# Views of Technology Education in Canada and the United Kingdom

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The impact of discoveries, inventions, and creative developments in science, mathematics, and technology is apparent in practically all spheres of life, but these fundamental fields of human inquiry and action often play an ambiguous role in education (Black & Atkin, 1996). Influenced by continuing changes in national policy and social and economic life, many curriculum projects have emerged. In Japan, for example, "Life Environmental Studies" was introduced in 1989 as a new integrated subject instead of science and social studies in the first and second elementary school grades (Yamazaki, 1996).

This paper reviews curricula in technology education in four regions of the United Kingdom (U.K.), Alberta and British Columbia (B.C.) in Canada, and Japan. Emphasis is on the degree of integration between science and technology and changes in the subject, the subject matter sequence, and the contributions of the subject to the entire curriculum.

## Technology/Industrial Arts Education in Japan

To date, few international attempts have been reported on contemporary technology/industrial arts education in Japan. Murata and Stern (1993) described the curriculum in transition and the current tendency of technology/industrial arts and vocational technical education at the secondary and postsecondary levels. Okuya et al. (1993) provided a schemata of each organization of the Ministry of Education, Science, Culture and Sports (MESCS) in Japan, the present school system, and the current courses of study, especially industrial arts education in the lower secondary schools. Yamazaki (1996) provided an outline of the Japanese school system based upon the MESCS (1991) and the statutory curriculum standards published by MESCS (1989a, 1989b, 1989c), and presented an outline of the current system of science and technology education training and certification of teachers in Japan.

According to the current course of studies, there is no technology/industrial arts education related subject in elementary schools. However, there are technology education related subjects in vocational or comprehensive upper secondary school courses, but they are not listed as general education in upper secondary schools although there are compulsory homemaking related subjects listed.

The current course of studies also provides the prescribed subjects and standard number of yearly school hours (total 1,050 hours) in lower secondary schools. A school hour at this level is defined as a class period of 50 minutes. Industrial arts and homemaking is one of nine required subjects. Requirements for first and second grades in industrial arts is 70 hours (6.7%) and third grade is 70 to 105 hours (6.7 to 10%).

Industrial arts and homemaking subjects comprise 11 areas. The six areas of the industrial arts strand are woodworking, electricity, metalworking, machine, cultivation, and fundamentals of information. Okuya et al. (1993) introduced the overall objectives and content of woodworking, electricity, and fundamentals of information. Since the MESCS has never published the current course of study in English, this paper provides each objective and the content for metal working, machines, and cultivation as follows:

### METAL WORKING

*Objective:* Students will understand the properties of metal material and design and produce sample metal goods reflecting form and function.

*Content:* Students will be able to:

1. Design metal goods based on:
   a. Function and structure of metal goods in accordance with their purpose and condition.
   b. Forming concrete product ideas and producing idea sketches and production plans.
   c. Production processes and procedures.
2. Understand the features and proper usage of metal materials, joining materials, and metal work tools.
3. Regarding using and working with metal work tools and machines:
   a. Know the composition and proper usage of tools and machines.
   b. Cut, fold, and file metal materials.
   c. Properly use a drill and lathe.
   d. Properly assemble a product using a sketch and the plan for production.
4. Consider the role of metal in daily life and industry.

### MACHINE

*Objective:* Students will understand mechanisms, machine operation and maintenance, and energy conversion. They will design and build a simple machine model.

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*Content:* Students will be able to:

1. Demonstrate capability in regard to the mechanism, elements, and materials of machinery through:
   a. Understanding the transmission of mechanism.
   b. Knowing the features and functions of machine elements.
   c. Understanding how energy is changed into work and power.
   d. Knowing the features and functions of machinery materials.
2. Design and manufacture a movable model.
3. Regarding machine maintenance:
   a. Disassemble and assemble a machine according to maintenance sequence and specifications.
   b. Examine and correct a fault in a machine.
4. Examine the role played by machines in daily life and industry.

**CULTIVATION**

*Objective:* Students will understand the conditions of crop growth and cultivation techniques, and develop the ability to raise crops systematically.

*Content:* Students will be able to:

1. Regarding crop cultivation:
   a. Know the classification and the growing process of crops.
   b. Make a plan in accordance with the purpose of cultivation.
2. Regarding the environment suitable for the cultivation of crops:
   a. Understand the relationship between the growth of crops and the properties of light, temperature, and water.
   b. Understand the relationship between the growth of crops and the properties of soil and fertilizers.
3. Regarding cultivation methods:
   a. Demonstrate careful work habits to support the growing process of crops.
   b. Identify and prevent diseases and noxious insects in crops.
   c. Cultivate crops utilizing environmental adjustment.
4. Examine the relationship between agricultural cultivation and life.

**Technology Education in the U.K.**

The education systems of England and Wales, Scotland, and Northern Ireland are independent of each other and significantly different (King, 1994). A new national curriculum in England and Wales was introduced in 1995 (Department for Education, 1995) and supported the need for students to learn life skills and problem solving using the designing and making approach. This approach is based on the theory that children learn best through "doing," and through the application of practical project work, they enhance their technological understanding by applying theoretical principles to "real life" situations (Shield, 1996). The national curriculum applies to students of compulsory school age (5 to 16 years) in local education agency funded schools, including central government funded privately run special schools. It is organized on the basis of four key stages.

**Definition of Each Key Stage in England and Wales**

Table 1 shows the definition of each key stage in England and Wales. Key Stage 1 mean ages are from 5 to 7, that is, first and second grades. Key Stage 2 relates to ages 8 to 11, which correspond to third to sixth grades. Students in Key Stage 3 are ages 12 to 14, which relates to the seventh to ninth grades while students in Key Stage 4 are 15 to 16 years old and are typically in Grades 10 to 11.

**Table 1**

***Intepretation of Each Key Stage in England and Wales***

| Key stage | Mean ages | Year |
|---|---|---|
| 1 | 5-7 | 1-2 |
| 2 | 8-11 | 3-6 |
| 3 | 12-14 | 7-9 |
| 4 | 15-16 | 10-11 |

Table 2 shows required subjects at various stages in England. These include English, mathematics, science, design and technology, information technology, and physical education in all key stages. History, art, and music are required from Key Stage 1 to 3. At Key Stages 3 and 4, students must learn a modern foreign language.

**Table 2**

***Subjects in England***

| | Key stage | | | |
|---|---|---|---|---|
| Subject | 1 | 2 | 3 | 4 |
| English | + | + | + | + |
| Mathematics | + | + | + | + |
| Science | + | + | + | + |
| Design & technology | + | + | + | + |
| Information technology | + | + | + | + |
| History | + | + | + | – |
| Geography | + | + | + | – |
| Art | + | + | + | – |
| Music | + | + | + | – |
| Physical education | + | + | + | + |
| Modern foreign language | – | – | + | + |

Because many programs are in the process of integrating science and technology, a review of the science curriculum in England and Wales is presented. The current version of the national curriculum in science has three main threads in common with all other subjects:

> (i) The National Curriculum is divided up into Programmes of Study. These outline broadly the concepts, skills and processes which children are required by law to study through particular stages of their schooling. The Key Stages correspond to the ages at which they are taught.
> (ii) Each Programme of Study has a series of Attainment Targets written through it. There are now four Attainment Targets in science, one being concerned with skills and processes and the other three with knowledge and understanding.
> (iii) Each Attainment Target has eight Levels, each level associated with a particular Statement of Attainment which pupils are expected to know and understand. (Bentley & Watts, 1994, p. 5)

### Attainment Targets of National Curriculum in Science in England and Wales

In science, each attainment target now has a variety of strands associated with it as follows:

*Attainment Target 1: Experimental and Investigative Science*
*Attainment Target 2: Life Processes and Living Things*
*Attainment Target 3: Materials and Their Properties*
*Attainment Target 4: Physical Processes*

At the end of Key Stages 1, 2, and 3, standards of pupils' performance are set out in eight level descriptions of increasing difficulty, with an additional description above Level 8 to help teachers to differentiate exceptional performance.

> In general terms, the rate of progress in each Attainment Target is not usually one per year; some children progress faster than this, others not so fast. Attaining a level in one Attainment Target in a subject does not necessarily mean that the child is at the same level in all the targets inside that subject. By the time children reach Key Stage three the teacher may have to contend with huge spreads of attainment in any one student—and therefore in any one class. (Department of Education, 1995, p. v)

### Attainment Targets in Technology

In the current version published in 1995, information technology has been separated from design and technology in the English and Wales curriculum. The number of attainment targets in the current proposed version are only two: designing and making. Each attainment target has strands within it and each key stage has associated with it "design and make tasks" (DMTs), whereby the programs of study are translated into schemes of work and classroom activities. In each key stage, DMTs are divided into (a) core DMTs where content is prescribed and (b) supplementary DMTs where the content supports the core to produce a balanced course of study. Table 3 shows each attainment target and its related strand.

**Table 3**

***Each Attainment Target and Strand in the National Curriculum in Design and Technology in England and Wales***

1. Designing
   - Strand A. Investigating, clarifying, and specifying the design task.
   - Strand B. Modeling, developing, and communicating design ideas.
2. Making
   - Strand A. Planning and organizing making.
   - Strand B. Using a variety of components, tools, equipment, and processes to make products safely.
   - Strand C. Testing, modifying, and evaluating.

### Examinations and Qualifications in the U.K.

There are many different kinds and levels of qualifications in the U.K. (Mackinnon, Statham, & Hales, 1995). Some are normally obtained through study at school, some through further or higher education, and some at the workplace. In England, Wales, and Northern Ireland, the General Certificate of Secondary Education (GCSE) was introduced for those aged 16 or over. GCSE is awarded on a 7-point scale, with much emphasis originally placed on assessment of course work as well as a final examination. A variety of different GCSE syllabi is provided by the regional examination group. There are five examination groups on technology in England, and one of each group in Wales and Northern Ireland.

The GCSE assessment objectives are weighted 40% written paper and 60% course work. The different components of assessment objectives in design and technology are weighted as in Table 4.

**Table 4**

***The GCSE Assessment of Design and Technology Objectives***

| Assessment | Course work | Written paper | Total |
|---|---|---|---|
| Designing | 20% | 20% | 40% |
| Making | 40% | 20% | 60% |
| Total | 60% | 40% | 100% |

### The Relationship Between Each Grade and Level in Scotland

In the elementary and secondary grades of Scotland, there is a relationship between each grade and level (Scottish Office Education Department, 1993a). Each grade has five levels of attainment with Level A being the most easily attainable and Level E being the most difficult to attain.

The five main areas of the Scottish school curriculum are:

1. Language—including English and at least one foreign language in Secondary S1 and S2, which are the first two years of secondary school.
2. Mathematics.
3. Environmental studies—a broad area with three main aspects: scientific studies and applications, including health education; social studies, including history and geography; and technological activities and applications, including information technology.
4. Expressive arts—a broad area with four main aspects: art and design, music, physical education, and drama.
5. Religious and moral education.

Cross-curricular aspects of education allow use of any of these five main areas to develop other important aspects of a broad and balanced education such as enterprise education, environmental education, media education, and the relationship of these areas to the European common market community.

Student knowledge, skills, and attitudes form the attainment targets for the Scottish national guidelines. Subjects can be independent or integrated. An example of the integrated emphasis is found in the environmental studies program where

> many teachers believe that the best way to introduce young children to this range of studies is through the direct experiences which they have of their environment. If the subjects are taught in an integrated way, the studies can often be made to link more directly with pupils' experiences and the interrelatedness of separate subjects is easier to maintain. (McClelland, 1993, pp. 17–18)

### The Framework for Attainment Outcomes and Targets in Technology in Scotland

The suggested learning is set out as a number of attainment outcomes in each subject area. Each attainment outcome is also composed of several strands. The framework for attainment outcomes and targets in technology includes the following:

- Understanding and using technology in society
- Understanding and using the design process strands
- Knowledge and understanding
- Planning
- Collecting evidence
- Applying skills and presenting
- Solutions
- Interpreting and evaluating
- Developing informed attitudes (Scottish Office Education Department, 1993b, pp. 4–5)

In Scotland, all the students take the first Scottish Certificate of Education Standard grade courses, which started in 1984. These have three levels of study and award (foundation, general, and credit) based on continuous assessment. Pupils receive a certificate at the end of their fourth year of secondary school, around age 16, and are given a "profile" of their attainments.

### Technology Education in Northern Ireland

The curriculum in Northern Ireland is organized into six areas of study: English, mathematics, science and technology, environment and society, creative and expressive studies, and language studies (Northern Ireland Curriculum Council, 1990). The science and technology area of study includes science, biology, chemistry, physics, technology and design, and home economics. Technology and design is a compulsory subject for all students ages 5 to 16 and is optional for pupils from the age of 16.

King (1994) reported on the characteristics, aims, and model of technology and design in the Northern Ireland curriculum. He also referred the contributions of technology and design to the whole curriculum 4 to 16. Technology and design has been identified as the main contributory subject to the development of information technology capability.

### Technology Education in British Columbia

In British Columbia, Canada, information and computer technology belongs to the curriculum organizers of science, math, and technology (Province of British Columbia, Ministry of Education, 1994). However, the curriculum organizer "applied skills," similar to the practical arts in the 1970s in the United States includes studies in technology education, business education, and home economics. Each of these subject areas will be phased in over a two-year period. Technology education began implementation in September 1996, with full implementation in September 1997. Business education and home economics will both commence implementation in September 1998.

The Ministry of Education published Technology Education Component in Integrated Resource Package (IRP; Province of British

Columbia, Ministry of Education, 1995a, 1995b, 1995c). There is an increased emphasis on providing students with opportunities to design and make products and systems using a variety of materials, tools, and technologies. The curriculum is consistent with international trends in technology education. The prescribed learning outcomes are to be integrated into the existing K to 6 curriculum along with home economics and business education. At Grade 7, schools may choose to offer one of the three applied skills components.

The technology education curriculum has four prescribed curriculum content areas: communication technology, production, control/energy and power, and self and society (O'Riley, 1996).

**Career and Technology Studies in Alberta**

Table 5 presents the recommended time allotment (minimum hours per year) in junior high schools (Alberta Education, 1995b) and the number of minimum credits in senior high schools (Alberta Education, 1995c) for each core course in Alberta, Canada. Instead of practical arts, career and technology studies (CTS) has been introduced as one of the complementary subjects.

Through CTS, secondary education in Alberta is responding to the many challenges of modern society, helping young people develop daily skills, while nurturing a flexible, well-qualified workforce.

**Curriculum Structure of CTS**

CTS is organized into strands and modules (Alberta Education, 1995a). Strands define competencies that help students:

- Build daily living skills.
- Investigate career options.
- Use technology (managing, processes, tools) effectively and efficiently.
- Prepare for entry into the workplace and/or related postsecondary programs.

**Program Philosophy/Rationale in CTS**

Modules are the building blocks for each strand. They define what a student is expected to know and be able to do (exit-level competencies). Modules also specify prerequisites and facility and instructional parameters, where necessary. Module learner expectations are a culmination of the specific learner expectations, which provide a more detailed framework for instruction. They define the scope and depth of knowledge, skills, and attitudes the student should acquire.

**The Situation Reviewed**

Recently, many countries have systematically introduced technology education as a subject or part of an integrated science, technology, and society education program from kindergarten to senior high school. This appears to be a world trend. In England and Wales, technology is represented through the subjects of design and technology and information from ages 5 to 18. There are also five cross-curricular themes of the national curriculum in England and Wales.

In Northern Ireland, science and technology as an integrated subject is offered from ages 5 to 11. In Scotland, students learn environmental studies, an STS-related and inte-

**Table 5**

***The Recommended Time Allotment (Minimum Hours per Year) in Junior High Schools and the Number of Minimum Credits in Senior High Schools for Each Core Course in Alberta***

| | Junior high schools minimum hrs./year | Senior high schools minimum credits |
|---|---|---|
| Language arts | 150 (15.8%) | 3 |
| Mathematics | 100 (10.5%) | 3 |
| Science | 100 (10.5%) | 3 |
| Social studies | 100 (10.5%) | 3 |
| Physical education | 75 (7.9%) | 3 |
| Complementary courses | 150 (10.5%) | 10 |
| Career technology studies | | |
| Fine and performing arts | | |
| Second languages | | |
| Native languages | | |
| Other | | |
| Health and personal life skills | [a] | |

[a] Health and personal life skills is a required course, but it is not necessary to offer this course each year. Therefore, it is recommended that health and personal life skills be offered for 150 hours or more over the three years, Grade 7 through Grade 9. Schools shall offer two provincially authorized complementary courses except where instruction in a language other than English is offered, then only one provincially authorized complementary course is required.

grated subject, from ages 5 to 14.

In Alberta, Canada, elementary science includes technology education. Schools have also invested in integrated science and technology education programs at the middle grades with focus toward providing 21st-century competencies for all learners. Secondary students learn integrated career and technology education. CTS still has a vocational education color in comparison to the U.K. and the British Columbia (B.C.) technology education programs.

In B.C., the Applied Skills Integrated Resource Package from kindergarten to Grade 12 provides a technology education component as part of the curriculum for the first time and establishes an articulated elementary to secondary level technology education program.

In Japan technology education is currently an ordinary subject only at the junior high school level. Unfortunately, there is no articulation of technology education subject matter and process from elementary to the upper secondary level. However, there is consideration of the inclusion of such a comprehensive program in the next revision of the Japanese national curriculum.

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