB - GREEN BAY INTEGRATED
HS - HUMBER ST. BARBE R.C.
LE - LABRADOR EAST INTEGRATED
LR - LABRADOR R.C.
LW - LABRADOR WEST INTEGRATED
ND - NOTRE DAME INTEGRATED
NI - NOVA INTEGRATED
PA - PENTOCOSTAL ASSEMBLIES
PB - PORT AUX BASQUES INTEGRATED
SD - SEVENTH DAY ADVENTIST
SV - STRAITS-VINLAND INTEGRATED
SR - ST. JOHN'S R.C.
WI - WESTERN INTEGRATED

The Questionnaire

This study was based on the draft Science, Technology and Society Course Description (Dept. of Education, June 1990) and a descriptive questionnaire designed by the researcher which correlated with corresponding sections of the draft. A four point Likert scale was used, and respondents were asked to circle one of the following choices - Strongly Agree, Agree, Disagree or Strongly Disagree. The four point Likert scale was used as a means of forcing the respondent to make a decision on a particular question. At the end of each section, science teachers were given an opportunity to add written comments. Before completing the questionnaire, each science teacher was asked to read the draft STS course description. The draft course description provided science teachers with the necessary background information to complete the questionnaire.

The questionnaire was designed to parallel the sections of the draft course description and to reveal teachers' perceptions of the proposed STS course and their concerns about implementation. These factors include: (1) The Nature of the Science, Technology and Society Course (2) Course Content (3) Instructional Time and Strategies (4) The Role of the Teacher (5) Resource Material (6) Evaluation Strategies (7.) Preservice and Inservice and (8) Personal Data.

Data Analysis

The questionnaire data were analyzed using the Statistical Package for the Social Sciences (SPSS-X). This is a comprehensive statistical set of programs that can be used to manage, analyze and display data. For this study, frequency and percent counts were used to organize the data.

Chapter Summary

In this chapter the researcher has examined the methodology and design for the study. The research questions, the pilot study, the procedure, the questionnaire, and the data analysis have been presented. The next chapter will focus on the findings and the analysis of data.

CHAPTER 4

ANALYSIS OF DATA

Introduction

This chapter presents an analysis of the data collected from the Science, Technology and Society questionnaire (see Appendix A). The questionnaire was administered to secondary science teachers in the province of Newfoundland and Labrador. The questionnaire consisted of eight parts.

Part A - Science, Technology and Society: The Nature of the Course
Part B - Course Content
Part C - Instructional Time and Strategies
Part D - The Role of the Teacher in a Science, Technology and Society Course
Part E - Resource Material
Part F - Evaluation Strategies
Part G - Preservice and Inservice
Part H - Personal Data

Results

The Science, Technology and Society questionnaire was distributed to 417 secondary science teachers. Seven of the questionnaires were spoiled, resulting in a total population of 410. One hundred and eighty three, or 45% of the respondents, completed and returned the questionnaire. As shown in Figure 1, chapter 3, the sample does reflect a regional distribution of secondary science teachers in the province of Newfoundland and Labrador. All reasonable efforts were taken to ensure that science teachers would complete and return the STS questionnaire. These included a reminder letter to all non-respondents (see Appendix D), a fax message to all science program co-ordinators and approximately 30 telephone calls to non-respondents throughout province.

Part A: STS: The Nature of the Course.

This section examined the nature of the proposed STS course and how this course would fit into the existing science curriculum. Items 1-7 are presented in Table 1. Respondents were asked to rate each statement on the extent to which they agree or disagree by selecting one of the four choices: Strongly Agree, Agree, Disagree or Strongly Disagree. It should be noted that the total number of responses in some of the tables is fewer than the total number of completed questionnaires. This is due to the fact that not all the respondents completed every item on the questionnaire.

Table 1

STS: The Nature of the Course
(n=180)

Nature of the course:	Strongly Agree %	Agree %	Disagree %	Strongly Disagree %
1. STS in the curriculum	65.7	32.5	.6	1.2
2. STS as a separate course	30.2	43.2	16.0	10.7
3. STS integrated	29.0	42.0	24.3	4.7
4. STS by science specialist	35.9	46.7	15.0	2.4
5. STS motivating to students	43.5	52.9	2.9	.6
6. Related to real life	64.1	35.3	.6	0
7. Incentive for additional science courses	34.5	56.5	6.5	2.4

A high percentage of respondents agreed or strongly agreed that STS should be included in the science curriculum. The fact that an almost equal number chose the "integrated course" was an unexpected result. It could be that teachers felt for those who would not be taking the STS course it would be worthwhile to integrate STS issues into existing science courses. A high percentage also agreed that it should be related to real life, and motivating to students, and an incentive to complete additional science course.

STS as a Separate Science Course.

As discussed in Chapter 1, the Department of Education has formed a provincial working group to develop and implement an STS course for the senior high science curriculum. Science teachers were asked if they thought STS should be taught as a separate science course. Table 2 presents the data from question eight of the questionnaires.

Table 2

STS as a Separate Science Course
(n=157)

	Yes	No
Should STS be taught as a Separate Science Course?	70.1%	29.9%

As shown in Table 2, 70.1% of science teachers surveyed felt that STS should be taught as a separate course while 29.9% of science teachers surveyed did not agree with a separate STS course. The slight discrepancy between results in Table 1 (73.4%) and Table 2 (70.1%) could be attributed to the lower number of responses to this question.

STS Integrated into Present Science Curriculum.

Table 3 presents the data on the percentage of instructional time that should be allotted to the STS components.

Table 3

STS Component: Time Allocation

(n=117)

	Percent				
Statement	0-5%	5-10%	10-15%	15-20%	20%
The amount of instructional time allotted to STS	13.2	26.4	17.0	17.0	26.4

As shown in Table 3, there is a range of responses from 5% to 20% of instructional time allotted to STS instruction. Respondents were almost equally divided between those who recommended 5-10% of instructional time and those who felt 10-20% of instructional time would be required to integrate STS into the present science curriculum.

Format of STS Course

The following three tables (4-7) describe the format of the proposed STS course. These data are derived from those respondents who felt that STS should be taught as a separate science course.

Table 4

STS Course: 1 or 2 credit
(n=123)

	One Credit	Two Credit
Should the STS course be a 1 or 2 credit course?	35.8%	64.2%

As shown in Table 4, 35.8% respondents indicated that STS should be a one credit course while 64.2% felt it should be a two credit course. In the present high school curriculum all current science courses are two credit. This finding tends to support an additional two credit science course for the secondary school.

Table 5 examines the question, At which level would an STS course be most appropriate?

Table 5

STS course: Appropriate Level
(n=119)

	Level I	Level II	Level III
Most appropriate level for STS course	30.3%	45.4%	24.4%

As shown in Table 5, 45.4% of respondents felt that the STS course should be offered to Level II students.

Table 6 presents the responses to the question "For which group of students would the STS course be designed?"

Table 6

Target Group

(n=124)

	Students All	Above Average	Academically Weak
Group of Students	77.4%	18.5%	4.0%

As shown in Table 6, 77.4% of science teachers who felt that STS should be taught as a separate science course indicated that all students should complete an STS course.

Part B: Course Content

In this section the researcher presents the course content for the proposed STS course. Table 7 indicates the extent of agreement with the recommended core and elective modules.

Table 7
Proposed Course Content
(n=162)

Statements	Strongly Agree %	Agree %	Disagree %	Strongly Disagree %
Introduction to STS	69.8	29.6	.6	0
Medical Technology	54.6	41.7	3.1	.6
Natural Technology	59.8	38.4	1.2	.6
Information Technology	51.8	3.9	2.4	1.8
The Automobile	25.3	56.2	14.8	3.7
Recreation Technology	27.5	62.5	8.8	1.3
Nutrition	35.2	56.2	6.8	1.9
Energy	52.1	44.8	1.8	1.2
Material Science/Technology	38.0	57.7	3.7	0.6
Space Technology	31.3	59.5	6.7	2.5
Cybernetics	37.0	55.6	6.2	1.2
Advanced Optics	31.3	52.5	14.4	1.9
Biotechnology	47.2	44.8	7.4	0.6

It can be seen that science teachers agreed with most of the proposed modules outlined in the STS Course Description. There was a higher level of discrepancy with the Automobile (18.5%) as a core module and Advanced Optics (16.3%) as an elective than with the other modules proposed. Most teachers agreed with the proposed course content. However, several teachers commented on the need for additional topics to be included in the course.

Teachers' Comments

If you make a course, make sure some of it can be related to Newfoundlanders -- fishery, forestry and recycling.

I like the idea of an STS course but I hope that relevant examples from Newfoundland are used.

There should be an awareness of the effects of technology on a global scale as well as locally in terms of how it influences our daily lives.

I am satisfied with the way the course already looks.

Course Content

In this section, science teachers were asked to design an STS course by indicating whether the modules suggested in the STS course description should be core, elective or not suitable. Also, science teachers were given an opportunity to suggest additional modules for an STS course. Table 8 presents the findings.

Table 8
Core/Elective Units
(n=162)

Statements	Core	Elective	Not Suitable
Introduction to STS	93.9%	6.1%	0%
Medical Technology	68.7%	31.3%	0%
Natural Technology	78.2%	21.2%	0.6%
Information Technology	59.4%	39.4%	1.2%
The Automobile	25.8%	63.2%	11.0%
Recreation Technology	19.8%	74.1%	6.2%
Nutrition	68.9%	30.2%	0.9%
Energy	57.7%	40.5%	1.8%
Material Sci./Technology	33.8%	61.9%	4.4%
Space Technology	19.8%	73.5%	6.8%
Cybernetics	25.6%	66.9%	7.5%
Advanced Optics	13.8%	77.4%	8.8%
Biotechnology	46.0%	50.%	3.7%

As in Table 8, eleven percent of respondents felt that the Automobile module was not suitable and 8.8% of respondents felt that the Advanced Optics module was not suitable. In addition, teachers suggested that the following topics should be included in a secondary STS course -- marine technology, global climate, endangered species, nutrition, communication, environmental issues and human population.

Part C: Instructional Time and Strategies

In this section the researcher examined instructional strategies and instructional time for the proposed STS course. Table 9 presents the findings.

Table 9
(n=163)
Instructional Strategies

Statements	Strongly Agree %	Agree %	Disagree %	Strongly Disagree %
Compulsory activities	17.1%	38.4%	42.7%	1.8%
Individual interests	48.8%	47.6%	2.4%	1.2%
Teacher directed	7.3%	26.1%	55.2%	11.5%
Small groups	26.5%	65.7%	6.0%	1.8%
Panel discussions	11.7%	67.9%	16.7%	3.7%
Role playing activities	18.3%	62.2%	15.2%	4.3%
Computer technology	53.0%	45.1%	1.8%	0%
Problem solving/Creative thinking	45.5%	49.1%	4.2%	1.2%
Inquiry-based activities	44.5%	51.8%	2.4%	1.2%
Thinking skills	40.7%	55.6%	3.1%	0.6%
Examine local issues	54.2%	45.2%	0.6%	0%
Examine global issues	47.3%	52.1%	0.6%	0%
Use of resource people	55.8%	41.8%	2.4%	0%
Use of debates	23.8%	64.6%	8.5%	3.0%

As shown in Table 9, most science teachers agreed or strongly agreed with the suggested instructional strategies. Teachers appear to agree strongly on the encouragement of individual interests. Also, teachers strongly agree in promoting creative thinking skills and inquiry-based activities. There is strong agreement on the need to examine both local and global issues and the use of resource people in science instruction. However, there was disagreement with lessons consisting mainly of teacher directed instruction, the development of STS concepts through panel discussions, and role playing activities to clarify STS issues.

Teachers were asked whether the recommended instructional time in the draft STS course description was adequate to cover the course content. Results are reported in Table 10.

Table 10
(n=170)
Total Time Allotment

Statements	Strongly Agree	Agree	Disagree	Strongly Disagree
Sixteens hours for core units	17.4%	71.6%	10.3%	0.6%
Twelve hours for elective units	13.4%	69.8%	15.4%	1.3%

As shown in Table 10, most teachers felt that 16 hours of instruction were adequate to cover the core units and that 12 hours of instruction were adequate to cover the elective units. However, teachers were reluctant to comment because they have not taught the course.

An estimate of the proposed instructional time for the following approaches is presented in Table 11.

Table 11
(n=170)

Instructional Time for Specific Approaches

Statements	Percentage
Teacher directed	20-40%
Students working at their own pace	10-20%
Paper and pencil tests	5-20%
Students working in small groups	10-30%
Students involved in panel discussions, debates and role playing	5-20%
Students involved in inquiry based activities	10-20%

Teacher directed lessons were allocated 20-40% of the instructional time. This seems to support the belief that most science teachers are traditional in their teaching and focus primarily on teacher directed instruction. However, the finding that a number of teachers favor students "working at their own pace", "in small groups" and involved in a variety of non-traditional activities, indicates the acceptance of a combination of approaches and teaching strategies.

Part D: The Role of the Teacher.

In this section the researcher examined teaching techniques that would be employed in an STS course. Science teachers were asked to respond to eleven items on the role of the teacher. Table 12 presents the findings.

Table 12
(n=162)

Teaching Techniques

Statements	Strongly Agree	Agree	Disagree	Strongly Disagree
Questioning techniques	61.3%	38.0%	0.6%	0%
Different possible solutions	62.1%	36.6%	1.2%	0%
Formal discussions	42.6%	55.6%	1.9%	0%
Resource persons	50.6%	48.1%	1.2%	0%
Work on projects	44.7%	54.0%	1.2%	0%
Hands-on experiences	62.1%	36.6%	1.2%	0%
Variety of strategies	46.9%	48.8%	3.8%	0.6%
Modules of interest	57.8%	41.6%	0.6%	0%
Student participation	60.5%	38.3%	1.2%	0%
Real-life examples	69.6%	30.4%	0%	0%
Life long learning skills	63.4%	36.0%	0.6%	0%

As shown in Table 12 most science teachers agreed with the teaching techniques suggested for the proposed STS course. This supports the openness of teachers to a variety of approaches that was evident in the data from Table 11.

Part E: Instructional Resources

Science teachers were asked to respond to five possible instructional resources for the proposed STS course. The results are presented in Table 13.

Table 13

(n=167)

Instructional Resources

Statements	Strongly Agree	Agree	Disagree	Strongly Disagree
Variety of resources	65.9%	32.3%	1.2%	0.6%
Department of Education	16.0%	56.4%	25.8%	.8%
Community resource persons	38.2%	56.4%	4.8%	0.6%
Prescribed textbook	14.0%	28.7%	45.1%	12.2%
Audio-visual material	45.8%	48.2%	4.8%	1.2%

As shown in Table 13, the majority of respondents agreed that a wide variety of resources would be necessary to teach an STS course. As in Table 9, the use of community resource persons was endorsed again here. Audio-visual materials were also considered important in an STS course. However, approximately 57% disagree or strongly disagree that a prescribed text would be suitable for an STS course.

Part F: Evaluation Strategies

Science teachers were given eight evaluation strategies that could be used in the proposed STS course. The findings are reported in Table 14.

Table 14

(n=170)

Evaluation Strategies

Statements	Strongly Agree	Agree	Disagree	Strongly Disagree
Paper and pencil tests	19.9%	58.4%	18.1%	3.6%
Individual observation	15.7%	77.7%	5.4%	1.2%
Project work	47.9%	49.7%	2.4%	0%
Debates and role-playing	37.3%	54.8%	7.2%	0.6%
Laboratory work	25.9%	66.9%	7.2%	0%
Science fairs	18.9%	50.0%	20.0%	3.0%
Self-evaluation	3.7%	47.8%	44.1%	4.3%
Anecdotal notes	11.9%	61.3%	24.4%	2.5%

As shown in Table 15, most science teachers agreed with paper and pencil tests, individual observation, project work, debates and role-playing and laboratory work. Twenty-three percent disagree or strongly disagree with science fairs as an evaluation strategy. This last finding supports commonly accepted views on the purposes of participation in science fairs. Also, 47.1% disagree or strongly disagree with self-evaluation as an alternative evaluation strategy.

Part G: Preservice and Inservice

The researcher examined the preservice and inservice needs for the successful implementation of the proposed STS course. Question 1 dealt with time required to provide inservice for the course, and the findings are presented in Table 15.

Table 15
(n=170)

Preservice/Inservice Requirements

	Inservice Time			
Statements	Strongly Agree	Agree	Disagree	Strongly Disagree
1 to 2 day school-based	27.3%	30.8%	27.3%	14.7%
1 to 2 day regional	37.1%	33.1%	19.9%	9.9%
One week institute	30.4%	38.5%	27.0%	4.1%
Summer institute	29.2%	25.0%	38.2%	7.6%
Semestered course	20.1%	30.9%	38.8%	10.1%
Follow-up	48.2%	35.5%	14.2%	2.1%

As shown in Table 15, there is a wide range in the selected option for inservice. Most science teachers felt that a 1 to 2 day regional inservice and/or a one week institute would be required to inservice the proposed STS course. Also, teachers strongly agreed that follow-up would be a necessary component of any STS inservice.

Inservice Schedule

Question 2: The researcher examined the most appropriate time to schedule inservice. The findings are reported in Table 16.

Table 16
(n=170)

Scheduling of Inservice

Statements	Strongly Agree	Agree	Disagree	Strongly Disagree
Early fall	45.1%	29.9%	18.8%	6.3%
Late spring	35.5%	29.8%	22.0%	12.8%
Before school opens	18.1%	16.7%	37.0%	28.3%

Table 16 indicates that most respondents preferred that inservice take place in the early fall, possibly September or October. Also, there was strong agreement with inservice being scheduled during late spring. In addition, most teachers did not support the scheduling of inservice during August or just before school opens.

Inservice Topics

Question 3: The researcher examined topics that should be addressed in an STS inservice. The results are presented in Table 17.

Table 17
(n=166)

Inservice Topics

Statements	Strongly Agree	Agree	Disagree	Strongly Disagree
Science content	53.2%	41.8%	2.8%	2.1%
Philosophy	25.9%	51.8%	16.9%	5.4%
Sources of information	59.3%	35.3%	4.8%	0.6%
Instructional strategies	55.4%	42.8%	1.2%	0.6%
Resource materials	71.4%	28.6%	0%	0%
Student evaluation	34.7%	57.5%	7.2%	0.6%

As shown in Table 17, most science teachers felt that resource material, sources of information, science content and instructional strategies should be priorities in the inservice.

Inservice Presenters

In this section, the delivery of the STS inservice and who should be involved in the inservice was examined and science teachers were asked to what extent they agree with suggested inservice presenters. Table 18 reports the findings.

Table 18
(n=161)

Inservice Presenters

Statements	Strongly Agree	Agree	Disagree	Strongly Disagree
Science co-ordinators	53.0	41.0	5.4%	0.6%
Classroom teachers	45.8%	45.2%	8.4%	0.6%
Scientists	47.6%	45.7%	5.5%	1.2%
Dept. of Education	35.4%	52.4%	9.8%	2.4%
School principals	11.7%	50.3%	34.4%	3.7%
Community resource People	27.0%	54.0%	18.4%	0.6%

Most science teachers agree that science program co-ordinators, classroom teachers, and scientists should be involved in the inservice. Also, approximately 40% of respondents felt that school principals should not be involved in the inservice.

Personal Data: Gender

The researcher examined the personal data of the respondents and the data are presented in tabular form. Tables 19-27 report the findings and a profile of the average secondary science teacher will be presented at the end.

Table 19
(n=170)

Personal Data: Gender

Gender	Percentage	Number
male	87	140
female	13	21

Table 19 shows that 87% of respondents were male and 13% were female.

Age

Table 20 reports the age of those science teachers who completed the questionnaire.

Table 20
(n=170)

Personal Data: Age

Age	Percentage	Number
0-29	28.3	47
30-39	34.3	57
40-49	34.3	57
50-59	3.0	4
>60	0	0

As presented in Table 20, 68% of the science teachers who responded to the questionnaire were between the ages of 30-49. These results are consistent with the findings which show that the 1989-1990 median age for Newfoundland and Labrador teachers is 39.0 years (Press, 1990).

Years Teaching Science.

Question 3 examines the number of years that each respondent has been teaching science. Table 21 presents the findings.

Table 21
(n=170)

Personal Data: Years Teaching Science

Years	Percent	Number
0-4	24.4	41
5-9	13.1	22
10-14	13.1	22
15-19	22.0	37
20-24	22.0	37
>24	5.4	2

As shown in Table 21, 24.4% of the science teachers surveyed have been teaching from 0-4 years while 5.4% have been teaching science for more than 24 years. Between these two extremes, 26% have from 5 to 14 years experience and 44% have from 15 to 24 years experience.

Instructional Time for Science

Science teachers were asked to report the percentage of the week spent teaching science. The data are presented in Table 22.

Table 22
(n=170)

Personal Data: Instructional Time for Science

Science Instruction	Percent
<20	8.4
20-39	16.2
40-59	10.2
60-79	13.8
80-100	51.5

Table 22 indicates that 51.5% of science teachers spend more than 80-100% of their teaching in the field of science.

Science Major.

Science teachers were asked for their major while attending university. The data are presented in Table 23.

Table 23
(n=170)

Personal Data: Science Major

University Major	Percent
Physics	6.0
Chemistry	5.4
Biology	43.1
Earth Science	9.6
Mathematics	15.0
Other	21.0

As shown in Table 23, that 43.1 of science teachers majored in biology. Fewer than 6% majored either in chemistry or physics. This finding may have significance for inservice, in view of the number of physical science-based topics proposed for the course.

Certification Level.

In this section the reseacher obtained the teachers' certification level. Table 24 reports the findings.

Table 24
(n=170)

Personal Data: Certificate Level

Certificate Level	Percent
Level One	0
Level Two	0
Level Three	0
Level Four	1.2
Level Five	32.1
Level Six	42.3
Level Seven	24.4

As shown in Table 24, most science teachers are qualified at Levels Five to Seven, with 42% of science teachers having a Level six teaching certificate.

Completed Science Courses.

In this section the researcher examined the number of science courses each science teacher completed while attending university. The data are shown in Table 25.

Table 25

(n=170)

Personal Data: Science Courses Completed

Completed Courses	Percent
0	0
1-5	9.0
6-10	12.6
11-15	9.6
16-20	9.6
.>21	59.3

It can be seen in Table 25 that the majority of secondary science teachers have completed at least 21 science courses.

Knowledge of STS in Science Education.

Science teachers were surveyed on their knowledge of STS in science education. Table 26 presents the findings.

Table 26

(n=170)

Personal Data: Knowledge of STS Education

Level of Knowledge	Percent
slightly	33.3
moderately	58.2
very	8.5

As shown in Table 26, approximately 58% of science teachers surveyed rated themselves as moderately knowledgeable of STS in science education while 8.5% of science teachers rated themselves as very knowledgeable of STS in science education.

Interest in Course.

In this section the researcher examined whether science teachers would like to teach a Science, Technology and Society course. Table 27 displays the data.

Table 27
(n=180)

Personal Data: Interest in Teaching an STS course

Would like to teach an STS course	Percent
Yes	78.8
No	16.5
Undecided	4.7

As shown in Table 27 approximately 79% of science teachers said they would like to teach an STS course and less than 1 in 5 said they would not like to teach an STS course.

Secondary Science Teacher Profile

A profile of a typical secondary science teacher in the province of Newfoundland and Labrador is presented below, based on the data collected from the STS questionnaire.

Profile:

Gender:	Male
Age:	30-49 yrs.
Years Teaching Science:	15-24 yrs.
Percent of Science Instruction:	80-100%
Science Major:	Biology
Certificate Level:	Level VI
Number of Science Courses Completed:	>21 courses
Knowledge of STS:	moderate
Interest in Teaching an STS course:	Yes (78%)

Chapter Summary

The researcher has presented the data from the questionnaire administered to secondary science teachers in the province of Newfoundland and Labrador. Each section of the questionnaire has been reported and teachers' comments have been included to support the findings. A summary of these findings will be reported in the next chapter.

CHAPTER 5

SUMMARY AND RECOMMENDATIONS

Introduction

This chapter presents a summary of the problem investigated and outlines recommendations for further research in the field of Science, Technology and Society. The study was conducted in an attempt to answer the following questions:

1. What are teachers' concerns about implementing the proposed secondary STS course?
2. What are teachers' perceptions of their role in implementing the proposed secondary STS course?

The population sample for the survey consisted of 410 secondary science teachers in 29 school boards within the province of Newfoundland and Labrador. Questionnaires were mailed directly to science teachers within those 29 school boards.

The STS questionnaire was used as a means of investigating the science teachers' concerns and their perceptions of their role in this course. The STS questionnaire was composed of eight parts from A-H and consisted of Likert scale items -- "strongly agree", "agree", "strongly disagree", and "disagree". In addition, there were items that required a "yes" or "no" response. Data collected from the one hundred and eighty three science teachers were analyzed using the SPSS-X statistical package.

Results of this survey indicate that secondary science teachers are primarily male teachers between the ages of 30-49 years, have taught secondary science for 15-24 years and have a level VI teaching certificate. The majority of science teachers surveyed have at least twenty university science credits completed and would like to teach the STS theme in science education. Teachers generally agreed with the instructional strategies and evaluation techniques suggested for the proposed STS course. Items that appeared to give teachers' concern included the nature of the course, course content, and instructional resources. Also, they were divided in their opinion on the preservice and inservice that would be required for implementation and its mode of delivery. Each of these concerns will be discussed in the following sections.

Nature of the Course

The majority of science teachers agreed or strongly agreed that STS topics should be addressed in the science curriculum and felt that STS should be a separate course. Teachers who supported a separate STS course stated the following:

> STS course at Level I or II would be more beneficial to students. The impact of STS on our lives is very important and a course emphasizing this would give it the attention it deserves.
>
> Separate STS course definitely, preferably at Level II.
>
> I like the idea of an STS course.

These findings are supported by (Bybee & Mau, 1986) international survey of science educators. Bybee found that science educators supported the STS theme in science education and the majority of science educators supported a separate STS course. Although seventy percent of the science teachers surveyed in Newfoundland and Labrador study supported a separate STS course of the secondary science curriculum, thirty percent of the secondary science teachers were strongly opposed to the development of a separate course. The researcher found that these teachers were concerned about the delivery of the STS topics and how these STS topics would fit into a senior high school curriculum.

The teachers who opposed the development of an STS course felt that STS can be addressed by integrating STS topics into the present secondary science curriculum. The following comments were commonly expressed by teachers who were opposed to a separate STS course.

> STS components should be and are integrated in the present science courses.
>
> The high school system already has too many courses for students to cope with at one time. Many subject matters are overlapped both directly and indirectly in other courses.
>
> Why don't we update and improve on our existing science courses... When these courses are updated make STS a unit of these courses.

Although 70% of secondary science teachers supported a separate STS course there was a considerable range in opinion regarding the format of the proposed STS course. Sixty two percent of teachers who supported a separate STS course felt that a two credit STS course was appropriate, while 38% felt that it should be a one credit course. In addition, teachers were divided on the appropriate level for the proposed STS course. Most science teachers, (45%), felt that the course should be offered at Level II, while 30.3% said Level I and 24.4% felt that Level III would be an appropriate level. These findings regarding the nature of the STS course seem to indicate that most science teachers support a two credit STS course. However, there is a varied response to the appropriate level for such a course.

Course Content

In this survey, the majority of science teachers supported most of the recommended core and elective modules. Two modules, the Automobile and Advanced Optics were not accepted as well by science teachers as the other modules outlined in the draft STS course description. This seems to indicate that teachers felt that the Automobile module and Advanced Optics module were not suitable for an STS course.

An opportunity was given for teacher input. Teachers were asked if there were additional topics that should be addressed in an STS course. Many teachers recommended additional topics for such a course. The most commonly suggested topics were as follows:

- Natural Resources
- Marine Technology
- Nutrition
- The Future
- Nuclear Technology
- Communication
- Technology and Careers
- Global Climate
- Food Technology
- Renewable Resources
- Endangered Species

The majority of these topics are similar to those reported (Bybee & Mau, 1986). They found that food resources, population growth, global climate, nutrition, energy, nuclear reactors, extinction of plants and animals and mineral resources were the most important topics to be addressed in an STS course. It appears that science teachers perceive that an STS course should include these topics. This seems to be in conflict with the suggested course content. The fact that teachers suggested alternative topics could indicate that agreement may not be as strong as Table 8 suggests.

Instructional Resources

The results of this study indicated that science teachers would require a variety of resource persons and instructional resources to successfully teach an STS course. These would include community resource persons, computer software, newspapers, magazines, and audio-visual materials. By indicating that a variety of resource materials should be used in teaching an STS course, teachers surveyed seemed to support a more holistic approach to the teaching of science. Often, secondary science teachers tend to be more traditional in their teaching and to use a prescribed textbook as the primary resource. Over half of the science teachers in this survey felt that a variety of instructional materials should be utilized and a prescribed textbook or Department of Education support documents would be only a part of the instructional package. The following comments were expressed by science teachers who favored a variety of instructional resources.

> A number of textbooks and periodicals should be supplied to the library. A teacher source book of resources and laboratory activities should also be supplied.

> If the Department of Education cannot make arrangements to get the appropriate type and number of instructional resources in the school then the STS course should not be implemented.

> The modules should definitely be the main body of information for the course, but teachers should definitely make use of print materials like magazines, newspapers, as well as any relevant audio-visual materials whenever possible.

It seems that many teachers support the practice of resource-based learning and using a variety of instructional resources to teach the proposed STS course.

Preservice and Inservice

The results from the survey indicated that secondary science teachers were concerned about the nature of STS preservice and inservice. Most science teachers felt that inservice should be scheduled early in the school year and should be of a regional nature. Although 68% of science teachers supported a one week STS institute, most science teachers rejected the idea of a summer institute or a semesterized university credit course. Also, 83.7% of teachers felt that follow up inservice would be required after the first year of implementation.

Inservice Components

Teachers were concerned about the topics that should be addressed in an STS inservice. They felt that resource materials, science content, instructional strategies, and sources of information should take priority, while philosophy of instruction was also viewed as a priority. These findings are similar to those reported by Mitchener and Anderson (1989). They found that 10 of 14 teachers who used the STS program, Topics in Applied Science did not feel comfortable or sufficiently competent to teach the STS program.

Delivery of Inservice

In terms of the delivery of the STS inservice and who should be involved in the inservice most science teachers felt that program co-ordinators, classroom teachers, scientists, and Department of Education personnel should be presenters. School principals and community resource persons were not perceived as playing a major role in the inservice. Several teachers commented on the delivery of the proposed STS inservice:

> Co-ordinators may have to inservice teachers who take over the teaching of the course in future years.

> Teachers can share their ideas --everyone can learn from each other

> I like the involvement of community resource persons because they will find out what the STS course consists of and how they will be able to add to the course.

The role of preservice and inservice will be a key factor in the successful implementation of the proposed STS course.

Summary of Concerns

Based on the STS questionnaire most science teachers support the development of a separate STS course at the secondary level. However, it appears that science teachers are concerned about the design of the course, the course content, instructional resources and the preservice and inservice required to successfully implement the proposed STS course. Given the teachers' concerns and their perceptions of proposed course, the next section will outline several recommendations.

Recommendations

Based on the data collected from the STS questionnaire administered to 410 secondary science teachers and the concerns expressed by secondary science teachers, the following recommendations are made:

1. The question of whether STS issues should be presented in a separate STS course or as an integrated approach within the science disciplines requires further research.
2. After the first year of implementation, a modified version of the questionnaire should be administered to science teachers to monitor implementation problems and/or successes.
3. If an STS course is developed, the course content should reflect local issues and concerns as well as global issues. The topics should not mirror content used in other provinces or countries. They should also be perceived as relevant to students' lives.
4. Teacher education programs should ensure that science teachers are trained to teach STS from elementary to secondary levels.
5. If a separate STS course is developed for secondary schools in Newfoundland and Labrador, the findings of this study should be incorporated into the design and implementation of such a course.
6. If an STS course is developed, it is imperative that the Department of Education provide the necessary funding to ensure that the appropriate learning resources are provided to each school and that teachers are given inservice that will meet their

individual needs. Inservice plans should include follow up after first year of implementation, with feedback from teachers determining the nature of the inservice needed.

Chapter Summary

This chapter has presented a summary of the findings resulting from the STS questionnaire administered to 407 secondary science teachers. In addition, several recommendations are presented in this chapter. Since science, technology and society education is a relatively new theme in science education, teachers must be aware of the impact of this curriculum innovation. This study has provided insight and valuable information regarding teachers' perceptions of STS education and their concerns about implementing the proposed STS course. It is hoped that this information will be used to develop the final draft of the STS course description and to suggest guidelines for a successful implementation plan.

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APPENDIX A

INSTRUCTIONS:

The Department of Education is currently developing a secondary **Science, Technology and Society** course. The proposed STS course is scheduled for piloting in the 1992-93 school year. I have designed this questionnaire to obtain information on secondary science teachers' perceptions of the course and concerns about implementing the proposed course. The data collected will be used to develop an implementation plan.

Please read the attached **DRAFT** course description before completing the questionnaire. The course description is a draft document and its content may change. This questionnaire will provide you with an opportunity to have input into the development and implementation of the **Science, Technology and Society** course. Therefore, your participation is important.

Please use the comments section to elaborate on your responses. These sections will provide teachers with the opportunity to expand on their perceptions and concerns.

It is important to answer every question. There are no right or wrong answers. It is **your** view on teaching the proposed **Science, Technology and Society** course. Please be assured that all responses will be kept in strict confidence. Thank you for your cooperation.

Please return the questionnaire **ONLY** in the enclosed stamped envelope by November 6, 1991.

Return Address:

Mr. Barry LeDrew
Science Consultant
Dept. of Education
P.O. Box 8700, St. John's
Newfoundland,
A1B 4J6

PART A: Science, Technology and Society: The Nature of the Course

This section examines the nature of the proposed course in **Science, Technology and Society** (STS) and how this course will fit into the existing science curriculum. Please rate each statement on the extent to which you agree or disagree. For each statement you may: Strongly Agree (SA), Agree (A), Disagree (D), or Strongly Disagree (SD)

Example: I like teaching Science SA A N D SD

Please circle your choice:

1. STS emphases should be included in the secondary science curriculum . . . . SA A D SD
2. An STS course should be taught as a separate science course . . . . SA A D SD
3. STS components should be integrated into the present science courses . . . . SA A D SD
4. A course in STS should be taught by a science specialist . . . . SA A D SD
5. STS topics would be motivating to students . . . . SA A D SD
6. STS topics would relate science to real-life issues . . . . SA A D SD
7. STS topics would encourage students to complete additional science courses . . . . SA A D SD

Please answer the following questions in the space provided.

8. Should STS be taught as a separate course? If yes, go to 11, if no, go to question 9.

Yes........1
No.........2

9. Please give your reason for integrating STS and then complete question 10.

____

____

10. If integrated with present science courses, what percentage of instractional time should be allotted to the STS component? Go to Part B.

0-5%..............1
5-10%............2
10-15%...........3
15-20%...........4
20%...............5

If you answered question 10, skip 11-13.

Please circle your choice:

11. Should the proposed secondary STS science course be a 1 credit or 2 credit course?

one credit........1
two credit........2

12. At which Level would an STS course be most appropriate?

Level I...........1
Level II..........2
Level III.........3

13. For which group of students would the STS course be designed?

- all students...........................1
- above average students............2
- academically weak students......3

Comments:

____

____

PART B: Course Content

This section examines the proposed **Science, Technology and Society** (STS) course content as outlined in the draft course description. **Please read the draft course description before completing this section.**

The following core and elective modules are listed in the draft course description. Indicate to what extent you approve of this selection.

1. Proposed core modules.

(a) An Introduction to Science, Technology and Society . . . . SA A D SD

(b) Medical Technology . . . . SA A D SD

(c) Natural Resources . . . . SA A D SD

(d) Information Technologies . . . . SA A D SD

(e) The Automobile . . . . SA A D SD

2. Proposed elective modules.

(a) Recreation Technology . . . . SA A D SD

(b) Nutrition . . . . SA A D SD

(c) Energy . . . . SA A D SD

(d) Materials Science/Technology . . . . SA A D SD

(e) Space Technology . . . . SA A D SD

(f) Cybernetics . . . . SA A D SD

(g) Advanced Optics . . . . SA A D SD

(h) Biotechnology . . . . SA A D SD

3. If you were to design an STS course, which modules would you choose for the course? Please indicate your choice by placing an (X) in the appropriate space.

Proposed Modules	CORE	ELECTIVE	NOT SUITABLE
a. An Introduction to STS			
b. Medical Technology			
c. Natural Resources			
d. Information Technologies			
e. The Automobile			
f. Recreation Technology			
g. Energy			
h. Materials Science/Technology			
i. Space Technology			
j. Cybernetics			
k. Advanced Optics			
l. Biotechnology			

4. Please list other topics or issues that you think should be included in the proposed STS course.

1. ______________________________

2. ______________________________

3. ______________________________

4. ______________________________

5. ______________________________

Comments:

____

____

PART C: Instructional Time and Strategies

This section examines the possible instructional strategies for teaching the STS course. Please indicate the extent to which you agree or disagree. Circle only one selection. It is important to answer every question.

Instruction in an STS course should be characterized by:

1. a large number of compulsory manipulative activities that students must complete . . . . SA A D SD
2. opportunity to pursue individual interests (e.g., research projects) . . . SA A D SD
3. lessons consisting mainly of teacher directed instruction . . . . SA A D SD
4. learning in small groups . . . . SA A D SD
5. the development of STS concepts through panel discussions . . . . SA A D SD
6. role playing activities to clarify STS issues . . . . SA A D SD
7. computer technology as a tool for learning . . . . SA A D SD
8. scheduled time for problem solving and creative thinking activities . . . SA A D SD
9. inquiry-based investigations . . . . SA A D SD
10. higher level thinking skills . . . . SA A D SD
11. students being given an opportunity to examine **local** STS issues . . . . SA A D SD
12. students being given an opportunity to examine **global** STS issues . . . SA A D SD
13. the use of resource people (e.g. visiting scientists and guest speakers) SA A D SD
14. the use of debates to assist in decision-making on STS issues . . . . . . SA A D SD

Based on the draft STS course description please indicate whether you think the recommended instructional time would be adequate to complete each of the proposed modules.

16. Sixteen hours of instruction (24 forty-minutes periods) to cover each core unit . . . . SA A D SD

17. Twelve hours of instruction (18 forty-minute periods) to cover each elective unit . . . . SA A D SD

Given below are six instructional approaches which might be used in the proposed STS course. Please indicate what percentage of instructional time should be devoted to each of these approaches. The total should be worked out of 100%.

18. Teacher directed lessons to the whole class. . . . . _______

19. Students working individually at their own pace on projects and problem solving activities . . . . _______

20. Paper and pencil exercises to be completed by the whole class. . . . . . _______

21. Teachers working with small groups on projects and activities . . . . . . _______

22. Students involved in panel discussions,debates and role playing . . . . . _______

23. Students involved in inquiry-based activities. . . . . _______

24. Other (please specify) ________________ . . . . _______

Comments:

____

____

____

PART D: The Role of the Teacher in a Science, Technology and Society Course:

This section examines the role of the teacher in an STS course. Please indicate the extent to which you agree or disagree. Circle only one selection. It is important to answer every question.

1. In an STS course the teacher would:

a. make use of questioning techniques that promote creative and divergent thinking .... SA A D SD

b. encourage different possible solutions to a science, technology and society issues. .... SA A D SD

c. provide ample time for formal discussions of science, technology and society issues .... SA A D SD

d. invite resource people into class to participate in classroom activities .... SA A D SD

e. schedule ample time for students to work on their projects and investigations .... SA A D SD

f. give students an opportunity to have hands-on experiences .... SA A D SD

g. use a variety of teaching strategies such as role playing, brainstorming and debating .... SA A D SD

h. select science, technology and society modules that interest students .... SA A D SD

i. place a high priority on student participation when discussing science, technology and society issues .... SA A D SD

j. maintain student interest in science by using real-life examples .... SA A D SD

k. develop skills for life-long learning .... SA A D SD

PART E: Instructional Resources

This section will examine the learning resources in the proposed STS course. Please indicate the degree to which you agree or disagree with the following statements.

In an STS course the learning should be structured so that:

1. a wide variety of resources are used including newspapers, science magazines, and audio visual material . . . . SA A D SD
2. the most frequently used resources are modules provided by the Department of Education . . . . SA A D SD
3. community resource persons are used where appropriate . . . . SA A D SD
4. the primary learning resource is a prescribed textbook . . . . SA A D SD
5. audio-visual materials are suggested to complement the modules . . . . SA A D SD

Please suggest other possible resources.

____

____

____

____

Part F: Evaluation Strategies

This section examines various evaluation strategies and techniques that could be used in a **Science, Technology and Society** course.

In your opinion, evaluation in a STS course should consist of:

1. paper and pencil tests (including unit tests, mid-terms and final exams) . SA A D SD
2. individual observation of students . . . . SA A D SD
3. projects (including research projects, logs, and journals) . . . . SA A D SD
4. student participation in discussions,debates and role playing . . . . SA A D SD
5. evaluating laboratory work . . . . SA A D SD
6. participation in science fairs . . . . SA A D SD
7. self-evaluation . . . . SA A D SD
8. written comments on students (anecdotal notes) . . . . SA A D SD

Comments:

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PART G: Preservice and Inservice

This section examines teachers' perceptions of the preservice and inservice needs for the successful implementation of a **Science, Technology and Society** course. Please indicate the extent to which you agree or disagree. Circle only one selection. It is important to answer every question.

1. To successfully implement a STS course at the secondary level you will need:

   a. 1 to 2 day school-based inservice . . . . SA A D SD

   b. 1 to 2 day regional inservice . . . . SA A D SD

   c. a one-week institute . . . . SA A D SD

   d. an STS summer institute (4 weeks) at MUN . . . . SA A D SD

   e. a one-credit semester course in STS . . . . SA A D SD

   f. follow up in first year of implementation . . . . SA A D SD

2. In your opinion, what is the best time to schedule the inservice? Please indicate the extent to which you agree or disagree. Circle only one selection. It is important to answer every question.

   a. Early fall (i.e. September or October) . . . . SA A D SD

   b. Late spring (i.e. April or May) . . . . SA A D SD

   c. Before school opens (i.e. August) . . . . SA A D SD

   d. Other (please specify) . . . . SA A D SD

   ____

3. The following topics should be addressed in an STS inservice. Please indicate the degree to which you agree or disagree with the following statements.

a. science content related to STS issues . . . . SA A D SD

b. philosophy of instruction . . . . SA A D SD

c. sources of information on STS issues . . . . SA A D SD

d. instructional strategies . . . . SA A D SD

e. resource materials . . . . SA A D SD

f. student evaluation . . . . SA A D SD

Please circle your response to the following items.

4. Science program co-ordinators should be involved in the inservice . . . SA A D SD

5. Classroom teachers should be involved in the inservice as resource persons . . . . SA A D SD

6. Scientists should be involved in the inservice as resource persons on STS issues . . . . SA A D SD

7. Department of Education (i.e., science consultants) should be involved in the inservice . . . . SA A D SD

8. School principals should be involved in the inservice . . . . SA A D SD

9. Community resource persons should be involved in the inservice . . . . SA A D SD

Comments:

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Part H: Personal Data

Name:(optional) ______________________

School: ______________________

School Board: ______________________

Please circle your response to the following items:

Sex: Male.......1
Female......2

1. What is your age?

0-29......1
30-39....2
40-49.....3
50-59.....4
≥ 60.....5

2. How many years have you been teaching?

0-4........1
5-9........2
10-14.....3
15-19.....4
20-24.....5
≥25.......6

3. How many years have you been teaching science?

0-4........1
5-9........2
10-14....3
15-19....4
20-24....5
≥25.......6

4. What per cent of the week do you spend teaching science?

<20%....1
20-39....2
40-59....3
60-79....4
80-100..5

5. What was your major at university?

physics..........1
chemistry........2
earth sci.........3
biology..........4
mathematics.....5
other (specify)
__________..6

6. Please indicate the number of years teaching each science course.

physics ______
biology ______
chemistry______
earth sci. ______
gen.sci. ______
env.sci. ______
phy.sci. ______
jr. high ______

7. Please give an approximate percentage of time you spend teaching the following course(s).

physics ______
biology ______
chemistry______
earth sci. ______
gen. sci. ______
env. sci.
____
phys. sci.______
jr. high ______

8. What is your current teaching certificate level?

Level One......1
Level Two......2
Level Three....3
Level Four......4
Level Five......5
Level Six........6
Level Seven...7

9. Please list your university degree(s).

____
____

10. How many science courses have you completed?

0..........1
1-5........2
6-10........3
11-15.....4
16-20.....5
>21........6

11. How knowledgeable are you of STS in science education?

slightly knowledgeable......1
moderately knowledgeable....2
very knowledgeable..........3

12. Would you like to teach a Science, Technology and Society course?

yes......1
no.......2

Thank you for your cooperation!

Please return questionnaire to:

Mr. Barry LeDrew
Science Consultant
Dept. of Education
P.O. Box 8700, St. John's. NF.
A1B 4J6

PLEASE RETURN QUESTIONNAIRE ONLY BY November 6th, 1991.

APPENDIX B

SCIENCE TECHNOLOGY SOCIETY

COURSE DESCRIPTION

Division of Curriculum and Instruction

Second Draft
April 11, 1990

TABLE OF CONTENTS

PHILOSOPHY

All general education curricula are based on individual needs, social needs, and a relevant body of knowledge. All three are rapidly changing in modern society, driven by revolutionary developments in powerful and pervasive science-based technological systems. Indeed, modern society has become characterized and defined by scientific knowledge and technological know-how. The massive forces represented in those systems have become the primary factor in social change and definition. A culture of science and technology has emerged; every aspect of the human condition is affected by the benefits and losses associated with the growth of science and technology.

Scientific knowledge is acquired and technology is applied by humans to extend their individual and collective capacities. These human attributes have now reached the extent that humankind can essentially design and create (or destroy) the physical environment and significantly impact the social reality. Science and technology can now enable humans to create a future and orchestrate reality in its physical and social dimensions. These developments have provided human capacities heretofore unavailable, coupled with its responsibilities and requisite decisions. As this area of human capacity evolves, the resulting changes are not only social and cultural but personal; humans evolve technology, technology evolves humans.

An understanding of the interrelationships of science and technology to social and personal realities must become a hallmark of the educated citizen. The human capabilities and realities it presents must be apparent, since social and personal decisions related to science and technology are now a grave responsibility of all citizens in a democratic society. Thus, a knowledge of science alone is no longer sufficient; **it must be science in a relevant context of technology and social impact.** This concept of the connectedness of science, technology and society forms the rational and instructional bases of STS courses.

This educational goal can be accomplished only through development of scientific and technological literacy; an understanding of the operations, interactions and outcomes, intended and unintended, of our prevalent science-based technological systems. This concept of literacy must also include attitudes, concepts and decision-making skills attuned to a technological and global community. Students must learn what science and technology is doing **to** them as well as **for** them.

RATIONALE

Science for Every Student (Report 36 of the Science Council of Canada, 1984) and *Towards An Achieving Society* (The Report of the Task Force on Mathematics and Science Education, 1989) both recognize the significance and importance of the Science-Technology-Society theme in the science curriculum. Both reports emphasize the need for this theme to be addressed directly in the curriculum.

The development of this course is based on a number of important assumptions, among which are the following:

1. One of the most important forces that is shaping the nature of society is the influence of science and technology.
2. Many of the major issues and problems that face society today are directly or indirectly related to science and technology.
3. The appropriate application of scientific knowledge and technological know-how may lead to the solutions to these issues and problems.
4. One of the top priorities of our education system is to provide students with the knowledge and skills to deal with these scientific and technological issues.
5. Today's students must be able to deal with scientific and technological issues if they are to be informed decision-making citizens.

The development of the STS curriculum is a response to the pervasiveness of scientific and technological issues that face the citizens of today's society. Science and technology have probably been the cause of many of the world's major problems but at the same time science and technology may provide the solutions. More and more aspects of everyday life have been or are being affected by science and technology. The world is changing dramatically in response to the rapid growth of scientific knowledge and technological power.

Science and technology are inherently neither good nor bad. Both are value-free. It is the use of the scientific knowledge and technology that determine whether the impact will be viewed as good or bad. Furthermore, the response to science and technology will be shaped by individual and societal values, traditions, and emotions that may vary from generation to generation and from one society to another.

In a democratic society it is the citizens who make decisions and who ultimately control science and technology. It is the responsibility of our education system to ensure that the students of today, tomorrow's decision-makers, will be equipped with the knowledge and skills required to make the best possible decisions.

Students will live and work in a society that is even more technological than it is today. It is critical that they not only be aware of scientific and technological issues but also able to analyze and make decisions related to the issues. They must understand how they are affected by, and can affect, developments in science and technology.

The social and economic future of Newfoundland will depend on the appropriate use of science and technology to manage our resources and develop new economic opportunities, which in turn will depend on how well we educate our youth to utilize science and technology.

This course will allow students to explore the relationships among science, technology and society and at the same time develop a better understanding of the basic science concepts involved. Opportunities will be provided for students to study examples of current technology and to develop an understanding of how these technologies affect themselves and society in general. Critical-thinking, problem-solving and decision-making skills will be developed in the process of analyzing these technologies. These skills can then be transferred to other situations and will enable students to deal with new technologies as they emerge.

Students are exposed to many examples of science and technology in their everyday lives. When they leave school a small percentage of students will continue to study or work in science fields. A much larger percentage will work in science-related or technological areas. We have a responsibility to ensure that students are equipped with the knowledge and skills required to live in a scientific and technological society. This course will not only promote the integration of the student with the work world but will also help the student become a more productive individual and a better informed and more effective citizen.

PROGRAM GOALS

Students should learn how to apply critical-thinking skills in the social realm so that they can make intelligent decisions in a variety of contexts. Our schools should instruct students in thinking and problem-solving skills. This basic emphasis should begin in elementary years and continue through secondary school. To achieve this goal, the method by which science is taught should focus on processes that are central to developing problem-solving and inquiry skills.

The overall goals of science education are the same for all students, regardless of their academic ability. The main differences exist in the levels of expectation and in the depth of treatment for students of different academic abilities.

The overall goals for **Science-Technology-Society xxxx** are to provide students with opportunities to:

1. develop an understanding of the interrelationships among science, technology, and society.
2. gain knowledge of science and of technologies as applications of science and to develop some degree of scientific and technological literacy.
3. develop critical-thinking, problem-solving, and decision-making skills so that they may respond appropriately to scientific and technological issues.
4. develop research skills.
5. participate in high-interest activities which will both motivate the student to learn science and provide a realistic view of science. These activities will also provide opportunities for success, satisfaction, and increasing self-confidence.
6. become familiar with current issues related to STS and aware of the positive and negative consequences of science and technology.

LEARNING OUTCOMES

From the stated goals, a number of learning outcomes are identified for **Science-Technology-Society xxxx.** These learning outcomes identify what a student is expected to gain as a result of participation in this course.

After completion of **Science-Technology-Society xxxx**, students should:

1. **Develop an understanding of the interrelationships among science, technology and society.**
   (a) understand that technology is both a cause and a result of scientific activity.
   (b) understand that society influences and responds to scientific activity.
   (c) understand the role of society in controlling technological development.
   (d) understand that historical events have shaped and will continue to shape technologies.
   (e) recognize that decisions concerning scientific and technological issues are influenced by values.

2. **Gain knowledge of science and of technologies as applications of science and to develop some degree of scientific and technological literacy.**
   (a) understand that technology is an application of the concepts and principles of science.
   (b) understand the basic science concepts and principles involved in selected examples of common technologies.
   (c) recognize science as a problem-solving process or approach, as opposed to a catalogue of facts to be memorized.

3. **Develop critical-thinking, problem-solving, and decision-making skills so that they may respond appropriately to scientific and technological issues.**
   (a) understand how evidence and opinion are determined.
   (b) be able to apply decision-making skills to problem-solving situations.
   (c) be able to analyze decisions involved in the development, implementation, and use of technologies.

(d) be able to propose alternative solutions to problems arising from scientific or technological issues.

(e) be able to use knowledge of technologies in practical situations.

4. Develop research skills.

(a) be able to apply as many of the scientific processes as possible. These include observing, classifying, quantifying, communicating, inferring, predicting, formulating hypotheses, defining operationally, controlling variables, interpreting data, experimenting and formulating models.

(b) develop skills in information retrieval and processing.

5. Participate in high-interest activities which will both motivate the student to learn science and provide a realistic view of science. These activities will also provide opportunities for success, satisfaction, and increasing self-confidence.

(a) recognize the potential of science and technology for both a positive and negative impact on society.

(b) assess the effect of science and technology on the skills and knowledge required by the work force.

6. Become familiar with current issues related to STS and aware of the positive and negative consequences of science and technology.

(a) develop an interest in scientific and technological issues.

(b) recognize that they can be successful in having some 'control' over situations involving technology at different levels - personal, local, or regional.

(c) develop a sense of self-confidence in dealing with technologies in their everyday lives.

INSTRUCTIONAL STRATEGIES

This Science and Technology Course is somewhat different from the traditional Science Course. Whereas traditional courses utilize a textbook as a primary resource, this course is based heavily on the principles of resource - based learning. Traditional courses address explanations of phenomena, this course focuses on issues in order to make students aware of the relationships that exist among science and technology and society. Issues can be defined as situations involving two or more people with differing viewpoints and knowledge. As such, they tend to be controversial, for example, forest harvesting techniques and low level flying in Labrador.

The effective treatment of an issue requires that students engage in two related, but distinct processes: the inquiry process and the decision-making process. The inquiry process involves exploring an issue by **expanding upon** the various points of view and examining the associated scientific, technological, and social "sub-issues". The decision-making process involves **narrowing the focus** to the point where a course of action can be decided upon. Some of the requisite skills needed to employ these processes include:

- basic research skills for locating, organizing and selecting information
- critical thinking skills for analyzing information and alternatives
- creative thinking skills for searching out and creating alternatives and predicting consequences.
- problem-solving and decision-making skills
- communication skills to better convey one's own point of view and understand other points of view
- group and discussion skills

Issue inquiry and decision making usually involve group activities. Students in this course will sometimes be asked to make individual decisions or conduct individual explorations of an issue, but groups will be given the task of resolving complex issues.

Types of Decisions

Before commencing the course it is necessary to point out to the students that there exist four main types of decisions.

- An impulsive decision is made quickly without thinking or adequate prior knowledge.

- A habit decision is made strictly out of habit.
- A non-decision is no decision at all. The person thinks about the choices but can't decide.
- A careful decision is one made after considering choices and relevant information gathering facts. The person is either happy with the results, or learns from them and so becomes more confident in decision making. This is the type of decision this course will attempt to develop.

The instructional strategies which may be employed to analyze and make decisions on scientific and technological issues are limited only by the imagination and expertise of the teacher. Presented below is a brief description of a number of strategies which teachers should consider using in their course.

I Structural Models for Analysis

Most issues examined in this course are complex. Students, however, often take positions 'for' or 'against', an issue based on an inadequate understanding. Developing structural models allow students to analyze issues and reveals the complexities of many issues.

The five steps of webbing method used to analyze issues are:

1. Place the issue at the centre of the diagram
2. Draw six (or more) major weblines to the major related factors that influence the issue.
3. Brainstorm to elicit a variety of viewpoints and related concerns for each major factor.
4. If time and resources are available, show the web diagram to other students, teachers and community resource people to be sure the major points of view are included.
5. Use the web diagram to plan courses of action for groups during the issue inquiry.

II Brainstorming

Brainstorming is a group strategy that is used to generate ideas. It encourages all ideas and gives those with some merit a chance to develop. As such, it is an especially useful strategy for treatment of an issue. In addition to facilitating the generation of ideas and the identification of points of view that otherwise might be missed, it demonstrates the creative potential of a group and emphasizes the value of collective thinking. It also helps members realize that if they show respect for one another they will be able to work together without fear.

III Higher-Order Questioning

The development of the upper levels of Blooms taxonomy (Analysis, Synthesis, and Evaluation) is an important focus of the STS Course. Rather than being tested on their knowledge, students will be evaluated on how well they use that knowledge to hypothesize, estimate, predict assess, conclude, decide and recommend. Instead of being tested on how well they can answer questions, they will be tested on what kinds of questions they are able to ask. Using rather than memorizing facts is the business of the course, content becomes the tool, not the task.

The instructional strategy then becomes one of question asking high-order questions. For example:

Analysis

Can you compare the effect of Zap with that of other pesticides, such as DDT, or birds eggs?

Synthesis Can you suggest alternate ways to control diseases such as malaria and typhus?

Evaluation Decide what you think the government should do in this situation. Consider the needs of the public and the farmers as well as government

IV Role Playing

The resolution of STS issues requires that a number of viewpoints be explored; role playing is an ideal strategy for examining various points of view - allowing for the interaction of people and the sharing of information. To the extent that students are able to immerse themselves in various roles, the strategy also enables them to better understand the importance of emotional motivation in situations involving conflict.

V Debating

Debate is formal discussion that begins with a statement of point of view on an issue. It is an ideal strategy for exploration of issues since it explores different points of view. Debates in the Science and Technology course will provide opportunities for students to:

- explore different points of view
- respond critically to technological issues
- practise and observe a technique that is used both nationally and internationally to resolve issues.

Debate format varies from rigid adherence to a set of prescribed rules to informal, more loosely controlled dialogue and discussion. The teacher must choose a suitable format.

VI Media Use and Analysis

One of the objectives of the STS Course is the development of skills to critically analyze the media. The media should become an integral part of the course.

- as an application of technology
- as a source of up-to-date background information
- as a source of course content
- as a medium to motivate and stimulate students and to promote discussion
- as a vehicle to expose students to a broad range of out-of-class, "real world" situations and viewpoints

VII Community Explorations

A Science and Technology Course should be a practical one with the objective of better preparing individuals to function in society. It then must bridge the gap between science in the classroom and science in the outside world. The use of field studies, guest speakers, interviewing, and taking polls can help bridge the gap.

VIII The Use of Computers

Computers are symbols of technological advances. They should then be used as much as possible in a Science and Technology Course. Students should develop an understanding of both the advantages and the limitations of computers and how they can be used for facilitating interaction, conducting simulations and games, solving problems and making decisions, keeping records, doing word processing, and handling information.

* Science and Technology II - Instructional Resources Manual - Province of British Columbia.

APPENDIX C

Dear Superintendent

I am in the process of completing a Master's degree in science curriculum and instruction at Memorial University. The title of my thesis is Teachers' Concerns and Perceptions in Implementing the Proposed Science, Technology and Society Course. The Department of Education is currently developing a new secondary science course entitled Science, Technology and Society. This course will be significantly different in its philosophy of instruction, course content, and student evaluation from traditional science courses such as physics and chemistry.

This study involves a teacher questionnaire for secondary science teachers in your district. The data collected from this questionnaire will be used to develop an implementation plan for the proposed Science, Technology and Society course.

I am a science program co-ordinator with the Labrador East Integrated School Board and I will be asking my colleagues from each school board to deliver the survey instruments to teachers within your district. This letter is to inform you of the study and to ask for your support in obtaining the necessary data from the secondary science teachers within your district.

Yours sincerely,

Bruce Vey

APPENDIX D

Dear fellow science teacher,

I realize this is a very busy time of the year as you begin planning for the upcoming school year. However, I would appreciate a few minutes of your time to read this letter and complete the attached questionnaire.

I am presently completing a Master's degree in science curriculum and instruction at Memorial University. My thesis is entitled "The Proposed Science, Technology and Society Course: Secondary Science Course for Schools in Newfoundland and Labrador: Teachers' Perceptions and Concerns." The attached questionnaire has been sent to all secondary school science teachers in our province and it will provide science teachers with an opportunity to have input into the development of the proposed course.

The Department of Education has established a provincial working group to develop a Science, Technology and Society (STS) course for secondary students. STS has become a megatrend in science education and it focuses on the interaction of science and technology in a social context in an attempt to increase scientific literacy for all citizens. The proposed STS course will probably be piloted in secondary schools during the 1992-93 school year. With any curriculum innovation, the classroom teacher is the key figure in determining the successful implementation of an STS course. The intention of the enclosed questionnaire is to survey science teachers' perception of STS and their concerns about implementing the proposed STS course.

Please be assured that all responses will be kept in strict confidence. Thank you for taking the time to complete the STS questionnaire.

Although your participation is voluntary, I would sincerely appreciate it if you would complete the questionnaire and return it by October 30, 1991. A stamped, self-addressed envelope has been included. Thank you for your time and consideration. If you have any questions, please call me at 726-6529.

Yours sincerely,

Bruce Vey

APPENDIX E

November 14, 1991

Dear Science Teacher,

About two weeks ago you received a Science, Technology and Society questionnaire to complete. I appreciate that school is a busy place and filling out this instrument is time consuming but every response is important to the accuracy of my study. If possible, please fill out your copy and place it in the mail as soon as possible.

If you have already completed the questionnaire, please disregard this reminder and accept my thanks for you co-operation.

Yours sincerely,

Bruce Vey