EDUC 498

Science, Technology and Society Issues in
Education.
Summer, 1990

A few years ago I had to travel from Chicago to Vancouver by air. Chicago's O'Hare airport is one of the largest and busiest on earth. So, as is typical, the plane had to wait its turn to take off. To engage the passengers during this delay, the pilot came on the intercom system and began an almost poetic narrative.
"Today, thanks to the work of two bicycle mechanics from Dayton, Ohio, you and 120 or so other passengers will make a journey of more than 1500 miles in the space of three and one half hours. The same journey took your grandparents many days, and took their parents weeks or months. You will make it in saftey and comfort not dreamt of by your forebears...."

Quite aside from delight at meeting a pilot willing to provide a historical and literary alternative to the usual inane announcements in commercial airliners, I was caught on the phrase, thanks to the work of two bicycle mechanics. He was, of course, referring to those major pioneers of powered flight, the Wright Brothers. I began to wonder whether or not there could be contemporary counterparts to the Wright Brothers. Would it be possible to have the modern day equivalents of those persistent bicycle mechanics who managed to accomplish what the leading scientists of the day, such as Lord Kelvin, had declared to be impossible. Have science and technology progressed to the point where average people can neither participate in their processes nor even understand their products and implications?

It is certain that modern science and technology are complex enterprises. They are also extremely expensive, often requiring tools costing thousands, millions, and even billions of dollars. Even many technicians in today's labs and institutes have Ph.D. level educations in science and engineering. But it is worth noting that the massive wave of personal computing, represented by the development of the Apple computer and its counterparts, began not in a university, corporate or government lab or research institute, but in a garage workshop with the efforts of two talented teen agers: Steve Jobs and Steve Wosniak. Both men were very skilled electronics hobbyists, and they had a reasonable grounding in science, but they were far from the white coated research scientist so frequently presented as the image of modern science.

David Suzuki has remarked that "science is too important to be left to scientists." The comment simply takes note of the fact that scientists, once they move beyond the laboratory, are often no better at assessing the social consequences of their research than any one else. Although they are often claimed to be so, science and technology are not value free, any more than any other endeavours shaped by human intentions and choices are value free. It is essential that today's citizens develop their understanding of science and technology so that they can participate in the political and social decision making that must accompany the application of scientific research and technological innovation on a large scale basis. No sector of human life today is untouched by science and technology, from health, to work, and through to recreation.

But do modern human beings feel that they have some "voice" in the direction of science and technology, or do they feel that they are simply being pushed by an ever-increasing wave of new products, new ideas, and new approaches. Do they feel that they can participate, even as informed spectators in the scientific and technological era in which they live. Or do they feel, as many seem to, that these issues are simply too complex or sophisticated for them to understand so they must rely on experts and hope for the best. If this is the attitude that is developing, then many people are becoming less and less competent at a personal level of choice and decision making, and are becoming more and more passive in the process.

Science curricula are an important element of the mosaic of learning experiences which schools provide to children in every country on earth with an organized school system that attempts anything beyond the attainment of basic literacy. But what is to be found in school science to address the ability of students to function as citizens in societies that are highly influenced by science and technology. Does a knowledge of the physiology of circulation equip students to decide about the priorities for selecting candidates for heart transplants? Does an understanding of the Periodic Table of the Elements enable a person to discuss the "Star Wars" concept for a space based missle defense system? Does an understanding of the Gas Laws determine that a person can transfer this learning to deciding whether or not to replace their old refrigerator, and which model to buy? How can we help people to evaluate, plan, select, and implement courses of action that require time, effort, money, and persistence in areas such as personal health and nutrition or an energy conservative life style? What role does school play in the development of citizens who are informed, and who seek to remain informed, about science and technology questions, and who see themselves as being able to participate in these at some level. It is the purpose of this course to address these questions.

Course Purposes and Goals.

This course is founded on the premise that in order to educate students so that they can become technologically and scientifically literate citizens of the modern world teachers will need to develop certain specific teaching skills and will need to understand what areas of knowledge they will have to navigate through in order to assist students. It is a further premise of the course that teachers do not have to be scientists or technologists in order to teach effectively about these domains, but that a certain basic understanding of the processes of science and technology is required. It will also be important for teachers to have an interest in these domains so that they can function as models for students of both sexes, of a range of ages, and from a variety of social and cultural backgrounds.

With this general statement of premises in mind, the course has the following goals.

I. The development of teaching skills necessary to helping students understand what science is, what science is not, and how science and technology relate to each other the first goal of the course.

II. The second goal of this course is to help teachers develop the skills and understanding required to assist students to learn what technology is, and how technological processes and purposes may differ from those of science.

III. The third goal of the course is to help teachers develop the skills required to assist students to think critically about the social/cultural implications of science, applied science, and technology.

IV. The fourth goal of the course is to help teachers understand the processes of scientific and technological creativity, invention, and production so that they can nurture student talents in these areas in classroom settings.

V. The fifth goal of the course is to help teachers develop the skills required to participate personally in science and technology through the use of modern computer based systems of information management, personal expression and creativity, and information access.

VI. The sixth goal of the course is to help teachers understand how to develop teaching strategies to foster student knowledge of science and technology as cultural activities having a social and historical context.

Course Outline.
This course will address the following topics.

Course Outline and Requirements.
What is science/ what is technology?
Some exercises in ways of seeing:
Where did the All Earthlings Go??
Design, Form, and Function.

Map-making as a pioneering technology and an embryo science.
Critical Thinking 1: The National Enquirer vs the Skeptical Enquirer.
Critical Thinking 2: The Anatomy of a Modern Issue.
A Process Ecosystem.

Design Problems : Structures.
It must be true...the Government tells me so.
Decision Making: General Models.
Thinking Tools for Complex Problems: Trees, Matrixes, and Holistoscopes.

You are what you eat: a problem in information quality and access.
Building Things 1: the use of kits and models in technology and science education. Children Solve Problems: some exercises in Lateral Thinking.
Social Action Research—From the Classroom to Real World Action.

Decision-Making Models in Science and Technology.
Simulation Games as Models of Reality.
Model Rockets
Systems Thinking. The Universe in a Paper Bag.

As can be seen from the above outline, Intersession is really a pretty compressed time frame in which to work in a course like this. This means that a certain amount of preparation will be necessary on your parts between sessions. There will be five components of student production required to satisfy the requirements of the course. These will be:

Task 1.

Select a current issue in the domain of Science, Technology and Society. Issues such as Acid Rain, the use of Organ Transplants, Automation and its impact on work, The Greenhouse Effect Fish Farming, the use of Pesticides or Herbicides, the Wolf Kill in B.C., or Water Conservation and Use in B.C. would all be suitable topics.

Develop a Curriculum Package for use in the context of your chosen issue. A curriculum package is the equivalent of a Unit Plan,(see General Guide to Instructional Design) but it includes not only a theoretical/conceptual plan, but also the real activities and materials that you would expect teachers and/or students to use. There is no precise definition of a "unit" in teaching. A unit is generally more than one lesson in duration. It can include follow up at home activity for students. A unit also includes the student assignments and the procedures to be used to assess and inform student performance.

If your package needs to include real materials, ie. sample government pamphlets, etc., then they should be included in your design. Students will share their Curriculum Packages on the last meeting of the course. The acid test for the design quality of an Instructional Unit is that another teacher, without being able to speak to you, the designer, directly, should be able to implement your design with a group of students of the age/grade and skill level for which it was intended.

Task 2. Critical Thinking.

Design a one lesson instructional plan to develop student critical thinking concerning an STS issue that has been presented in a printed format. An example might be a study guide to help students examine a set of newspaper articles related to performing heart transplant operations on infants. The emphasis should be on developing students capacity for critical thought, hence questions about the balance, objectivity, and fairness of the materials, its value stance, any hidden messages, etc., should be explored. The material should be designed for use by a teacher with a typical class at a chosen age/grade subject level/emphasis in a period of 45-55 minutes duration, with a possible follow up homework assignment.

Task 3. A Construction Challenge.

The essence of human technological thinking is the conversion of an idea into actuality. The Wright brothers didn't just dream about flying, or create elaborate drawings of possible planes, they used the tools and materials at their disposal (or invented new ones), and built a working prototype. In the process of thinking technologically, there is a shift in the focus of learning from Instruction to Construction. As teachers, it is important for you to experience this shift by coming to grips with an constructional problem. So, for Task Three, you should develop a design for a construction involving something that operates, that works, or that solves a number of design problems. Of course, we can't expect you to build a full scale working aircraft capable of carrying a human pilot in one month, but you might be able to create a working model.

Using simple materials, create an aircraft powered by a rubber band. The rubber band may be an actual typical office rubber band, or it can be another form of elastic (old tire tube, undershort elastic, etc.) Powered flight means that the plane doesn't just glide, but is actually propelled in some way by the band acting as a motor. The plane can be hand launched (ie. the plane doesn't have to start up, taxi, and take off as well as fly on the power of its elastic engine.) The plane must be an original design and must be hand made, not a prefabricated kit. You may use parts of a kit, ie. wheels or a propellor, but they must be in the minority of the materials. Planes will be flown on the last day of the course. De briefing will focus on what you have learned from the design exercise, and on what you think its educational applications are. Thus, accompanying your design should be a brief discussion of (1) what you learned from the exercise (about flight, planes, tools, materials, and educational potential) and (2) what you think students could/would learn from such a task, and how you might use and/or modify it for use with a typical student group at a chosen grade level.

Some people don't like building planes. If not, you may propose another design challenge, but it should be one appropriate for a school class or sub-set of students, K-12. Because time is limited, if you wish to go off on your own direction, please see me by the end of Session 2 and get me to approve your idea. An example project might be a simple robot built from the parts of an old computer plus other hardware, a new type of container that heats its contents when opened, etc..

Task 4. CHOICE Area: Choose ONE item from the list below.

(a) Create a simple instructional program on an STS related topic using the Macintosh Hypercard program— example, a stack on the History of Aviation.

(b) Develop a student study pack on an Invention and its Inventor(s).

(c) Develop a simulation game for an STS issue.

(d) Develop a design problem for use with student of a selected age/grade. (Similar to Task 3 of this course.)

(e) Develop an instructional unit using appropriate science fiction books to develop students' understanding of STS issues or of an issue.
(f) Do a critical review of one module of the current ST11 course for B.C.

The Weighting of Each Task will be as follows.

Task 1: 25%
Task 2: 25%
Task 3: 25%
Task 4: 25%
Total: 100%