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PRESERVICE SCIENCE TEACHERS BELIEFS ABOUT SCIENCE -TECHNOLOGY AND THEIR IMPLICATION IN SOCIETY

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ABSTRACT. The purpose of the study was to discern the beliefs of pre-service science teachers (PST) concerning science technology and their implications in society. A quasi-experimental design was used. The results indicate that students who experienced Science Technology and Society (STS) approach perform better than students enrolled in section where traditional approaches in terms of student understanding of scientific process, student ability to apply scientific concepts related to science and technology, more positive student attitudes, and demonstration of more and better creativity skills. The STS approach was found to have an impact on the beliefs of PST in science education.

KEYWORDS. Science Technology & Society (Sts), Preservice Science Teacher, Teacher Preparation, Real-World Context.

INTRODUCTION

As we move into the 21st century, science and technology will play an increasingly important role in all aspects of our society. It is imperative, therefore, that our future decision-makers develop positive attitudes about and confidence in their ability to solve problems using scientific concepts and principles. These attitudes foster curiosity to understand and appreciate the natural world as well as to comprehend the impact of science and technology on the individual, culture, and society. The quality of life in the future will rest on the contributions of the students in schools now.

Everyday development of science and technology change the society both negatively and positively. This rapid changing society should be evaluated by educators and social scientists. In the future, it is hard to guess how scientific and technological developments will affect human life.

The main purpose of science education should describe the role of science and technology as a way of solving current problems in light of the advantages and disadvantages of science and technology (Solbes & Vilches, 1997)

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To promote students' meaningful learning that occurs when new experiences are related to what students already know, science educators should encourage student discussion, argumentation, social negotiation and cooperative learning (Tsai, 2001). Science education should also help students develop their problem solving skills and apply scientific knowledge to solving everyday problems.

Making responsible decisions for resolving problems related to science and technology address one of the most important goals for future citizens and leaders. Science educators should consider this goal. The STS approach serves an excellent way to achieve this aim.

Science-Technology-Society has been recognized as a major reform in science education (NSTA, 1990). The major goal for STS efforts is the production of scientifically and technologically literate persons who can evaluate the quality of scientific information on the basis of its source and the methods used to generate it (NRC, 1996) Seventeen features are identified by NSTA to describe a scientifically and technologically literate person. These features include:

- Uses concepts of science and of technology as well as an informed reflection of ethical values in solving everyday problems and making responsible decisions in everyday life, including work and leisure
- Engages in responsible personal and civic actions after weighing the possible consequences of alternative options
- Defends decisions and actions using rational arguments based on evidence
- Engages in science and technology for the excitement and the explanations they provide
- Displays curiosity about and appreciation of the natural and human-made world
- Applies skepticism, careful methods, logical reasoning, and creativity in investigating the observable universe
- Values scientific research and technological problem solving
- Locates, collects, analyzes, and evaluates sources of scientific and technological information and uses these sources in solving problems, making decisions, and taking actions
- Distinguishes between scientific and technological evidence and personal opinion and between reliable and unreliable information
- Remains open to new evidence and the tentativeness of scientific/technological knowledge
- Recognizes that science and technology are human endeavors
- Weighs the benefits and burdens of scientific and technological development
- Recognizes the strengths and limitations of science and technology for advancing human welfare
- Analyzes interactions among science, technology, and society

• Connects science and technology to other human endeavors, e.g., history, mathematics, the arts, and the humanities

• Considers the political, economic, moral, and ethical aspects of science and technology as they relate to personal and global issues

• Offers explanations of natural phenomena which may be tested for their validity (NSTA, 1990)

The purpose of the STS approach is to engage students in problem solving activities that they have identified. STS programs begin with real world issues and concerns. Students focus on problems and questions that related to their personal life.

Teacher education programs should provide a learning environment for prospective teachers to improve their understanding of the interaction among science, technology and society (Yager, Tamir and Kellerman, 1994)

METHOD

The study involved sixty-six pre-service science teachers in science education at Gazi University. It was completed during the spring semester (14 weeks period). Control and experimental group were used. Each group has thirty-three pre-service science teachers. Traditional instructional methods were used in control group. The STS teaching and learning methods were used in the experimental class. Students in STS class have been involved with following learning experience; role-playing; debates; library searches; brainstorming; problem-solving; class discussion and presentations; and decision making. A quasi-experimental design was the research design for this study. Several units form environmental and genetics issues were selected as the major topics for the experimental and control groups. These included such general topics as; nucleic acids, structure of DNA and RNA, gene therapy, chromosome, genetic code, genetic problems and disorders, genetic engineering and its implications to society, environmental pollutions and source of these pollutions such as radioactive, water, soil and air pollutions. The Views on Science Technology and Society (VOSTS) questionnaire was used to collect data. This questionnaire (VOSTS) was developed by Aikenhead, Fleming and Ryan in 1987. It is an inventory of student viewpoints about science, and how science is related to technology and society. The VOSTS consists of 114 multiple choice items that address a broad range of STS topics; however, this study consisted of six questions (Appendix 1) which were selected from the VOSTS to determine students' beliefs about science and technology and their implications on society. These six items were related to the environmental and genetics contents that thought during the spring semester. The same instruments were used for pre and post tests. The pre-tests were given at the beginning of spring semester. The teachers then thought the issues for using STS approaches or non-STS approaches. The post-tests were given at the end of spring semester.

RESULTS

Table 1 and Figures 1 through 6 indicate the data collected from the records for each of the six items.

First item provides information corcerning preservice science teachers beliefs about how science and technology can help people make some moral and ethic decisions. In the control group, students believed that technology and science cannot help people when they make moral and ethical decisions. Because moral and ethical decisions are made solely on the basis of an individual's values and beliefs for both pre and post-test (See Figure 1.a). In treatment group, at the beginning of the semester students believed similar to control group but at the end of the semester the post-test indicated that students beliefs have changed, most of them thought science and technology can help students make some moral decisions by providing background information and making them more informed about people and the world around them. This background information can help them cope with the moral aspects of life (See Figure 1.b).

The second item is related to ideas about how science and technology offer a great deal of help in resolving social problems such as poverty, crime, and unemployment. In control groups, both pre and post test indicate that most of the pre-service science teachers believe science and technology solve many social problems; however, it is noted that they also cause many of these problems. People should use science and technology wisely to solve social problems. They did not change their ideas during the semester (See Figure 2.a). For treatment groups, the pre-tests showed that students generally focus on the role of the people who are responsible for using science and technology rather than the importance and the role of science and technology for solving social problems. In post test, students not only mention about the importance and role of people but also mention that science and technology can solve the problems (See Figure 2.b).

The third item used to get information about how knowledge of science and technology helps students to solve student problems in daily life. Students in control groups think that science and technology provide knowledge to understand everyday problems but most of them mention that the concepts and the problem solving techniques they learn from science classes are not directly useful in their everyday lives on both the pre-tests and post-tests (See Figure 3.a). At the beginning of the semester students in the experimental groups thought similarly to what was found with the control groups. But in this case the post-tests showed that they changed their ideas. Most of them indicated that everyday problems are more easily and logically solved if treated like "science" problems. Moreover, ideas and facts that they learn from science classes help them to solve problems or make decisions about their problems in their daily lives (See Figure 3. b).

The fourth item is concerned with environmental issues that are unsolvable today such as pollution problems. The pre-tests show that student beliefs are similar in both control groups and experiment groups. Students in both think that science and technology cannot fix the environmental problems because they are the reason that we have the problems. They believed that more science and technology will bring more pollution problems (See Figure 4.a and 4.b). In the pos- tests, the control groups did not change their beliefs. Students still thought that science and technology do not solve the problems. However, in the experimental group, most of the PSTs mentioned that science and technology are not able to resolve pollution problems. Instant they are everyone's responsibility. The public must insist that fixing these problems is a top priority. In this item, the results indicate that the PST in experimental groups develop more positive attitudes about science and technology than did others.

The fifth item was designed to probe the idea that high-technology industries will provide most of the new jobs in the next twenty years. PSTs in the control group responded that science and technology will provide many opportunities for people especially trained people who will be needed to operate and repair the new technology and to develop new kinds of hi-technology industries in both pre-tests and post-tests(See Figure 5.a). The PSTs in the experiment groups responded both positively and negatively in the pre-tests. In the post-tests, although some of the students responded similarly to those in the control groups, most of the students responded that only a few new jobs will be created. More jobs will be probably lost because of mechanical or computerized hitechnology (See Figure 5.b). This shows that when PSTs have more information about science and technology, they feel uncomfortable concerning their future.

The last item consists of the ideas about how technology will improve the standard of living. Both pre and post test showed that PSTs in the control groups responded that technology would make life easier, healthier, and more efficient. However, technology would also cause more pollution, unemployment, as well as other problems. They belived that people will be irresponsible with the technology. The standard of living may improve, but the quality of life may not (See Figure 6.a). Additionally, this result indicates that pre-service science teachers have a conflict regarding their beliefs about using examples including technology in daily life, rapid development of technology. This is because they do not feel comfortable in discussing negative effects of these aspects of technology in the classroom.

These results show the STS approach increases pre-service science teachers' beliefs about effectiveness of science and technology on society. Since pre-service teachers understand and visualize the interactions among science, technology and society as well as their effects on daily lives, they become more confident about the STS approach because they understand the importance of science and technology for the future of the society.

DISCUSSION AND CONCLUSION

The purpose of this study was find out how the impact of the Science-Technology-Society (STS) approach had on the beliefs of pre-service science teachers. The results indicate that the PSTs in experimental groups changed their ideas about scientific, technological, and social issues during the study. Even though the control group responded similarly, the experimental group responded differently for the pre-tests and post-tests. As a result of the study, pre-service science teachers beliefs about the importance of science and technology; being more responsible about solving problems and being aware of effectiveness of science and technology on our daily life have all been increased. In addition, pre-service teachers started to use more collaborative efforts with their colleagues instead of working alone on problems.

The effectiveness of STS instruction has been studied by many researchers. For example, Winter and Volk's (1994) study showed that STS instruction increased student achievement in chemistry. Another study conducted from Bradford, Rubba and Harkness (1995) showed that the views of college students concerning STS interactions increased after they were taught by the STS approach.

Science educator should focus on authentic instruction that give students opportunities to use their knowledge in real life situations instead of just "giving" them content knowledge in traditional classroom setting. This would increase students' positive attitudes toward science classes.

Using present information in the science classrooms increases students' positive attitudes toward science as well as their creativity (Yager, 1990). The STS approach encourages and enhances scientifically literate individuals. This is a major aspect of preparing for life in a democratic society (Wrage and Hlebowitsh, 1991)

Increasing pre-service science teachers' understanding of the theoretical and applications control to the STS approach will lead students to use more typical information from the science, technology, and society in context that students experience daily. This quality of program for preparing pre-service teachers will improve our society by preparing more scientifically literate citizens. It will succeed for making instruction more relevant and meaningful while modeling the nature of science and its importance in preparing students in future citizens.

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Comparisons between the Traditional (Control group) and the STS Students (Eperiment group) on each selected items

1.Item:

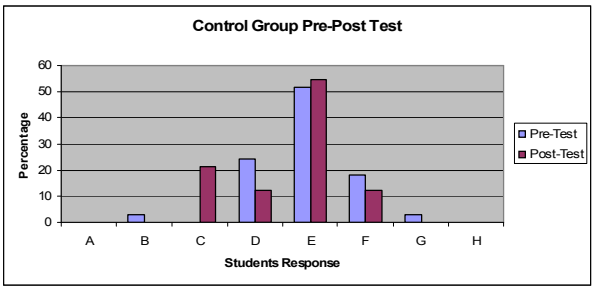

Figure 1.a Control Group (Traditional Approach)

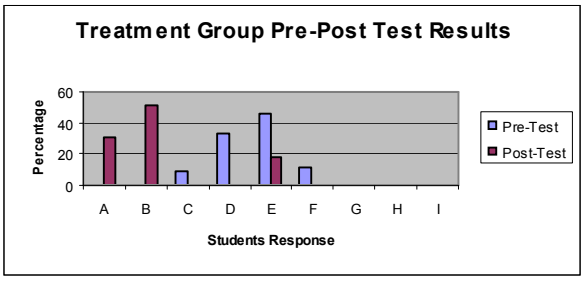

Figure 1.b. Treatment Group (STS Approach)

2.Item:

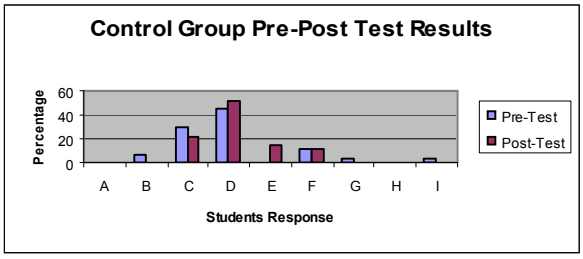

Figure 2.a. Control Group (Traditional Approach)

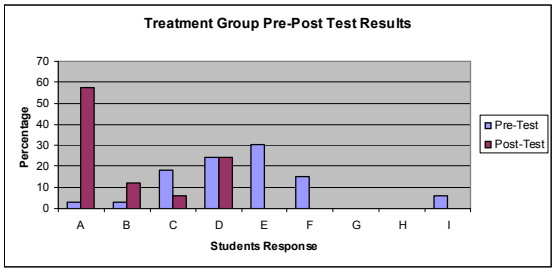

Figure 2.b. Treatment Group (STS Approach)

3. Item:

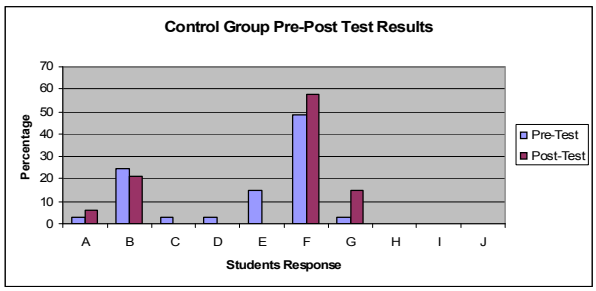

Figure 3.a. Control Group (Traditional Approach)

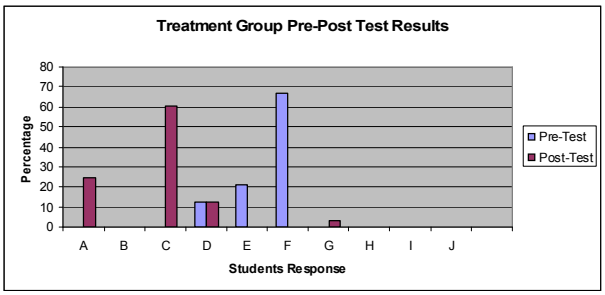

Figure 3.b. Treatment Group (STS Approach)

4.Item:

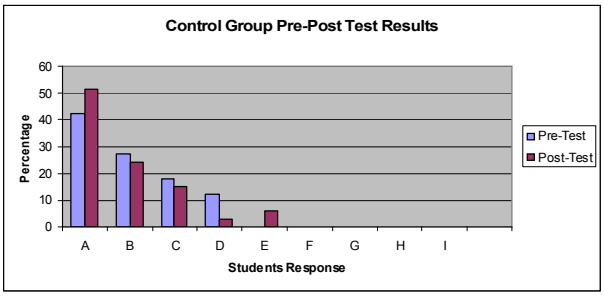

Figure 4.a. Control Group (Traditional Approach)

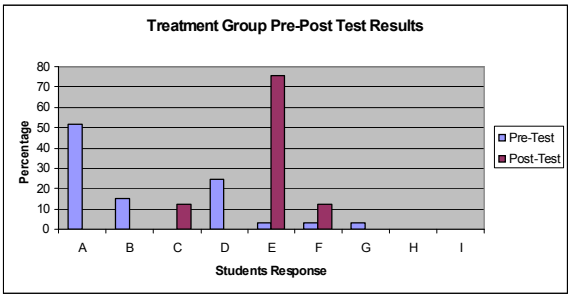

Figure 4.b. Treatment Group (STS Approach)

5. Item:

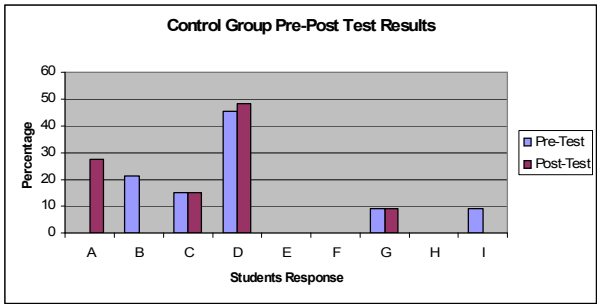

Figure 5.a. Control Group (Traditional Group)

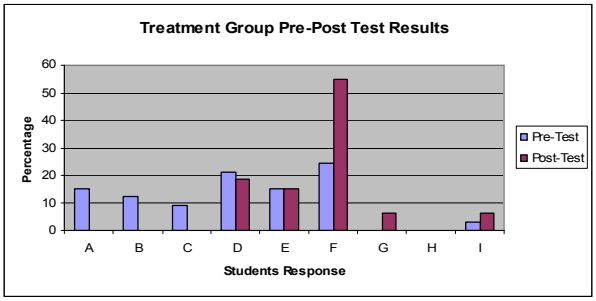

Figure 5.b. Treatment Group (STS Approach)

6. Item:

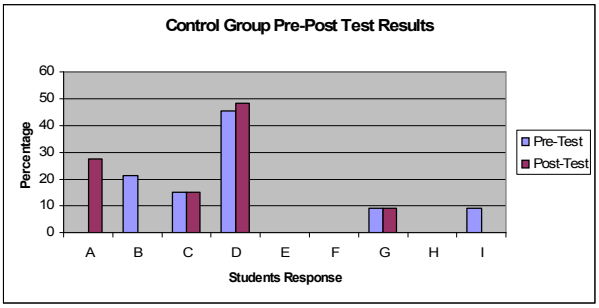

Figure 6.a Control Group(Traditional Approach)

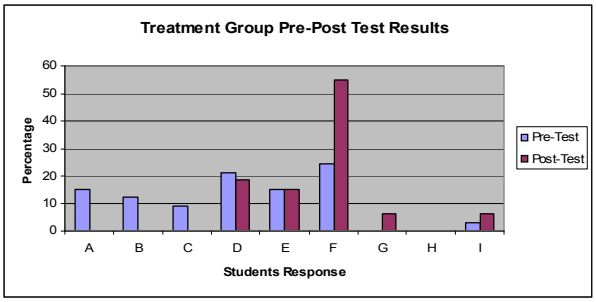

Figure 6.b. Treatment Group (STS Approach)

Table 1. A measure of Students Response about Science Technology and their Implications

		A		B		C		D		E		F		G		H		I		J	
		Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
1. Item	**Control**			3			21,2	24,3	12,1	51,5	54,6	18,2	12,1	3							
	Treatment		30,3		51,5	9		33,3		45,6	18,2	12,1									
2. Item	**Control**			6		30,3	21,2	45,6	51,5		15,2	12,1	12,1	3				3			
	Treatment	3	57,6	3	12,1	18,2	6	24,3	24,3	30,3		15,2									
3. Item	**Control**	3	6	24,3	21,2	3		3		15,2		48,5	57,6	3	15,2						
	Treatment		24,3				60,6	12,1	12,1	21,2		66,7		3							
4. Item	**Control**	42,4	51,5	27,3	24,3	18,2	15,2	12,1	3		6										
	Treatment	51,5		15,2			12,1	24,3		3	75,8	3	12,1	3							
5. Item	**Control**		27,3	21,2		15,2	15,2	45,6	48,5					9	9			9			
	Treatment	15,2		12,1		9		21,2	18,2	15,2	15,2	24,3	54,6		6			3	6		
6. Item	**Control**		3		3		24,3	45,6	48,5	33,3	15,2	12,1	3					3	9		
	Treatment		3	39,4		18,2		15,2			39,4	21,2	57,6					6			

Note:

1.The data indicate percentage of students population

2.Percentage of clasess with significant gains for each item

APPENDIX

Appendix 1: VOSTS items that used in the research as pre and post test

40221 Science and technology can help people make some moral decisions (that is, one group of people deciding how to act towards another group of people).

Your position, basically: (Please read from A to I, and then choose one.)

Science and technology can help you make some moral decisions:

A. by making you more informed about people and the world around you. This background information can help you cope with the moral aspects of life.

B. by providing background information; but moral decisions must be made by individuals.

C. because science includes areas like psychology which study the human mind and emotions.

Science and technology **cannot** help you make a moral decision:

D. because science and technology have nothing to do with moral decisions. Science and technology only discover, explain and invent things. What people do with the results is not the scientist's concern.

E. because moral decisions are made solely on the basis of an individual's values and beliefs.

F. because if moral decisions are based on scientific information, the decisions often lead to racism, by assuming that one group of people is better than another group.

G. I don't understand.

H. I don't know enough about this subject to make a choice.

I. None of these choices fits my basic viewpoint.

40412 Science and technology offer a great deal of help in resolving such social problems as poverty, crime and unemployment.

Your position, basically: (Please read from A to I, and then choose one.)

A. Science and technology can certainly help to resolve these problems. The problems could use new ideas from science and new inventions from technology.

B. Science and technology can help resolve some social problems but not others.

C. Science and technology solve many social problems, but science and technology also **cause** many of these

problems.

D. It's not a question of science and technology helping, but rather it's a question of **people** using science and technology wisely.

E. It's hard to see how science and technology could help very much in resolving these social problems. Social problems concern human nature; these problems have little to do with science and technology.

F. Science and technology only make social problems worse; it's the price we pay for advances in science and technology.

G. I don't understand.

H. I don't know enough about this subject to make a choice.

I. None of these choices fits my basic viewpoint.

40421 In your everyday life, knowledge of science and technology helps you personally solve practical problems (for example, getting a car out of a snowdrift, cooking, or caring for a pet).

Your position, basically: (Please read from A to J, and then choose one.)

The systematic reasoning taught in science classes (for example, hypothesizing, gathering data, being logical):

A. helps me solve some problems in my daily life. Everyday problems are more easily and logically solved if treated like science problems.

B. gives me greater knowledge and understanding of everyday problems. However, the problem solving techniques we learn are not directly useful in my daily life.

C. Ideas and facts I learn from science classes sometimes help me solve problems or make decisions about such things as cooking, keeping healthy, or explaining a wide variety of physical events.

D. The systematic reasoning **and** the ideas and facts I learn from science classes help me a lot. They help me solve certain problems and understand a wide variety of physical events (for example, thunder or quasars).

E. What I learn from science class generally **does not help me** solve practical problems; but it **does help me** notice, relate to, and understand, the world around me. What I learn from science class does **not** relate to my everyday life:

F. biology, chemistry and physics are not practical for me. They emphasize theoretical and technical details that have little to do with my day-to-day world.

G. my problems are solved by past experience or by knowledge unrelated to science and technology.

H. I don't understand.

I. I don't know enough about this subject to make a choice.

J. None of these choices fits my basic viewpoint.

40451 We have to be concerned about pollution problems which are unsolvable today. Science and technology cannot necessarily fix these problems in the future.

Your position, basically: (Please read from A to I, and then choose one.)

Science and technology can NOT fix such problems:

A. because science and technology are **the reason** that we have pollution problems in the first place. More science and technology will bring more pollution problems.

B. because pollution problems are so **bad today** they are already beyond the ability for science and technology to fix them.

C. because pollution problems **are becoming** so bad that they may soon be beyond the ability of science and technology to fix them.

D. No one can predict what science and technology will be able to fix in the future.

E. Science and technology **alone cannot** fix pollution problems. It is everyone's responsibility. The public must insist that fixing these problems is a top priority.

F. Science and technology **can** fix such problems because the success at solving problems in the past means science and technology will be successful in the future at fixing pollution problems.

G. I don't understand.

H. I don't know enough about this subject to make a choice.

I. None of these choices fits my basic viewpoint.

40521 High-technology industries will provide most of the new jobs in the next twenty years.

Your position, basically: (Please read from A to I, and then choose one.)

A. Yes. New information and rapid change are the keys to society's future.

B. Yes, because Canada's industries will have to become more efficient by installing hi-tech systems in order to compete.

C. Yes, because new Canadian industries will produce hi-tech products. Public demand for these products will create new jobs.

D. Yes. There will be many new jobs. Specially trained people will be needed to run and repair the new technology and to develop new kinds of hi-tech industries.

E. Yes. Specially trained people will be needed to run and repair the new technology, BUT it will replace some of today's jobs. Overall, the total number of jobs will be about the same.

F. No. Only a few new jobs will be created. More jobs will be lost because of mechanical or computerized hitechnology.

G. I don't understand.

H. I don't know enough about this subject to make a choice.

I. None of these choices fits my basic viewpoint.

40531 More technology will improve the standard of living for Canadians.

Your position, basically: (Please read from A to I, and then choose one.)

A. Yes, because technology **has always** improved the standard of living, and there is no reason for it to stop now.

B. Yes, because the more we know, the better we can solve our problems and take care of ourselves.

C. Yes, because technology creates jobs and prosperity. Technology helps life become easier, more efficient and more fun.

D. Yes, but only for those who can afford to use it. More technology will cut jobs and cause more people to fall below the poverty line.

E. Yes and no. More technology would make life easier, healthier and more efficient. BUT more technology would cause more pollution, unemployment and other problems. The standard of living may improve, but the quality of life may not.

F. No. We are irresponsible with the technology we have now; for example, our production of weapons and using up our natural resources.

G. I don't understand.

H. I don't know enough about this subject to make a choice.

I. None of these choices fits my basic viewpoint.

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