A TEACHER'S GUIDE TO FORCE OF NATURE THE DAVID SUZUKI MOVIE

Science and Technology in Society



A TEACHER'S GUIDE TO FORCE OF NATURE

Introduction

The purpose of this guide is to encourage teachers of grades 9–12 to incorporate the National Film Board documentary **Force of Nature** into their lesson plan by identifying where and how the film can support current curriculum expectations. In addition to connecting film content with subject outcomes, the guide offers a number of suggestions and activities to help teachers extend the discussion of a variety of themes, organized under the following headings:

Population, Consumption and Sustainable Development

Internment, Hiroshima, Human Rights and the Next Generation

Science and Technology in Society

Towards a New Perspective

These units can be explored selectively or collectively, depending on their relevance to the curriculum for which the teacher is responsible. Each unit is accompanied by a table that identifies the activities therein, provides a description of each of these activities, and indicates the particular pedagogy employed. A second and third table provide direction as to where the activities may be incorporated into the curriculum by identifying the relevant general and specific curriculum links for each of the provinces and territories.

Force of Nature is a powerful ninety-minute documentary based on David Suzuki's Legacy Lecture. Dr. Suzuki described this address, presented in 2010 to a live audience at UBC's Chan Centre, as "his last chance to say what he wants." The film effectively punctuates the lecture with scenes from his personal life and news footage chronicling major political, scientific and social events of the past seventy years. The result is a highly relevant, thought-provoking and entertaining viewing experience that students will find both interesting and inspiring.

While the film explores a range of themes related to the questions of "who we are, why we are here and where we are headed as a species," Dr. Suzuki's core message is clear: humans have exhausted the limits of the biosphere and it is imperative that we rethink our relationship with the natural world. Though much of the narrative is devoted to articulating how our species has altered the physical, biological and chemical integrity of the planet, he does offer viewers a blueprint for survival and his assurance that the same qualities that have made humanity a force of nature will guide us on a new pathway to a future full of meaning and real wealth.

Force of Nature examines a number of key themes and concepts addressed in subject areas across the high school curriculum, including:

- Population, Consumption and the Global Economy
- Sustainable Development
- Science and Technology in Society
- Racism and Human Rights
- Aboriginal Perspectives
 and Traditional Ecological Knowledge
- Scientific Literacy and the Media

Selected excerpts from the documentary can be used to support the teaching of these topics individually or, when shown in its entirety, the film offers an extremely effective interdisciplinary examination of the ecological crisis at hand and the role of sustainable development. "Science is the most powerful way of knowing. Through science we push back the curtains of ignorance and reveal the deepest secrets of nature. And implicit in this is that through science, as we acquire more and more knowledge, life will get better for people." –David Suzuki

he impact of science and technology on Dr. David Suzuki's personal life, human society and the health of our planet are key themes explored in *Force of Nature: The David Suzuki Movie*. Dr. Suzuki credits science with having "saved his life" as a young boy and while some applications from the field of molecular biology may have caused him to question his work as a research scientist, he believes science and technology offer our greatest hope for resolving the environmental crisis.

The curricula of all provinces and territories require that students develop an understanding of science, technology and society. The film's portrayal of specific controversies surrounding the relationship between these three elements offers an excellent starting point from which students can further explore the connections among these topics. The following activities will require students to use skills of critical thinking, co-operative learning and creative problem solving as they analyze the issues and discover their own responsibilities related to science, technology and a healthy society.

The chart below provides a quick reference to the relevant curricula in each province and territory. A more detailed curriculum matrix is found in the Appendix.

Province/Territory	Curriculum Links, Grade 10–12
Alberta	Science; English Language Arts; Information & Communication Technology
British Columbia	Civics; Science & Technology; Communications; Drama; English Language Arts
Manitoba	Science; Social Studies
New Brunswick	Science; Social Studies; English Language Arts
Newfoundland	Science; Social Studies; Arts
and Labrador	
Northwest Territories	Science; English Language Arts; Information & Communication Technology
Nova Scotia	Arts; Science; Social Studies; History; English Language Arts
Nunavut	Science; English Language Arts; Information & Communication Technology
Ontario	Science; Arts
Prince Edward Island	Science
Quebec	Ethics & Religious Culture; Math, Science and Technology
Saskatchewan	Science; Social Studies; English Language Arts
Yukon	Civics; Science & Technology; Communications; Drama; English Language Arts

A Summary of Activities

UNIT SEGMENT	ACTIVITY	DESCRIPTION	PEDAGOGY
Science, Applied Science, Technology & Society	1. Defining Our Terms	Students define, using examples, the terms science, applied science and technology.	Using graphic organizers (Venn diagram)
	2. Oak Ridge, Los Alamos, the Manhattan Project, and Hiroshima – Connecting the Dots	Students examine the link between Oak Ridge and Hiroshima and the link between scientific research and application.	Using graphic organizers (flow charts) Critical thinking
			Values clarification
	3. We Have the Technology	Students weigh the merits of the changes that technology has brought about.	Critical thinking
	4. What Gets Funded and Who Benefits	Students identify the factors that determine the direction of scientific research and the consequent inequalities in the attendant benefits.	Critical thinking Values clarification
			Integrated learning
Opening Pandora's Box	1.DNA, Genetic Engineering & Pandora's Box	Students describe past, present and future examples of bio-technology that demonstrate the potential for both positive and negative consequences for society.	Video analysis Values clarification Integrated learning
	2. Ethical Challenges	Students learn about different applications of genetic research and express their own views on the ethical implications of each.	Values clarification Integrated learning
	3. Designer Genes	Students examine the competing perspective on genetically modified foods (GMOs).	Critical thinking Action learning
Towards Scientific Literacy	1.Role of Media	Students explore what scientific literacy means and recognize the role to be played by scientists, media, government and individuals if we are to achieve a scientifically literate society.	Experiential learning Research Acting on learning
Science, Technology & the Future	1. What Do You Think?	Students assess their confidence in science.	Synthesis Using graphic organizers

Selected Learning Outcomes

The activities in this teaching guide address the following selected general learning outcomes (knowledge, skills and attitudes):

- Analyze a variety of social, ethical and legal issues related to applications of biotechnology in the health, agricultural or environmental sector;
- Reflect on ethical questions and engage in dialogue;
- Discuss ethical issues that may arise as a result of genetic testing for inherited conditions or disorders;
- Recognize and appreciate the role of mass media in communication, in contemporary society and in their personal lives;
- Analyze the impact of technologies on the environment;
- Examine societal and technological change, the links that may exist between the two, and consider whether advantages and stability have or have not resulted from such changes;

- Develop a concept of technology and explain its regional and global applications;
- Understand the role of technology as it applies to self, work and society;
- Understand developments in science and technology may have unforeseen consequences on society and the environment;
- Examine the interrelationships between literacies and knowledge, culture and values;
- Analyze the impact of various forms of media, identifying complexities and discrepancies in the information and making distinctions between sound generalizations and misleading oversimplification.



Force of Nature film director, Sturla Gunnarsson (left), with David Suzuki.

1. Science, Applied Science, Technology & Society

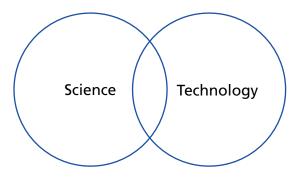
Activity 1: **Defining Our Terms**

Purpose: To define, using examples, the terms "science," "applied science" and "technology."

Background: The study of "Science, Technology and Society" (STS) examines the roles of science and technology in society, how science and technology reflect social, economic and cultural values, and the human and ethical implications of emerging technologies.

Procedure:

• Consult the website <<u>atschool.eduweb.co.uk/trinity/relate.html</u>> and explore with your students some of the suggested distinctions between science and technology. Use the Venn diagram below to summarize the distinctions and the overlap between the two:



Activity 2:

Oak Ridge, Los Alamos, the Manhattan Project and Hiroshima – Connecting the Dots

"Oak Ridge was the creation of a government project to make a very destructive weapon and was actually dropped on the land of my genes from Japan. And yet out of that came this very, very productive research institution that I'm very proud to have been a part of and that created me, I believe, as a scientist." –David Suzuki

Purpose: To understand the link between Oak Ridge National Laboratory and Hiroshima and the link between scientific research and application.

Background: Dr. Suzuki suggests that his time at Oak Ridge Laboratory was one of the most intense periods in his life and that it made him a scientist. In looking back, however, he notes, "one of the ironies, of course, that this [Oak Ridge] is a part of the Manhattan Project, that the uranium purified here had been used to create bombs that were dropped on Japan." The links between Oak Ridge, the Manhattan project and Hiroshima provide an interesting illustration of the link between science and technology.

Procedure:

- Draw a flow chart that captures the links between Oak Ridge, the Los Alamos National Laboratory, the Manhattan Project and Hiroshima.
- Develop a number of questions that you would ask a scientist at Oak Ridge if you had the opportunity to interview that person.
- Develop a number of questions that you would ask a survivor of Hiroshima if you had an opportunity to interview that person.

Activity 3:

We Have the Technology

Purpose: To weigh the merits of the "advances" that technology has wrought.

Background: Technological fixes are proposed to address many of our social and environmental challenges. In the film, Dr. Suzuki reminds us how technology has helped us successfully in the past. This activity is designed to help students assess the extent to which technology inhibits or promotes societal well-being.

Procedure:

- Have students use the chart below to evaluate one or more of the technological innovations identified therein. Identify other technological developments that you would like the students to consider.
- Have students place an asterisk in front of each technological development that they feel offers more benefits than burdens and have them defend their positions. Discuss some examples in which a short-term benefit has produced a long-term burden and vice versa.
- Discuss factors not identified in the chart such as the difficulty of predicting the effects of particular processes or devices.

TECHNOLOGICAL PROCESS OR DEVICE	BENEFITS	BURDEN
Chain saw		
Nuclear energy		
The automobile		
Mobile phones		
Antibiotics		

Activity 4:

What Gets Funded and Who Benefits

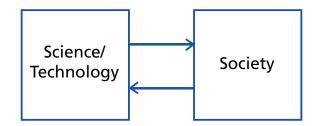
Purpose: To identify the factors that determine the direction of scientific research and the consequent inequalities in the attendant benefits.

Background: Scientific research is often expensive and therefore those who pay for the research are likely to determine the focus of that research. Taking advantage of the technology that results is also costly, and this reality frequently determines who will benefit.

Procedure:

Have students read Dr. Sydney Brenner's *Science* magazine article, "The Impact of Society on Science" <<u>sciencemag.org/content/282/5393/1411.full</u>> and consider the following:

Dr. Brenner notes that we "see evidence of the impact of science on society" everywhere and this is so obvious "that little more remains to be said about it." Further on in the article he notes that we are not as conscious of the impact society has on science.



• The impact of science on society, according to Dr. Brenner, is evident in our homes, in the food we eat, the cars we drive and the electrical gadgets we use.

Provide specific examples of these by completing the following:

AREA OF LIFE	EXAMPLES OF TECHNOLOGY
The homes in which we live	
The food we eat	
The cars we drive	
The electrical gadgetry in our homes	

- Dr. Brenner also suggests that the focus of science and society is uneven, that the concerns and needs of the developing world do not receive the same attention as those of the developed world. What evidence might be offered to support this suggestion?
- Dr. Brenner argues that the public needs to be aware of the factors that determine the direction in which society steers scientific research. Outline some examples of this pattern using the organizer below:

SOCIAL FORCES	IMPACT ON RESEARCH
Economic forces	
Political will	
Grant system	
Universities	

2. Opening Pandora's Box

"You have to regard science as a big lake. As you add information, it mixes up with everything else and somebody may draw out an idea over here and apply it or misapply it." –David Suzuki

Activity 1: **DNA, Genetic Engineering and Pandora's Box**

Purpose: To describe past, present and future examples of biotechnology that demonstrate the potential for both positive and negative consequences for society.

Background: In this video, James Watson argues for a new kind of eugenics, which allows parents to choose the DNA of their children, to make them healthier, more intelligent and even better looking. His vision may be disagreeable to some, but it's a possible outcome of the decades of scientific exploration launched by his and Francis Crick's discovery of the double-helix.

Procedure:

- Have students view *DNA: Pandora's Box* <<u>videosift.com/video/DNA-Pandora-s-Box-Part-5-of-5</u>> and discuss the following ideas, extrapolated from this video, regarding the implications of DNA research:
 - When you understand something, you can control it.
 - Individuals should direct evolution, not fate.
 - This is the future.
 - If we don't play God, who will?
- Discuss the following concepts:
 - Eugenics
 - Genetic injustice
 - Genetic enhancement
- What are the issues raised in the video by Matthew's story and Kay Jamieson's story?

Activity 2: Ethical Challenges: Examine Your Opinion on Genetic Research

Purpose: Students learn about different applications of genetic research and express their own views on the ethical implications of each.

Background: Students explore specific examples of the current and proposed uses of gene therapy, gene splicing, epigenetics and genetic screening. Following each case description, they are asked whether or not they would support the technique. Students then see how their views compare with the population at large.

Procedure:

• View the online simulation describing the principles of gene therapy: <u>http://videosift.com/video/DNA-Pandora-s-Box-Part-</u>5-of-5

Complete the "Ethical Challenge" by visiting: <u>pbs.org/wnet/dna/pop_ethical_challenge/index.html</u>

Activity 3: **Designer Genes**

"I was talking about the misapplication of genetics. He said, 'Well, you're a geneticist, how can you carry on with the work you're doing when you see all of these bad ways that science has been used?' And I said, 'Yeah, but I'm only studying fruit flies and I'm interested in basic research, not applications.' And he said, 'Look, that's too easy. . . . you have to regard science as a big lake, and scientists put their information in and raise the level of the lake.'" –David Suzuki

Purpose: To examine the competing perspectives on genetically modified foods (GMOs).

Background: Genetic engineering offers the possibility of using genes to modify existing plants or create new ones. Critics would argue that this can be a dangerous game. The following activity is intended to engage students in this debate.

Procedure:

• Discuss the implications of genetically modified foods and choose a method (letter to the editor, PowerPoint presentation, video, etc.) to report on and inform others of your findings and conclusions.

Resources

The New York Times: "Drought Resistance Is the Goal, but Methods Differ": nytimes.com/2008/10/23/business/23drought.html?ref=thefoodchain Oak Ridge National Laboratory: Genetically Modified Foods and Organisms: ornl.gov/sci/techresources/Human Genome/elsi/gmfood.shtml "Genetically Modified Foods; Harmful or Helpful?": csa.com/discoveryguides/gmfood/overview.php CBC News: "Genetically Modified Foods: A Primer": cbc.ca/news/background/genetics modification World Health Organization, Food Safety: "20 Questions on Genetically Modified Foods": who.int/foodsafety/publications/biotech/20questions/en/

PBS: "Genetically Modified Tomatoes": pbs.org/wnet/dna/pop_genetic_gallery/index.html

Extension

Dr. Suzuki has suggested that science cannot be left to the scientists.

- Discuss who makes the decisions in the above cases.
- If it is to be society that makes the decisions, how do we better ensure a scientifically literate society?

3. Towards Scientific Literacy

Activity 1: The Role of Media

"After having spent quite a few years in both television and radio, I was much more aware of the limitations and the increasing shallowness of what we were doing.

"So everything has just been shortened up, and of course it means you just don't have time for the profundity to develop a thought... I think you're carried along more by sensationalism than really getting the story in a half-hour or an hour show.

"Science, in fact, is just too important to be left to scientists or industrialists and politicians." -David Suzuki

Purpose: To explain what scientific literacy means and to recognize the role to be played by scientists, media, government and individuals if we are to achieve a scientifically literate society.

Background: Given the power of science to affect our lives, scientific literacy is a critical requirement for all citizens. Dr. Suzuki suggests that the media has not assumed its responsibility in this regard.

Procedure:

 Introduce the concept of scientific literacy by having students read/watch and discuss one of the following:

Robert M. Hazen: "Why Should You Be Scientifically Literate?": <u>actionbioscience.org/newfrontiers/hazen.html</u> Neil deGrasse Tyson on scientific literacy: <u>youtube.com/watch?v=5gK2EEwzjPQ</u> The Symphony of Science: "Symphony of Science: The Poetry of Reality": <u>youtube.com/watch?v=9Cd36WJ79z4</u>

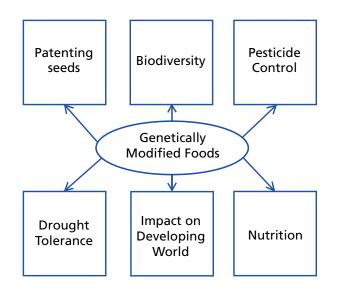
- Have students discuss the importance of scientific literacy after reading one of the following: Sir Paul Nurse: "Science and Society": <u>pbs.org/wnet/dna/pop_scientists/index.html</u> Lawrence Shapiro: "Will the Progress in Genetics Split or Unite Humanity?": <u>pbs.org/wnet/dna/pop_scientists/index2.html</u>
- Select an example from either a newspaper, magazine article or television program and conduct a study of the quality and depth of reporting on scientific issues. Use the following chart to analyze a given article or production and to record your findings and your conclusions.



GUIDING QUESTIONS	INFORMATION ACQUIRED	CONCLUSION REACHED
What conclusions are suggested by the headline/ title of the article/program?		
Who did the investigation? What are their qualifications?		
From the information given, could you write an outline plan of the investigation? Consider issues like sample selection, sample size and use of controls.		
What do other scientists say about the research? Are there other interpretations of the results?		
Would you be able to make a decision based on these articles/shows? How might you get more information?		

Other Teaching Suggestions:

- Evaluate the effectiveness of AI Gore and Bill Bryson in popularizing scientific issues.
- Is there a danger that in popularizing science we sacrifice complexity and sophistication? Discuss. Background information on Al Gore: <u>algore.com</u> Background information on Bill Bryson: <u>http://en.wikipedia.org/wiki/Bill_Bryson</u>
- You may also want to research Canadians who have popularized science such as Robert Bateman <<u>batemanideas.com</u>> and Farley Mowat <<u>thecanadianencyclopedia.com/index.cfm?PgNm=TCE&Params=A1ARTA0005502</u>>.
- Conduct a study in your school or community to determine the level of knowledge and concern about selected science issues that have significant social implications.
- Evaluate the quality of various YouTube presentations on genetically modified foods based on a set of criteria established by the class.



4. Science, Technology and the Future:

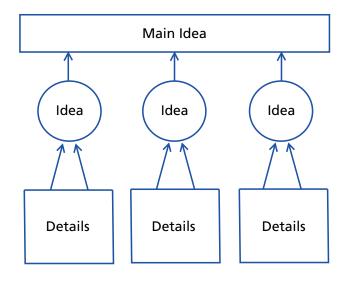
"Can we marshal the vision and the energy to change direction and follow a new path? We have in the past. Can we do it again?" –David Suzuki

What do you think? Is Dr. Suzuki's faith in science well placed?

Use the diagram below to organize your thoughts.

Instructions for diagram:

- a) Place your thesis statement in the Main Idea;
- b) Insert supplementary/supporting statements in the Idea "bubbles";
- c) Outline relevant facts or data that support the related Ideas.



Appendix

Curriculum Matrix

PROVINCE	SUBJECT	RELEVANT COURSES	CURRICULUM UNITS
Alberta	English Language Arts	English Language Arts, Grade 10–12	Create oral , print, visual, and multimedia texts
Alberta	Information & Communication Technology	Information & Communication Technology, Grades 10–12	Foundational Operations, Knowledge and Concepts
Alberta	Science	Biology 12	Cell Division, Genetics and Molecular Biology
British Columbia	Science	Biology 12	Cell Biology
British Columbia	Civics	Civic Studies 12	Informed Citizenship; Civic Deliberation; Civic Action
British Columbia	Communications	Communications 11 & 12	Comprehend & Respond; Communicate Ideas & Information
British Columbia	Drama	Drama 11 & 12: Film & Television	Context (Social, Cultural, Historical), Exploration & Analysis
British Columbia	English Language Arts	English Language Arts 10–12	Reading & Viewing
British Columbia	Science & Technology	Science & Technology 11	Science Module; Technology Module
Manitoba	Science	Biology 12	Genetics
Manitoba	Social Studies	Geographic Issues in the 20th Century, Grade 10	Food from the Land
Manitoba	Science	Current Topics in Science, Grade 11; Interdisciplinary Topics in Science, Grade 12	Science, Technology, Society and the Environment
Manitoba	Social Studies	World Issues, Grade 12	The Role of the Media in World Issues
New Brunswick	Science	Biology 11	The Cell
New Brunswick	Science	Biology 12	Genetic Continuity; Evolution, Change & Diversity
New Brunswick	English Language Arts	English Language Arts	Reading & Viewing
Newfoundland and Labrador	Science	Biology 3201	Genetics; Evolution, Change & Diversity
Newfoundland and Labrador	Social Studies	Atlantic Canada in the Global Community, Grade 9	Technology
Newfoundland and Labrador	Arts	Art & Design 2200-3200	Media Arts
Northwest Territories	English Language Arts	English Language Arts, Grade 10–12	Create oral, print, visual and multimedia texts
Northwest Territories	Information & Communication Technology	Information & Communication Technology, Grades 10–12	Foundational Operations, Knowledge and Concepts

PROVINCE	SUBJECT	RELEVANT COURSES	CURRICULUM UNITS
Northwest Territories	Science	Biology 12	Cell Division, Genetics and Molecular Biology
Nova Scotia	Arts	Film & Video Production 12	Film Development & Production
Nova Scotia	Science	Biology 11	Biodiversity; Interactions Among Living Things
Nova Scotia	Science	Biology 12	Genetic Continuity; Evolution, Change & Diversity
Nova Scotia	Science	Science 10	Sustainability of Ecosystems
Nova Scotia	English Language Arts	English Language Arts	Reading & Viewing
Nova Scotia	Social Sciences	Global History 12	Societal & Technological Change
Nova Scotia	Social Studies	Global Geography 12	Our Fragile Planet; Perilous Processes; The Peopled Planet; Feeding the Planet; Global Resources; Global Factory; The Future Planet
Nunavut	English Language Arts	English Language Arts, Grade 10–12	Create oral, print, visual and multimedia texts
Nunavut	Information & Communication Technology	Information & Communication Technology, Grades 10–12	Foundational Operations, Knowledge and Concepts
Nunavut	Science	Biology 12	Cell Division, Genetics and Molecular Biology
Ontario	Science	Biology 11; Biology 12	Cellular Biology; Genetics; Biochemistry; Molecular Genetics
Ontario	Science	Chemistry 12	Chemistry in the Environment
Ontario	Science	Environmental Science, Grade 11	Scientific Solutions to Contemporary Challenges
Ontario	Science	Science, Grade 12	Biotechnology
Ontario	Arts	Media Arts, Grades 9–12; Visual Arts, Grades 9–12	Creating & Presenting, Reflecting, Responding & Analyzing
Prince Edward Island	Science	Biology 801A	Genetics
Prince Edward Island	Science	Biology 6321A	Genetic Continuity; Evolution, Change & Diversity
Quebec	Ethics & Religious Culture	Ethics & Religious Culture	Reflects on ethical questions; Engages in dialogue
Quebec	Mathematics, Science & Technology	Mathematics, Science & Technology	Makes the most of his/her knowledge of science and technology; Seeks answers or solutions to scientific or technological problems; Communicates by using the language of science & technology
Saskatchewan	Science	Biology 30, Grade 12	Genetics; Evolution
Saskatchewan	English Language Arts	Communication Studies 20, Grade 11	The Art of Debating; Communications & the Interne

PROVINCE	SUBJECT	RELEVANT COURSES	CURRICULUM UNITS
Saskatchewan	English Language Arts	Journalism Studies 20, Grade 11	Print Journalism; Electronic Journalism; On Assignment
Saskatchewan	English Language Arts	Media Studies 20, Grade 11	Media Awareness, Exploring the Media of TV and Other Media
Saskatchewan	English Language Arts	Media Studies 20, Grade 11	Media Awareness, Exploring the Media of TV and Other Media
Yukon	Science	Biology 12	Cell Biology
Yukon	Civics	Civic Studies 12	Informed Citizenship; Civic Deliberation; Civic Action
Yukon	Communications	Communications 11 & 12	Comprehend & Respond; Communicate Ideas & Information
Yukon	Drama	Drama 11 &12: Film & Television	Context (Social, Cultural, Historical), Exploration & Analysis
Yukon	English Language Arts	English Language Arts 10–12	Reading & Viewing
Yukon	Science & Technology	Science & Technology 11	Science Module; Technology Module

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