SCIENTIFIC LITERACY

A Survey of Adult Canadians

Edna F. Einsiedel
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Table of Contents

Introduction

Scientific literacy is a concept that has interested policy makers, educators, and academic researchers for many years. Much has been written about the concept but, until recently, there have been few empirical attempts to measure literacy levels on science and technology.

This study is the first attempt to examine levels of science literacy among adult Canadians. It is part of a larger on-going study of science communications in Canada.[1]

The earlier phases of this research program examined the portrayals of science and technology in the Canadian press, followed by an analysis of Canadian science journalists. The present phase describes the Canadian public's interest in, exposure to, and understanding of, science and technology information. In short, a major aim is to establish the level of scientific literacy among adult Canadians.

In establishing some indication of levels of scientific literacy among Canadians, this study drew heavily from similar studies underway in the United States and Great Britain. The measures used in this study, in fact, reflect an effort to replicate those used in 1988 studies conducted in both those countries.[2] Similar

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[1] These studies have been supported by grants from the Social Sciences and Humanities Research Council to this researcher. See E.F. Einsiedel, "Portrayals of Science and Technology in the Canadian Press." Paper presented to the American Association for the Advancement of Science, January, 1989, San Francisco, Ca.

[2] A series of studies on scientific literacy in the U.S. has been conducted by Dr. Jon Miller for the National Science Foundation, the most recent one being the telephone survey of 2,041 Americans in June and July of 1988. The British survey was a joint project of Oxford University and the Social and Community Planning Research Unit under the direction of John Durant, Geoffrey Evans and Geoffrey Thomas. It was funded by the Economic and Social Research Council and was conducted in person among 2,009 British adults during the same time period.
For descriptions of these surveys, see Jon D. Miller, "Scientific Literacy". Paper presented to the American Association for the Advancement of Science, January, 1989, San Francisco, Ca. For earlier studies, see also J.D. Miller, The American People and Science Policy. New York: Pergamon Press, 1983.
Descriptions of the British results can be found in J.R. Durant, G.A. Evans and G. P. Thomas, "The public understanding of science". *Nature*, 340:6, July, 1989. See also J. Durant and G. Evans, "How much science do the people know? Good news and bad news about America and Britain." Paper presented to the American Association for the Advancement of Science, January, 1989, San Francisco, Ca.
The author would like to thank Dr. Jon Miller, Director of the Public Opinion Research Laboratory at Northern Illinois University and Director of the U.S. studies on scientific literacy, and Mr. Donald Buzzelli of the National Science Foundation, Washington, D.C., for their very helpful assistance and collaboration on this project. Dr. Tak Fung's assistance on data analysis is also gratefully acknowledged.

studies have also been conducted in Japan. As well, the European community has just completed a 12-country survey.

More generally, this study based on a national survey of 2,000 adult Canadians had the following objectives:

1. To describe science literacy levels among adult Canadians.

2. To compare Canadian science literacy levels with those of Britain and the United States.

3. To assess Canadian attitudes toward science and technology.

4. To determine levels of interest in and exposure to science and technology information.

5. To assess levels of knowledge about Canadian science.

The Concept of Scientific Literacy

What is scientific literacy and why is it important? A considerable literature on scientific literacy exists and it is not our purpose here to provide a thorough review of all the various ways the phrase has been defined. There is general consensus that scientific literacy is a multi-dimensional concept but there is no unanimity on what its dimensions are.

A British political scientist suggested that the term encompassed the following components:

1. An appreciation of the nature and aims of science and technology, including their historical origins and the epistemological and practical values which they embody.

2. A knowledge of the way in which science and technology actually work, including the funding of research, the conventions of scientific practice, and the application of new discoveries.

3. A basic grasp of how to interpret numerical data, especially relating to probability and statistics.

4. A general grounding in selected areas of science, including, for example, a number of key interdisciplinary areas such as matter and energy, information theory, and environment and health.

5. An appreciation of the interrelationships between science, technology, and society, including the role of scientists and technicians as experts in society, and the structure of relevant political decision-making processes.

6. An ability to update and acquire new scientific knowledge in the future.[3]

A current enterprise in the U.S. which has as its central purpose the reform of education in science, mathematics and technology started by defining what were considered to be the basic dimensions of scientific literacy:

1. Being familiar with the natural world and recognizing both its diversity and its unity.

2. Understanding key concepts and principles of science.

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[3] Michael Shortland, "Advocating science: literacy and public understanding". *Science popularization in a changing world*. UNESCO, 38:4. London:Taylor-Francis, 1988.

3. Being aware of some of the important ways in which science, mathematics and technology depend upon one another.

4. Knowing that science, mathematics and technology are human enterprises and knowing what that implies about their strengths and limitations.

5. Having a capacity for scientific ways of thinking.

6. Using scientific knowledge and ways of thinking for individual and social purposes.[4]

A Canadian educator's description of scientific literacy as a basis for science education presented the following elements:

1. Scientific knowledge which includes facts, concepts, principles and skills and their applications to new situations in science and technology;

2. The ability to engage in the processes of scientific inquiry;

3. General ideas about the characteristics and limitations of science;

4. Important relationships between science and society;

5. Attitudes and interests related to science.[5]

These descriptions are meant to be illustrative rather than representative but certain elements they have in common appear in other discussions of scientific literacy as well. For example, the importance given to understanding the interrelationships between science, technology and society is quite clear, and so is the necessity to portray science in more realistic terms. This means underscoring its limitations in addition to its strengths. Two further common dimensions relate to an understanding of scientific processes or modes of inquiry as well as a reliance on some base of knowledge which includes concepts and principles.

Why is scientific literacy important? Policy makers have always maintained that a basic level of scientific literacy is required in order for individuals to function in a scientific and technological culture and for a nation to compete more effectively in the industrialized world. Indeed, these reasons were cited at the 1988 National Conference on Technology and Innovation in Toronto when the

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[4] American Association for the Advancement of Science, "Project 2061: Science for all Americans". Summary. Washington, DC, 1989.

[5] G. Aikenhead, *Science in social issues: implications for teaching*. Science Council, Ottawa, 1980.

Minister of State (Science and Technology) announced a $10 million two-year national effort to raise public awareness of science and technology.[6]

Political scientists stress the advantages to political decision-making from an informed citizenry. The issues of the day on which citizens are called upon to take positions increasingly involve some level of scientific understanding. These have included such topics as toxic waste disposal, acid rain, pollution controls, reproductive technologies, water fluoridation, organ transplants, and genetic engineering. These are among those topics in recent years that have involved personal choices, regulatory preferences, or ballot-box decisions.

Others suggest that there are intellectual, moral and aesthetic benefits, in addition to economic ones, to the public understanding of science. The Science Council of Canada has described all of these benefits as fitting rationales for providing a strong science education for Canadians. Its report setting out the context for science education in Canada makes an argument for scientific literacy as a necessity for an informed citizen, a basis for further education, a preparation for the world of work, and a contribution toward personal development.[7]

It is obvious that the rationale for scientific literacy will vary depending on the perceived goals.[8] Our inclination is to argue for scientific literacy as a means of empowering the average citizen. To be scientifically literate is to have a sense of efficacy when dealing with issues scientific and to be discerning about technology and its attendant risks and benefits.

In summary, the ability to understand the world we live in is critical. This involves the ability to cope effectively with issues as they arise, and to recognize science for the enterprise that it is, a productive human activity bearing fruits that have both benefits as well as risks.

The Measurement of Scientific Literacy

There are inherent difficulties in moving from the conceptual to the measurement level, particularly when the concept is a complex, multi-

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[6] Industry, Science and Technology, "Science and Technology Public Awareness Campaign Educational Component: Evaluation Report 1988-1989". Ottawa.

[7] Science Council of Canada. *Science for Every Student: Educating Canadians for Tomorrow's World.* Report No. 36. Ottawa, Supply and Services, 1984.

[8] For a summary of these arguments, see J. Durant, "Why should we Promote the Public Understanding of Science?" In M. Shortland (ed.), *Scientific Literacy Papers.* Oxford, U.K.: Oxford University Press, 1987. See also The Royal Society, *The Public Understanding of Science.*London:The Royal Society, 1987.

dimensional one and when constraints on data collection also exist (such as doing interviews by telephone).

Within these limitations, there are, of course, a variety of ways scientific literacy can be measured. In both the British and American studies, scientific literacy has been examined on three levels:

1. An adequate vocabulary of basic concepts to understand issues on science and technology.

2. An understanding of the processes or approaches of science.

3. An understanding of the relationship of science and technology to society.

While not fully tapping the complexity of the concept, these elements were sufficiently diverse as to allow a rudimentary description of the scientific literacy of a large and representative sample as well as a comparison with findings from other countries. On a practical level, these dimensions essentially encompass an ability to read about, comprehend, and express an opinion on, scientific matters usually covered in the popular press.

Method

Sample

This telephone survey was conducted among 2,000 adult Canadians between November 24 and December 23, 1989. A procedure called random digit dialling was employed, based on random selection of telephone exchanges and the computerized generation of the last four digits of a telephone number. Numbers of respondents were stratified according to the population distribution in each province. A 50-50 quota for male and female respondents was employed. Field work was done by Decima Research of Toronto.

Survey Instrument

English and French versions of the questionnaire were developed which included a battery of 127 questions. While this may appear to be unduly long for a telephone survey, many clusters of questions used the same response set. For example, the knowledge quiz of 13 questions required respondents to simply answer "true" or "false", while a set of attitudinal items had respondents indicate whether they "strongly agreed", "agreed", "disagreed", or "strongly disagreed" with the statements. The interview lasted an average of 25 to 30 minutes.

Many of the questions — about two-thirds of the entire survey — replicated those utilized in the 1988 American and British surveys.

Sampling Error

In theory, in 19 cases out of 20, the results based on the entire sample will differ by no more than 2.2 percentage points in either direction from what would have been obtained by interviewing all adult Canadians. The range of error for smaller subgroups is larger. For example, the margin of sampling error for Western Canadians (572 of the 2,000 respondents) is plus or minus 4.2 percentage points.

In addition to sampling error, the practical difficulties of conducting any public opinion survey may introduce other sources of error.

Results

Exposure to Science and Technology Information

Quite a few Canadians — about 56 percent — say they watch a televised science program "regularly". However, when asked about specific programs such as *The Nature of Things*, *Nova*, or *National Geographic* specials, only about 30 percent or fewer admitted to watching these programs regularly. It is possible that regular newscasts which include an occasional science feature or science news story are considered "TV science programs" by some respondents.

The magazine read regularly by the largest number of Canadians was *National Geographic*. Fifteen percent said this was the magazine they read most often.

The radio science program most frequently listened to was *Quirks and Quarks*, though this was cited by fewer than four percent.

Table 1. Exposure to Science in the Media

	N	%
Percent who read a science magazine	605	30.3
Percent who watch science programs on TV regularly	1,112	55.6
Percent who listen to science program on radio	211	10.5

Perceptions of Media Coverage

In terms of their perception of how the media cover science and technology, respondents were more likely to say that coverage of such stories was generally positive but that there was not enough coverage of these topics. However, what there was available was generally considered "easy to follow."

The data on perceptions of coverage of science and technology in the media being mainly positive become more interesting when compared with perceptions of the coverage of politics. Only six percent considered political stories to be "generally positive" (compared to 45% for science stories), while 43 percent said these stories were "generally negative", in contrast to only 5 percent with a similar opinion for science stories.

Table 2. Perceptions of Media Coverage of Science and Technology

	N	%
Perceptions of coverage:		
S & T stories generally positive	908	45.4
S & T stories generally negative	103	5.2
Just as many positive as negative	804	40.2
Perceived amount of coverage:		
Too much coverage of S & T	48	2.4
Too little coverage of S & T	953	47.7
Coverage about right amount	895	44.8
Perceived difficulty level:		
S & T stories easy to follow	1,047	52.4
S & T stories not all that easy	471	23.5
S & T stories often difficult to follow	394	19.7

Interest in and Attentiveness to Science and Technology

In general, there appears to be considerable interest in science and technology stories, particularly those dealing with the environment, and medicine and health. Close to six in ten Canadians said they were "very interested" in these topics; well over four in ten indicated they were similarly interested in "new scientific discoveries". In contrast, under a third maintained they were "very interested" in business and a similar number expressed this high level of interest in politics.

These questions were posed very early in the survey, before respondents were asked the battery of questions specifically related to science and technology. This was done to minimize the potential impact of the survey topic on expressed levels of interest in science-related topics.

Table 3. Interest in and Informedness on Topics in the News

	Very Inter.	*Mod Inter.*	*Very Infor.*	*Mod Infor*
Agriculture, farm stories	16.6	47.3	11.6	44.8
Sports	23.9	38.6	31.9	34.9
Business, economics	30.1	51.2	21.1	52.9
New scientific discoveries	45.1	44.0	16.0	55.4
Entertainment	26.4	57.7	25.9	53.0
Space exploration	29.9	44.9	14.1	51.5
Politics	31.5	45.1	33.3	44.7
Computers, other communication technologies	23.8	49.2	14.3	46.1
New inventions, technologies	38.0	48.5	12.1	53.6
Environment	58.9	35.8	35.5	52.8
Medicine & health	59.3	35.9	29.1	55.5

While many respondents say they are very interested in various science and technology topics, fewer people feel they are very informed on these same topics. For example, twice as many say they are "very interested" in medicine and health topics as those who say they feel "very informed" on these topics. Those who consider themselves as "very informed" about "new scientific discoveries" are only a third of those who say they are "very interested" in the same.

With only minor variations, similar results were obtained from the British and American samples, with more respondents indicating greater interest in medicine and health topics and environmental stories than stories on politics or sports.

The "Science Attentives"
We created an index which consisted of scores on interest and informedness (with 3 being "very informed" or "very interested", 1 being "not interested" or "not informed") and an exposure score. The latter combined viewing of a TV science program, reading a science magazine, and reading a daily newspaper at least five days of the week as a measure of exposure. Scores on these three dimensions were added together for a composite score on "attentiveness".

Who are these "science attentives"? These individuals tend to be male, to have higher levels of education, and, not surprisingly, to have been exposed to science courses on both high school and post-secondary levels. They also tend to be older.

Activities Related to Science and Technology

The majority of Canadians reported <u>not</u> visiting any recreational or educational institution related to science and technology in the preceding year. While they reported more frequent visits to public libraries, they were less likely to have visited natural history or science and technology museums in the preceding year.

Table 4. Museum, Zoo, Library Visits

	No visit	Visited once/twice[a]
Zoo/aquarium	49.8	41.2
Art museum	65.5	25.3
Natural history museum	71.6	24.2
Science/technology museum	72.8	23.5
Public library	33.1	16.8

[a]Respondents were asked how many times they had visited these institutions in the last year. Figures in this column are only for those who indicated visiting these places one or two times. Public library figures are lower only because more respondents reported visits more frequent than once or twice in the last year.

Perhaps as a function of the differential amount of effort required for various political activities, there appears to be a greater likelihood to follow science and technology stories in the media than to join an interest group or to write one's legislator.

Table 5. Political Activities on S & T Issues

	N	%
Followed an issue regularly in media	1418	70.9
Signed a petition	1237	61.8
Joined interest group	489	24.5
Written MP or MLA	471	23.5
Written letter to the editor	234	11.7

Levels of Public Knowledge

In attempting to tap scientific literacy, a "Knowledge Quiz" was developed in the American and British studies and a majority of items was replicated in this survey. These items were designed to measure basic knowledge in a variety of areas such as biology, chemistry and geology. A couple of items were embedded in this quiz which were known to elicit very high rates of correct answers in order to make the respondent feel more comfortable with the quiz. These are items 5 and 6 in Table 6.

Table 6. Knowledge of Basic Scientific Ideas

	True	*False*	*DK*[1]
1. The centre of the earth is very hot.	84.8	4.4	10.8
2. The oxygen we breathe comes from plants.	80.4	13.9	5.8
3. Radioactive milk can be made safe by boiling it.	9.6	61.3	29.1
4. Lasers work by focusing sound waves.	25.0	38.0	37.0
5. Sunlight can cause skin cancer.	95.5	2.7	1.8
6. Hot air rises.	96.0	1.2	2.8
7. Human beings as we know them today developed from earlier groups of animals.	58.0	24.7	17.3

Table 6. Knowledge of Basic Scientific Ideas (continued)

	True	*False*	*DK*[1]
8. Air pollution can cause a greenhouse effect.	85.9	4.4	9.7
9. Electrons are smaller than atoms.	46.7	19.0	34.3
10. The earliest humans lived at the same time as dinosaurs.	33.8	45.9	20.3
11. The continents are moving slowly about on the surface of the earth.	74.9	9.8	15.4

12. Which travels faster, sound or light?
    - a. Sound travels faster..20.6
    - b. Light travels faster..73.8
    - c. Don't know/refused..5.7

13. Does the sun go around the earth or does the earth go around the sun?
    - a. Sun around earth..15.2
    - b. Earth around sun..78.4
    - c. Don't know/refused..6.4

    13b. How long does it take for the earth to go around the sun?[2]
    - a. One day..18.2
    - b. One month..3.9
    - c. One year..65.3
    - d. Don't know..12.7

[1]Don't Know

[2]This question was asked only of those respondents who answered correctly that it was the earth that revolved around the sun. The base for this question is 1,569.

Comparisons with Britain and the U.S.

There is a bright side and a gloomy side to the findings on this Knowledge Quiz. The bright side is that Canadians did not do too badly in comparison to the British and the Americans; in fact, Canadians did slightly better than the British on four items and outperformed the Americans on four as well. [These qualitative assessments were made by taking sampling error into account].

Canadians did better than Americans on the two questions on evolution ("humans...developed from earlier groups of animals" and "...humans lived at the same time as dinosaurs") and the questions on the revolution of earth around the sun. Americans were slightly ahead, however, on the question of continental drift.

More Canadian than British respondents knew that the oxygen we breath comes from plants and that electrons are smaller than atoms. Canadians also did better on the earth's revolution and its length, but worse on the evolution question.

While some comfort may be taken from the "good news" of doing slightly better than the British or Americans, on the other hand, it has been over three centuries since Copernicus and Galileo Galilei showed that the earth was not the center of the universe! Yet, under half of all Canadians still do not know that it takes the earth a year to revolve around the sun and over one in five do not know that it is the earth that goes around the sun, not the other way around.

Table 7. Canadian, British and American Comparisons on Knowledge of Basic Scientific Ideas

		(% Correct)	
	Canada	*Britain*	*U.S.*
The centre of the earth is very hot.	84.8	86.3	80.3
The oxygen we breathe comes from plants.	80.4	59.9	80.6
Radioactive milk can be made safe by boiling it.	61.3	65.1	64.1
Lasers work by focusing sound waves.	38.0	41.8	36.0
Sunlight can cause skin cancer.	95.5	93.5	96.9
Hot air rises.	96.0	96.7	97.0
Human beings as we know them today developed from earlier groups of animals.	58.0	79.0	51.7
Air pollution can cause a greenhouse effect.[1]	85.9	—	—
Electrons are smaller than atoms.	46.7	30.9	42.7

Table 7. Canadian, British and American Comparisons on Knowledge of Basic Scientific Ideas (continued)

	(% Correct)		
	Canada	*Britain*	*U.S.*
The continents are moving slowly about on the surface of the earth.[2]	74.9	71.7	80.1
The earliest humans lived at the same time as dinosaurs.	45.9	46.2	36.8
Which travels faster — light or sound? [% saying "light"]	73.8	74.7	76.1
Does earth go around sun....[3] [% saying "earth around sun"]	78.4	62.8	72.5
[% saying it takes "one year" for earth to go around sun][4]	51.2	34.1	44.9
Base: N =	2,000	2,009	2,041

[1]This question was asked only of the Canadian sample.

[2]This question was asked of the Canadian and British samples. The American question was slightly different: "The continents on which we live have been moving their location for millions of years and will continue to move in the future. Is that true or false?"

[3]Question: "Does the sun go around the earth or does the earth go around the sun?"

[4]Question: "How long does it take for the earth to go around the sun? One day, one month or one year?"

Other Scientific Concepts

A number of scientific concepts have been in the news or have become part of the parlance of an industrial society. Three of these are **"acid rain"**, **"computer software"**, and **"DNA"**.

Respondents were first asked to indicate whether they had a "clear understanding", "a general sense", or "a little or no understanding" of each of these terms. Those who said they had a clear understanding or a general sense were then asked to explain in their own words what they thought the concepts

"DNA" and "computer software" meant. On "acid rain", a structured question was provided, asking respondents to identify a cause of this problem.

Close to eight in ten respondents said they had a clear understanding or a general sense of the term "**acid rain**". Over half (55%) indicated they had some similar understanding of the term "**computer software**". Only a little over a third said they had a clear understanding or some general sense of the term "**DNA**".

Table 8. Self-reported Understanding of Some Science Concepts

	Clear Understanding	General Sense
Acid Rain	36.3	42.8
Computer Software	28.4	26.6
DNA	14.4	20.4

Those indicating they had a "clear understanding" or "a general sense" of acid rain were asked to indicate a cause of acid rain among a list provided:

Table 9. Perceived Cause(s) of Acid Rain

Aerosol sprays	36.9[a]
Coal-fired power plants	75.1[b]
Nuclear power stations	33.2
Chemical warfare byproducts	46.1
Don't know	5.0

[a]Figures do not add up to 100% as multiple answers were allowed.

[b]This figure includes those who also cited other causes. Only 37% correctly mentioned coal-fired power plants soley.

While coal-fired power plants were mentioned by the largest number, this included some respondents who also suggested other "causes" of acid rain. Eliminating the latter, we find that only 37.2 percent of all respondents were able to identify the correct answer.

"**Computer software**" was correctly described by 27 percent of all respondents while **DNA** was correctly described by only 14 percent. There were few variations in the correct responses to "computer software", with descriptions focusing on programs that enable a computer to execute tasks. A number of respondents who thought they had a clear understanding or a general sense of the term mentioned such items as the joysticks, the computer screen, computer paper, or the printer when asked about "software". Other interesting answers were elicited as well, with one suggesting it was "the stuff they make computer disks out of". Another thought "software" was "a little piece they add to give computers more power."

Among those who indicated they had a clear understanding or general sense of **DNA**, a few interviewees thought **DNA** was "something in your blood". Other responses included such descriptions as the following:

- "The study of genes"
- "It has to do with skin tissue"
- "L' energie du muscle"
- "Hormone du cerveau" [a brain hormone]

The most sophisticated correct answer was represented by the following: "[**DNA** is] deoxyribonucleic acid, a double-helix protein found in our chromosomes which provides our genetic blueprint." The more typical correct responses mentioned that it was genetic material responsible for our hereditary make-up.

There is a clear disparity between perceived knowledge and actual knowledge. Some of this may be attributable to the linguistic bias inherent in an open-ended question which favours the more articulate respondent. On the other hand, the same disparity exists for the question on **acid rain** where understanding was tested by posing a structured question and the respondent merely had to identify the correct answer from a list provided.

Health Knowledge

If there is one topic on science and technology that is most frequently covered by the mass media, it is medicine and health. A set of questions on factors contributing to heart disease was asked in the British and American surveys which was also posed to Canadian respondents.

As Table 10 shows, levels of knowledge are quite high, with almost all respondents identifying correctly that smoking, stress, lack of exercise, and too much animal fat contribute to heart disease. On the other hand, there is confusion over risk factors for other diseases, with over half mistakenly associating such things as lack of vitamins with heart disease as well.

Table 10. Knowledge of Heart Disease Factors (% Indicating Factor "Contributes")

Food with lots of additives	67.5%
Smoking	95.9
Lack of vitamins	54.6
Eating lots of animal fat	91.0
Not much exercise	95.3
Stress	96.2
Eating too little fibre	54.4
Eating too little fruit	56.8

Forty five percent of respondents correctly answered four items or fewer. Thirty seven percent answered correctly five or six items while only 18 percent got seven or eight items right.

A Composite Measure of Scientific Literacy

As discussed earlier, the concept of scientific literacy has a number of dimensions, three of which have been tapped in this study. These dimensions include the posession of basic scientific knowledge, some understanding of the relationship between science, technology and society (or "technological literacy"), and of scientific processes. Each of these dimensions and its associated measures will be discussed in turn.

An Index of Basic Knowledge

One measure of science literacy is knowledge of basic scientific ideas and concepts. An index of ten items was created which included the following:

1. The oxygen we breathe comes from plants.(T)

2. Electrons are smaller than atoms. (T)

3. The continents are moving slowly about on the surface of the earth. (T)

4. Human beings, as we know them today, developed from earlier groups of animals. (T)

5. Lasers work by focusing sound waves. (F)

6. The earliest human beings lived at the same time as the dinosaurs. (F)

7. Which travels faster? Light or sound? (Light)

8. Does the earth go around the sun or does the sun go around the earth? (Earth around sun)

9. How long does it take for the earth to go around the sun? (one year)

10. What is DNA?

Each respondent received a score of one for each correct answer, with a potential score ranging from zero to ten. The mean score on this ten-point scale was 5.5.[9]

A third of the sample scored four points or less, 47 percent scored between five to seven points while only a fifth obtained a score between eight to ten.

Group Differences
Scores on this basic knowledge index were grouped according to "low" (those getting zero to four items correct), "moderate" (those with scores from five through seven) and "high" (those with scores from eight to ten). Differences were then examined by age, gender, region, education, and exposure to high school and college science courses.

The differences among the various comparison groups were all significant. That is, knowledge of basic ideas differed significantly by region, age, gender, education, and exposure to science courses in high school or at the college level, with Western Canadians, those who were younger, had more education, had been exposed to science courses, and males more likely to score high on this index.

Table 11. Basic Knowledge, by Group Differences

	(N)	Low	Moderate	High
*Regional Differences:**				
West	(572)	23.1	48.3	28.7
Ontario	(728)	32.1	47.1	20.7
Quebec	(524)	44.5	44.7	10.9
Atlantic	(176)	38.6	47.2	14.2

[9] There were slight variations in the items used for the British and American indices as well as the ones used in this study. Only the mean for the Canadian index is being reported at this time.

Table 11. Basic Knowledge, by Group Differences (continued)

	(N)	Low	Moderate	High
*Age:**				
18-30	(677)	26.3	48.7	25.0
31-50	(839)	32.4	45.6	21.9
51+	(484)	44.8	46.1	9.1
*Gender:**				
Male	(1000)	21.7	47.3	31.0
Female	(1000)	45.0	46.3	8.7
*Education:**				
Less than High Sch.	(461)	54.0	41.0	5.0
High Sch. Grad.	(618)	36.6	50.8	12.6
Some College	(595)	24.9	50.3	24.9
Univ. degree+	(316)	12.7	40.8	46.5
Science Exposure:				
High School -*				
No science	(382)	54.7	39.8	5.5
1 or + courses	(1618)	28.3	48.5	23.2
College science -*				
No science	(1389)	39.7	46.8	13.5
Some science	(474)	12.4	45.6	42.0

*These differences were significant at $p < .05$ using the non-parametric Chi square test of significance.

Predictors of Basic Knowledge

When trying to explain a phenomenon (in this case, "basic scientific knowledge"), it is typical to ask what factors help explain (or "predict") this phenomenon. Using a procedure called multiple regression, we looked at the impact of a number of factors examined in previous studies: demographic factors such as age, gender, and education were investigated as well as two "science exposure" measures, exposure to high school science courses and exposure to college-level science. Multiple regression helps to answer the question, "how much of the variation in scientific literacy can be explained or accounted for by these factors?"

Our results show that gender, followed by education, were the most important predictors of one dimension of scientific literacy, as measured by our basic knowledge index. More importantly, all of these predictors were significantly correlated with scores on this index. The amount of variance accounted for by these variables combined was 39 percent.

It is important to keep in mind that a relationship such as gender and scientific literacy likely represents other underlying associations. For example, males might be more likely to get exposed to science courses or to be in science-related occupations. We examined the former hypothesis and found that this was, in fact, the case. Males were more likely than females to take science courses in high school and in college.

Table 12. Exposure to Science Courses, by Gender

	Males	*Females*
*High School Science:**		
None	16.3	21.9
One or Two	22.4	29.6
Three or Four	61.3	48.5
*College Science:**		
None	68.3	80.9
Few courses	18.0	13.0
Graduate level courses	4.1	1.9
Majored in science	9.6	4.2

* Differences are significant at $p < .05$

Other elements also help explain the poorer performance of women on this dimension: there were more women in the older age ranges and there were also more women in the lower education categories.

The regional differences were analyzed further by using multiple regression and controlling for such factors as age, education, gender, and exposure to science courses. Regional differences remained significant even when these factors were taken into account.

Science Literacy Index

A second level of scientific literacy was examined that included the second and third dimensions mentioned earlier: a measure of the application of science (sometimes referred to as "technological literacy"), or the relationship of science to society; and a measure of some understanding of "scientific processes". The former included the following set of items:

1. Radioactive milk can be made safe by boiling. (False)

2. Which of the following causes acid rain? (coal-fired power plants)

3. Air pollution can cause a greenhouse effect. (True)

4. What is computer software?

5. Health Knowledge Index

The health knowledge index consisted of the eight items presented in Table 10 which related to the factors contributing to heart disease. A respondent scoring 7 or 8 on this set of heart disease questions received three points; those getting 5 or 6 items right received two points while those scoring 4 or less received 1 point. One point each was provided to the first four questions for a maximum total of seven for "technological literacy".

The last dimension was investigated by asking respondents to describe what they thought a scientific study was, and to indicate the degree to which they thought astrology was "scientific." A more detailed analysis of responses to the former is on-going but for purposes of this study, we considered acceptable those responses which described the use of controlled or systematic observations, "experimentation" (although we recognize that many scientific studies do not use the experimental method), the testing of hypotheses or theories in systematic fashion, or the examination of cause-and-effect relationships. Also considered acceptable here were responses describing attitudes of open-mindedness in the process of testing ideas.

Two points were allotted to the factor for "scientific processes". These were added to the "Basic Knowledge" quiz and the measures of "technological literacy" to constitute a 19-point *Scientific Literacy Index*.

This index resulted in a mean score of 9.5 with a standard deviation of 3.3. The scores on this index were normally distributed. Seventy three percent of the respondents scored 11 points or less on this 19-point scale and only 3.3 percent scored 15 or higher.

Scores on this Index were correlated with age, gender, education, region and exposure to high school and college science courses. Younger individuals, males, those with more education, those who had been exposed to science courses, and those from the Western provinces were more likely to score high on this composite measure of Science Literacy.[10] Regression analysis showed the amount of variance explained by these variables to be 34 percent.

An inter-item reliability test was conducted among the items that constituted this Index. The reliability level was acceptable at .71, using Cronbach's alpha.

Table 13. Scientific Literacy Index, by Group Differences

	(N)	*Low*	*Moderate*	*High*
*Region:**				
West	(572)	28.5	45.5	26.0
Ontario	(728)	36.5	41.3	22.1
Quebec	(524)	55.0	34.9	10.1
Atlantic	(176)	46.0	39.2	14.8
*Age:**				
18-30	(677)	36.0	40.2	23.8
31-50	(839)	35.0	42.3	22.6
51+	(484)	53.7	38.4	7.9
*Gender:**				
Males	(1000)	28.4	42.5	29.1
Females	(1000)	51.4	38.8	9.8
*Education:**				
Less than Hi. Sch.	(461)	64.6	31.5	3.9
High School Grad.	(618)	44.7	45.3	10.0
Some College	(595)	30.8	43.7	25.5
Univ. Grad. +	(316)	11.7	38.9	49.4
Science Courses:				
High School -*				
No science	(382)	63.6	33.0	3.4
One, more courses	(1618)	34.3	42.5	23.2
College -*				
No science	(1389)	47.4	40.0	12.7
Some science	(474)	14.6	42.4	43.0

*Differences significant at $p < .05$ using Chi square.

[10] Scores of 0 to 8 were recorded "low"; 9 to 12 were "moderate" and 13 and up were labelled "high".

Perceptions of, Attitudes Toward, Science and Technology

Questions concerning respondents'positions on policy issues and their attitudes toward science and technology and their associated benefits and harms reflect perceived policy priorities of Canadians as well as their acceptance of, and comfort with, science and technology.

Policy Preferences
Perceptions of government spending on a variety of areas appear to suggest respondent preferences (in terms of areas where government is seen to be spending "too little") as well as areas of satisfaction. The reduction of pollution is a high priority area for Canadians.

Table 14. Perceptions of Government Spending

	Too Much	*About right*	*Too Little*
Health care	5.1	30.4	62.1
Reducing pollution	2.0	10.6	84.3
Education	4.2	32.8	60.4
Scientific research	10.4	33.6	45.0
Helping older people	1.9	29.4	65.7
Conservation	2.7	34.0	56.8
Helping people on low incomes	10.5	31.5	54.3
Developing weapons – national defense	56.6	23.4	14.0

While figures are available from the American and British studies for this set of questions, opinions on these topics are more likely to fluctuate with external events and the 16-month difference in the data collection periods make comparisons across these three countries unreliable.

Attitudes toward Science and Technology
A number of items tapping attitudes toward science and technology reveal that while a majority of Canadians recognize the benefits accrued from both, they also set limits on scientific activity such as the use of animals for research.

There is a general confidence in most people's ability to understand scientific information if it is explained clearly and in the citizen's ability to influence policy decisions. At the same time, there is some ambivalence about the pace of change accompanying innovations and the greater dependence on science rather than on "faith". A significant number also express some concern about the power perceived to be wielded by scientists.

A comparison with the American sample suggests slightly more polarized attitudes among Americans than Canadians. For example, slightly more Americans appear to accept the benefits of science and technology but also more agree that "we depend too much on science and not enough on faith". They are also less likely than Canadians to restrict scientists from using animals for research for the benefit of humans when the research "causes pain and injury" to these animals.

Canadians appear more likely to agree that it is not important to know about science in their daily lives. They are also slightly more likely than Americans to think astrology is "sort of scientific" and to read a horoscope more frequently.

The number of Canadians who agreed that "because of their knowledge, scientists have a power that makes them dangerous" is strikingly high, with four in ten agreeing with this statement. This group (820 respondents) was subsequently asked what kinds of powers they had in mind which made scientists "dangerous". Forty five percent mentioned powers relating to manipulation of nuclear energy. About one in five simply mentioned the element in the question, i.e., "the power of their knowledge". One in ten suggested their powers of genetic manipulation. Another five percent blamed scientists for chemical warfare while a similar number held them responsible for "environmental problems".

Table 15. Canadian and American Attitudes Toward Science and Technology

	Canada	*U.S.*
	(% Agree/Strongly Agree)	
1. Science and technology are making our lives healthier, easier, and more comfortable.	80.0	86.7

2. We depend too much on science and not enough on faith.	44.7	54.2
3. Scientists should be allowed to do research that causes pain and injury to animals like dogs and chimpanzees if it produces new information about human health problems.	43.8	55.8
4. If scientific knowledge is explained clearly, most people will be able to understand it.	83.6	72.8
5. It is not important for me to know about science in my daily life.	21.9	14.6
6. Some numbers are especially lucky for some people.	30.8	38.8
7. Science makes our way of life change too fast.	46.0	40.4
8. The interested and informed citizen can often have some influence on science policy decisions if he or she is willing to make the effort.	77.7	—
9. On balance, more jobs will be created than lost as a result of computers and factory automation.	51.9	43.8[1]
10. Because of their knowledge, scientific researchers have a power that makes them dangerous.	41.1	39.4

[1]The question asked of U.S. respondents was slightly different: "On balance, computers and factory automation will create more jobs than they will eliminate. Do you strongly agree, agree..."

With a number of measures such as the attitudinal items above, it is possible to determine whether these measures have certain dimensions in common. Using factor analysis, it is possible to reduce a larger set of measures into fewer ones which represent common or shared variation. As Table 16 shows, three factors underlie the ten attitudinal measures.

Table 16. Factors Underlying Attitudes

	Factor 1	Factor 2	Factor 3
1. Science & tech. making our lives healthier, easier, more comfortable.	-.3438*	.2018	.0290
2. We depend too much on science, not enough on faith.	.5859*	.0882	-.0162
3. Not important for me to know about science in daily life.	.4441*	.0296	.2738
4. Some numbers are lucky for some people.	.2646*	.0959	.1725
5. Science makes way of life change too fast.	.6464*	.0198	-.0139
6. Because of their knowledge, scientific researchers have power that makes them dangerous.	.5090*	.0649	-.2303
7. If scientific knowledge explained clearly, most people able to understand.	-.0621	.4426*	-.1515
8. Interested, informed citizen can have influence on science policy if willing to make effort.	-.0057	.4013*	-.0539
9. On balance, more jobs created than lost with computers, automation.	-.0888	.2480*	.1796
10. Scientists should be allowed to do research causing pain, injury to animals for new information on human health.	-.0868	.1711	.1769*

Results from factor analysis show factor one accounting for most of the variance (65.2%), with factors two and three accounting for 23.4 and 11.2 percent, respectively. The nature of the measures exhibiting a high degree of communality in factor one appears to represent a dimension we might label as "trust-distrust". The second dimension appears to represent "efficacy". The last factor is represented by a single measure and therefore must be taken on its face.

The "distrustfuls" are more likely to disagree that science and technology have made our lives healthier, easier and more comfortable and to agree that we depend too much on science, not enough on faith; that science is not important in daily life; that it makes life change too fast; that scientists wield a dangerous power because of their knowledge; and to believe in lucky numbers.

This group's profile corresponds with those who score lower on the basic knowledge quiz as well as the scientific literacy index: it tends to consist disproportionately of older individuals, women, those with less education, and those not exposed to science courses. The association between the factor this group represents and performance on the science literacy index is significant and moderately strong (Pearson's $r = 0.39$, $p < .001$).[11]

Use of, Belief in, Astrology

Table 17. Frequency of Horoscope Use and Belief in Scientific Basis of Astrology

	Canada	*U.S.*
Frequency:		
Read horoscope quite often/everyday	23.2	18.2
Read horoscope just occasionally	32.2	33.4
Almost never	18.4	12.5
Never	26.3	37.0
Perception:		
Astrology is "very scientific"	9.9	6.4
Astrology is "sort of scientific"	34.9	31.2
Astrology is "not at all scientific"	48.8	59.5

[11] Scoring on these items was along the following system: 1 = "strongly agree"; 2 = "agree"; 3 = "disagree"; and 4 = "strongly disagree." Those with lower scores were more likely to agree, for example, that "some numbers are lucky for some people" or that "we depend too much on science, not enough on faith." For consistency, reverse coding was used for the item, "Science and technology are making our lives healthier, easier, and more comfortable."

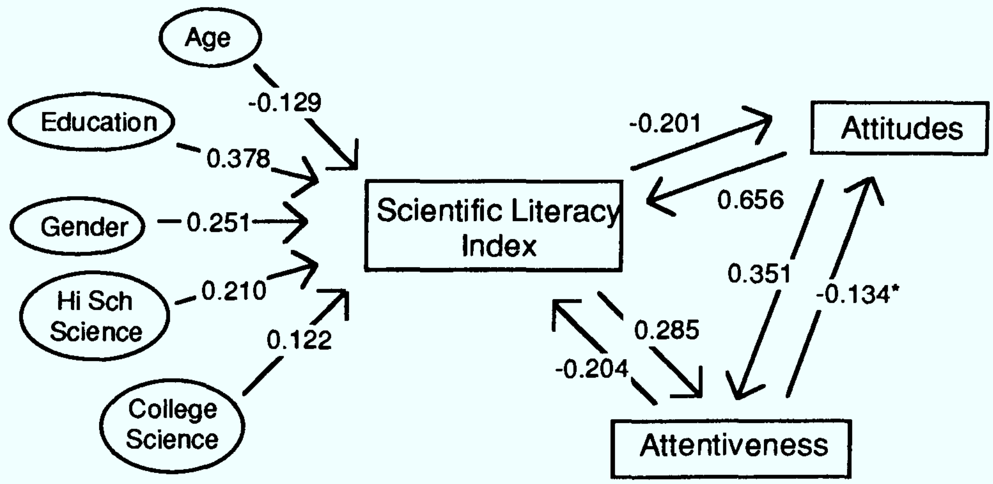
Does horoscope use and belief in the "scientific" nature of astrology correspond with how one does on the Knowledge quiz? Significant correlations were found for these relationships among the Canadian sample, with those scoring high reporting a greater likelihood of infrequent or no attention to horoscopes and labelling astrology as not scientific. These high scorers were also less likely to say that some numbers are lucky for some people.

Testing a Scientific Literacy Model

We have just presented a series of findings which so far have remained unconnected. We have described, for example, the extent of public interest in and exposure to science topics in the media; the extent of scientific literacy; public attitudes toward science and technology, and the extent to which background factors help to explain these elements. How do these elements relate to each other?

To help summarize this network of relationships, we tested a model which specified antecedents and consequents for scientific literacy. In this model, we suggested that certain background factors help to explain scientific literacy and these include education, exposure to science courses, gender and age.

Figure 1. A Scientific Literacy Model



*p >.05. These values represent standardized solutions. Their associated t-values are significant with one exception marked with asterisk.

The "consequents" of scientific literacy are more complex, involving attitudes as well as attentiveness to science information in the media. Rather than a unidirectional path (e.g., that scientific literacy leads to the acquisition of a set of attitudes or to a degree of attentiveness), we postulated that the relationships among these three elements would be reciprocal. For example, scientific literacy could lead to greater attentiveness to science-related topics but this attentiveness could also facilitate scientific literacy.

The model, presented above, was tested using a structural equation model called LISREL[12]. This approach has the advantage of allowing us to test "causal" relationships in a systemic way.

As the values in the diagram show, the model is a good predictor of the hypothesized relationships. The obtained goodness-of-fit index was .989, suggesting an excellent fit between the data and the model. The indices also reveal a fairly strong relationship between scientific literacy and the attitudinal set we labelled as the trust-distrust dimension. That is, those who scored low on the scientific literacy index tended to be more distrustful (described earlier as agreement with such statements as "scientists have a power that makes them dangerous" or "we depend too much on science, not enough on faith.").

We expected a reciprocal relationship between attentiveness and attitudes but it appears to be the case that the trust-distrust attitude set leads to greater attentiveness but not the other way around.

Perceptions and Knowledge of Canadian Science

There is a widely accepted argument that science is an international activity that often transcends national interests and boundaries. The reality, however, is that the extent and nature of scientific activity is often shaped by national priorities and various other national or cultural idiosyncracies. For example, it is no accident that Canadians have pioneered in such areas as telecommunications, transportation, or the earth sciences.

Indeed, the Science Council of Canada has maintained that science education be set in "a Canadian context":

> Science education in elementary and secondary schools should take into account the Canadian reality. Every Canadian student should know some of the history of science and technology in Canada and

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12 LISREL allows "the testing of the fit of the model to the data by comparing the observed correlations with the correlations among the variables predicted by the model." W.R. Dillon and M. Goldstein, *Multivariate analysis: methods and applications*. New York: John Wiley, 1984.

appreciate the importance of Canadian science and technology activity at local, regional and national levels.[13]

We decided to tap science awareness within a Canadian context by asking respondents whether they could name any Canadian scientist or a Canadian scientific achievement.

Awareness of Canadian Scientists and Achievements

The most striking finding from the question posed to respondents about whether they could name a Canadian scientist was that close to two thirds (63 percent) was unable to name a single one. This figure is most likely an underestimate since many of those who gave a scientist's name provided names of non-Canadian scientists. For example, among those mentioned were Thomas Edison, Jonas Salk, or Madame Currie.

Sixteen percent mentioned Frederick Banting while his insulin co-discoverer, Charles Best, elicited the highest number of second mentions at eight percent. Former scientist and broadcaster, David Suzuki was mentioned first by nine percent, and received second and third mentions by three percent each time. Canada's most recent Nobel winner, John Polanyi, was cited by fewer than one percent of respondents.

Table 18. Most Frequently Mentioned Canadian Scientists

	1st Mention	*2nd Mention*	*3rd Mention*
None	63.6	—	—
Frederick Banting	16.2	—	—
Charles Best	1.8	8.2	—
Alexander Graham Bell	5.3	1.8	1.3
John Polanyi	0.4	0.4	0.5
David Suzuki	8.7	3.3	3.1

Base in all cases is 2000.

Asked about Canadian achievements in science, over half (54%) could not mention a single achievement. Over a quarter mentioned the space arm while a

[13] Science Council of Canada, *Science for Every Student: Educating Canadians for Tomorrow's World*. Report 36. Ottawa: Supply and Services, 1984.

fifth (20%) cited the discovery of insulin. Other than the telephone, which elicited mention from 6 percent of the respondents, other "achievements" mentioned by those who were able to name something were cited by fewer than two percent.

Perception of Most Important Problem Facing Canadian Science and Technology
The environment was far and away the most important problem facing the country in the area of science and technology. About three in ten respondents cited the environment while an additional ten percent mentioned a specific environmental problem such as acid rain, the greenhouse effect or the ozone problem. A total of four in ten Canadians thus consider environmental problems to be the most critical.

The perceived importance of this problem is more remarkable when we consider that many polls have shown Canadians to come up with the same answer when asked the more general question, "What is the most important problem facing Canada today?"

The second most frequently mentioned problem was the underfunding of research (11 percent).

The third most frequently mentioned problem related to medicine and health, with a number of respondents mentioning cancer and AIDS research specifically. However, medical/health issues were mentioned by only nine percent, compared to the forty percent suggesting the environment.

Three in ten respondents could not come up with a problem.

Discussion of Findings

There is reason to lament the results of low levels of science literacy among adult Canadians, though the findings also suggest significant opportunities for addressing the problem. For those interested in such an effort, there already exists the advantage of a reservoir of public interest in science and technology topics.

Some areas require more careful consideration, if not concerted action. The dismal results with regard to gender justify greater efforts to target women to develop and nurture their interest in science early on. The regional differences also warrant more careful examination, although it is important to remember that these differences are less significant than the fact that science literacy levels in general are low.

Finally, there is an argument to be made for learning about science and technology in the context of one's own physical and cultural environment. The vast expanse of this country, its natural resource wealth, its cold climate and northern latitude have provided a uniqueness that has shaped its research efforts, technological innovations and economic opportunities. It may not be so surprising that adult Canadians know little about Canadian science and perhaps the question that ought to be asked now is whether young Canadians are in fact learning about science in a Canadian context.

In examining the findings from this study, it is critical to keep certain caveats in mind. The most important is that this study was conducted by telephone and is therefore circumscribed by the limitations of this method on the interviewing process. The questions by necessity could not be more complex, nor could we more fully explore the various dimensions of scientific literacy. In contrast, the British study was an in-person survey lasting about an hour and the researchers used this advantage to develop a wider range of measures to tap public understanding of "scientific processes".

The reader should also keep in mind that this was a survey of *adult* Canadians. The educational systems and curricula which this sample (particularly the older respondents) experienced may be different from those currently in place and the same study, conducted on pre-adults, could yield quite different results.

Appendix: Survey Instrument

Questionnaire for Canadian Science Literacy Survey
(Telephone Survey)

Hello, my name is __________ of ______ Research Centre, a national opinion research firm. We're talking with people in your area today about current issues. (DO NOT PAUSE)

A. Are you 18 years of age or older?

YES (CONTINUE) .... A
NO (ASK TO SPEAK TO ELIGIBLE RESPONDENT, IF STILL "NO," THANK AND TERMINATE) .... B

B. Have I reached you at your home telephone number?

Which is (   )________.

YES (CONTINUE) .... A
NO (ASK TO SPEAK TO ELIGIBLE RESPONDENT, IF STILL "NO," THANK AND TERMINATE) .... B

1. First, let me ask you how interested you are in current news events. Would you say that you are very interested, moderately interested, or not at all interested in current news events?

Very interested	(1)
Moderately interested	(2)
Not at all interested	(3)
Don't know/Ref.	(9)

There are a lot of stories in the news and it is hard to keep up with every area. I am going to read you a short list of topics and for each one - as I read it - I would like you to tell me if you are very interested, moderately interested, or not at all interested.

	Very Interes.	Moderately Interes.	Not at all Interes.	Don't Know
2. Agriculture and Farm stories	(1)	(2)	(3)	(9)
3. Sports	(1)	(2)	(3)	(9)
4. Business and economics	(1)	(2)	(3)	(9)

	Very Interes.	Moderately Interes.	Not at all Interes.	Don't Know
5. Stories about new scientific discoveries	(1)	(2)	(3)	(9)
6. Entertainment	(1)	(2)	(3)	(9)
7. Stories about space exploration	(1)	(2)	(3)	(9)
8. Politics	(1)	(2)	(3)	(9)
9. Computers and other communications technology	(1)	(2)	(3)	(9)
10. New inventions and technologies	(1)	(2)	(3)	(9)
11. Stories on the environment	(1)	(2)	(3)	(9)
12. Stories about medicine and health	(1)	(2)	(3)	(9)

Now I'd like to go through this list again and for each issue, I'd like you to tell me if you are very well informed about that issue, moderately well informed, or poorly informed.

	Very Inform.	Moderately Inform.	Not at all Inform.	Don't Know
13. Agriculture and farm stories	(1)	(2)	(3)	(9)
14. Sports	(1)	(2)	(3)	(9)
15. Business and economics	(1)	(2)	(3)	(9)
16. Stories about new scientific discoveries	(1)	(2)	(3)	(9)
17. Entertainment	(1)	(2)	(3)	(9)
18. Stories about space exploration	(1)	(2)	(3)	(9)
19. Politics	(1)	(2)	(3)	(9)

	Very Inform.	Moderately Inform.	Not at all Inform.	Don't Know
20. Computers, other communications technology	(1)	(2)	(3)	(9)
21. New inventions and technologies	(1)	(2)	(3)	(9)
22. Stories about the environment	(1)	(2)	(3)	(9)
23. Stories about medicine and health	(1)	(2)	(3)	(9)

24. Thinking about the kinds of topics we have been talking about, would you say you get *most* of your information about current news events from radio, television, newspapers, news magazines, books, or from talking to other people? (ACCEPT ONLY ONE RESPONSE)

Radio	(1)	
Television	(2)	
Newspapers	(3)	
News magazines	(4)	
Books	(5)	
Talking to others	(6)	
Other(specify)	(7)	______________________
Don't know	(99)	

25. Thinking about daily newspapers in particular, how many days in the last week did you happen to read a daily newspaper? (CIRCLE)

0 1 2 3 4 5 6 7 days (9) Don't know

26. What about television news? How many days in the last week did you watch the news on television?

0 1 2 3 4 5 6 7 days (9) Don't know

27. About how many times <u>yesterday</u> did you happen to listen to news on radio?

0 1 2 3 4 or more times (9) Don't know

28. How about magazines? Do you read any magazines regularly, that is, 3 out of every 4 issues available, from time to time, or not at all?

Regularly	(1)
From time to time	(2)
Not at all	(3)
Don't know/Ref.	(9)

29. Do you ever read any <u>science</u> magazines?

Yes	(1)	(GO TO Q 30)
No	(2)	(SKIP TO Q 32)
Don't know/Not sure	(9)	

30. Which science magazine do you read most often? (DO NOT READ... ACCEPT ONE RESPONSE)

Byte	— (1)
Canadian Geographic	— (2)
Discover	— (3)
Equinox	— (4)
National Geographic	— (5)
Psychology Today	— (6)
Science Dimension	— (7)
Other: _______________	(8)

32. What about science programs on television? Are there any science programs on television that you watch regularly or occasionally?

Yes	(1)	(GO TO PREAMBLE BEFORE Q 33)
No	(2)	(SKIP TO Q 39)
Don't know/not sure	(9)	(SKIP TO Q 39)

IF "YES" TO Q 32

I'm going to read you a list of programs. Could you tell me if you watch them regularly, occasionally or not at all? (READ AND ROTATE Q 33 - 37)?

	Regularly	Occasionally	Not at all
33. Nature of Things with David Suzuki	(1)	(2)	(3)
34. National Geographic	(1)	(2)	(3)
35. Nature	(1)	(2)	(3)
36. Nova	(1)	(2)	(3)
37. Other:________________	(1)	(2)	(3)

38. And what about radio? Which science programs on radio do you regularly listen to?

None	(1)
Quirks and Quarks	(2)
Other: (specify)____________	(3)

39. Thinking now about stories in the news, would you say that most of the stories you read or listen to about politics and government are generally positive, generally negative, or would you say there are just as many positive as negative stories?

Positive	(1)
Negative	(2)
About the same	(3)

40. What about stories on science and technology? Would you say most of these stories are generally positive, generally negative, or would you say there are just as many positive as negative stories?

Positive	(1)
Negative	(2)
About the same	(3)
Don't know/no response	(9)

41. In general, would you say there is too much coverage of science and technology in the media, not enough, or would you say the coverage is about the right amount?

Too much	(1)
About right	(2)
Not enough	(3)
Don't know/no response	(9)

42. Do you think that stories about science and technology in the news media are generally

Easy to follow	(1)
Not all that easy to follow	(2)
Often difficult to follow	(3)
Don't know/no response	(9)

Now, let me ask you about your use of museums, zoos, and similar places. I'm going to read you a short list of places and ask you to tell me how many times you visited each type of place during the last year, or the last 12 months. If you haven't been to a given place in the last year, just say none.

43. A science or technology museum	________
44. A zoo or aquarium	________
45. An art museum	________
46 A natural history museum	________
47. A public library	________

48. What do you think is the most important problem in science and technology facing Canada today? (ACCEPT ONE RESPONSE ONLY)

____

Now I'd like to read you some statements some people have made about science and technology. For each statement, please tell me if you generally agree or disagree, and if you feel especially strongly about a statement, tell me if you strongly agree or strongly disagree. First,

	Strongly Agree	Agree	Disagree	Strongly Disagree	DK/NR
49. Science and technology are making our lives healthier, easier, and more comfortable. Do you	(1)	(2)	(3)	(4)	(9)
50. We depend too much on science and not enough on faith.	(1)	(2)	(3)	(4)	(9)

	Strongly Agree	Agree	Disagree	Strongly Disagree	DK/NR
51. Scientists should be allowed to do research that causes pain and injury to animals like dogs and chimpanzees if it produces new information about human health problems.	(1)	(2)	(3)	(4)	(9)
52. If scientific knowledge is explained clearly, most people will be able to understand it.	(1)	(2)	(3)	(4)	(9)
53. It is not important for me to know about science in my daily life.	(1)	(2)	(3)	(4)	(9)
54. Some numbers are especially lucky for some people.	(1)	(2)	(3)	(4)	(9)
55. Science makes our way of life change too fast.	(1)	(2)	(3)	(4)	(9)
56. The interested and informed citizen can often have some influence on science policy decisions if he or she is willing to make the effort.	(1)	(2)	(3)	(4)	(9)
57. On balance, more jobs will be created than lost as a result of computers and factory automation.	(1)	(2)	(3)	(4)	(9)
58. Because of their knowledge, scientific researchers have a power that makes them dangerous.	(1) (Go to Q 59)	(2) (Go to Q 59)	(3) (Skip to Q 59)	(4) (Skip to Q 60)	(9) (Skip to Q 60)

IF AGREE OR STRONGLY AGREE TO Q 58 ASK

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59. When you think about these powers that make scientific researchers dangerous, what kinds of powers do you have in in mind? Any others?)

We are faced with many problems in this country. I'm going to name some of these problems and for each one, I'd like you to tell me if you think the government is spending too much money on it, too little money on it, or about the right amount.

	Too Much	About the Right Amt.	Too Little	Dk/NR
60. Health care	(1)	(2)	(3)	(9)
61. Reducing pollution	(1)	(2)	(3)	(9)
62. Education	(1)	(2)	(3)	(9)
63. Scientific research	(1)	(2)	(3)	(9)
64. Helping older people	(1)	(2)	(3)	(9)
65. Conservation	(1)	(2)	(3)	(9)
66. Helping people on low incomes	(1)	(2)	(3)	(9)
67. Developing weapons for national defense	(1)	(2)	(3)	(9)

68. Now for a different type of question. People have frequently noted that scientific research has produced both beneficial and harmful consequences. Would you say that on balance, the benefits of scientific research have outweighed the harmful results, or have the harmful results of scientific research been greater than its benefits?

Benefits outweigh harms	(1)
About equal (Volunteered)	(2)
Harms outweigh benefits	(3)
Uncertain/don't know/no response	(9)

Some people express their opinions or get involved in various ways on public issues. Others prefer to be less involved. Thinking about science and technology issues in particular, have you ever done any of the following?

	Yes	No	Don't know
69. Written a letter to the editor	(1)	(2)	(9)
70. Signed a petition	(1)	(2)	(9)
71. Written your MP or MLA	(1)	(2)	(9)

	Yes	No	Don't know
72. Joined an interest group	(1)	(2)	(9)
73. Followed the issue regularly in the media	(1)	(2)	(9)
74. Donated money for a cause involving some science issue	(1)	(2)	(9)

75. Do you happen to know of any CANADIAN achievements in science? (ACCEPT UP TO THREE RESPONSES...DO NOT READ LIST)

	Mentioned
Cystic fibrosis gene	(1)
Insulin discovery	(2)
Space arm	(3)
Telephone	(4)
Other:_______________________________	(5)

76. Can you tell me the names of any prominent CANADIAN scientist, either living or dead, you happen to remember? (ACCEPT UP TO THREE RESPONSES. DO NOT READ LIST)

No	01
Frederick Banting	02
Charles Best	03
Alexander Graham Bell	04
John Polanyi	05
David Suzuki	06
Other: (specify)_________________________	xx
Other: (specify)_________________________	xx
Other: (specify)_________________________	xx

Now let me change the subject somewhat and ask you a few questions about health. We hear a lot about the problem of heart disease and how we can avoid it. Let me read you a short list of items and I'd like you to tell me whether each item contributes to heart disease or not. First,

	True	False	Don't know /NR
77. Eating food with lots of additives	(1)	(2)	(9)
78. Smoking	(1)	(2)	(9)
79. Lack of vitamins	(1)	(2)	(9)
80. Eating a lot of animal fat	(1)	(2)	(9)
81. Not doing much exercise	(1)	(2)	(9)
82. Stress	(1)	(2)	(9)
83. Eating very little fibre	(1)	(2)	(9)
84. Eating very little fresh fruit	(1)	(2)	(9)

Here are a few short quiz-type questions. For each thing I mention, tell me if it's true or false. If you don't know or are not sure about a statement, say so and we'll skip to the next one.

	True	False	Don't know /NR
85. The centre of the earth is very hot.	(1)	(2)	(9)
86. The oxygen we breathe comes from plants.	(1)	(2)	(9)
87. Radioactive milk can be made safe by boiling it.	(1)	(2)	(9)
88. Lasers work by focusing sound waves.	(1)	(2)	(9)
89. Sunlight can cause skin cancer.	(1)	(2)	(9)
90. Hot air rises.	(1)	(2)	(9)
91. Human beings as we know them today developed from earlier groups of animals.	(1)	(2)	(9)
92. Air pollution can cause a greenhouse effect.	(1)	(2)	(9)

	True	False	Don't know /NR
93. Electrons are smaller than atoms.	(1)	(2)	(9)
94. The earliest humans lived at the same time as dinosaurs.	(1)	(2)	(9)
95. The continents are moving slowly about on the surface of the earth.	(1)	(2)	(9)

96. Which travels faster, sound or light?

light travels faster	(1)
sound travels faster	(2)
Don't know	(9)

97. Does the earth go around the sun, or does the sun go around the earth?

sun around earth	(1)	(SKIP TO Q 99)
earth around sun	(2)	(GO TO Q 98)
Don't know	(9)	(SKIP TO Q 99)

IF "EARTH AROUND SUN" TO Q 97, ASK:

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98. How long does it take for the earth to go around the sun? (READ)

one day	(1)
one month, or	(2)
one year?	(3)

99. How often do you read a horoscope or your personal astrology report? Do you read one...

Every day	(1)
Quite often	(2)
Just occasionally, or	(3)
Almost never?	(4)

100. Would you say that astrology is...

Very scientific	(1)
Sort of scientific, or	(2)
Not at all scientific	(3)

101. Now let me ask you about some topics or ideas that have sometimes been in the news. When you read or hear the term ACID RAIN, do you have a clear understanding of what it means, a general sense of what it means, or a little understanding of what it means?

Clear understanding	(1)	(GO TO 102)
General sense	(2)	(GO TO 102)
Little or no understanding	(3)	(SKIP TO 103)

IF "CLEAR UNDERSTANDING" OR "GENERAL SENSE" TO Q 101, ASK:

---

102. Which of the following causes acid rain?

Aerosol sprays	(1)
Coal-fired power plants	(2)
Nuclear power stations	(3)
Chemical warfare byproducts	(4)
Don't know/Refused	(9)

103. When you read or hear the term COMPUTER SOFTWARE, do you have a clear understanding of what it means, a general sense of what it means, or only a little understanding of what it means?

Clear understanding	(1)	(GO TO 104)
General sense	(2)	(GO TO 104)
A little/no understanding	(3)	(SKIP TO 105)

IF "CLEAR UNDERSTANDING" OR "GENERAL SENSE" TO Q 103, ASK:

---

104. Can you tell me in your own words what "computer software" is?

____

____

105. What about the term DNA? When you hear this term, do you have a clear understanding of what this means, a general sense, or a little understanding of what it means?

Clear understanding	(1)	(GO TO 106)
General sense	(2)	(GO TO 106)
A little/no understanding	(3)	(SKIP TO 107)

IF "CLEAR UNDERSTANDING" OR GENERAL SENSE" TO Q 105, ASK:

---

106. Can you tell me in your own words what "DNA" is?

____

____

107. Certain sets of words or terms sometimes appear in some articles. When you read or hear the term "SCIENTIFIC STUDY", do you have a clear understanding of what it means, a general sense of what it means, or a little understanding of what it means?

Clear understanding	(1)	(GO TO 108)
General sense	(2)	(GO TO 108)
A little/no understanding	(3)	(SKIP TO 109)

IF "CLEAR UNDERSTANDING" OR "GENERAL SENSE" TO Q 107, ASK:

---

108. Can you tell me in your own words what a "scientific study" is?

____

____

Now let me ask you about the long-term future. I am going to read you a list of possible results and ask you how likely you think it is that each of these results will be achieved in the next 25 years or so. Do you think that it is very likely, possible but not too likely, or not at all likely that this result will occur in the next 25 years?

	Very Likely	Possible But not Likely	Not Likely	No Response
109. The accidental release of a dangerous man-made organism into the environment	(1)	(2)	(3)	(9)
110. Another nuclear power plant accident like Chernobyl	(1)	(2)	(3)	(9)
111. A cure for the common forms of cancer	(1)	(2)	(3)	(9)
112. The landing of a human being on Mars	(1)	(2)	(3)	(9)
113. A cure for the disease AIDS	(1)	(2)	(3)	(9)
114. A significant reduction in acid rain levels	(1)	(2)	(3)	(9)

Now for a few final questions about yourself. These are only to allow us to compare groups of people and not individuals.

115. In what year were you born? 19___?

116. What level of education have you completed? (READ LIST – ACCEPT ONLY ONE RESPONSE)

Less than high school	(1)
High school degree	(2)
Some college/technical courses	(3)
College/technical degree	(4)
Some university	(5)
University degree	(6)
Post-graduate	(7)
Refused	(9)

Did you take any science courses in high school such as (READ LIST)

	Yes	No	Don't Recall/NR/NA
117. Algebra	(1)	(2)	(9)
118. Chemistry	(1)	(2)	(9)
119. Physics	(1)	(2)	(9)
120. Biology	(1)	(2)	(9)

121. How about science courses in college or university? Did you take a few courses in science, any graduate science courses, or did you have a science major?

Took none	(1)
Took a few courses	(2)
Majored in science	(3)
Graduate science courses	(4)
Don't recall/no response	(9)

122. What was the language you first spoke in childhood and still understand?

English	(1)
French	(2)
Other:____________	(3)

123. Do you have any children under 18 years old who live at home?

Yes	(1)
No	(2)
No response	(3)

124. In which income range does your annual total household income fall?

Under $15,000	(1)
$15 - $30,000	(2)
$30 - $45,000	(3)
$45 - $60,000	(4)
$60 - $75,000	(5)
$75,000 +	(6)
Refused	(9)

125. Do you currently work full-time, part-time or are you currently not working?

Not working	(1)
Part-time	(2)
Full-time	(3)

126. What is your occupation?____________________________

127. Respondent's gender:

Male	(1)
Female	(2)

THANK YOU FOR TAKING THE TIME TO COMPLETE THIS QUESTIONNAIRE.