CHAPTER 3

INTERNATIONAL CURRICULAR APPROACHES AND MODELS IN TECHNOLOGY EDUCATION

3.1 INTRODUCTION

This chapter is aimed at identifying international models and curricular approaches in implementing Technology internationally. Its focus is on the implementation in sixteen countries, namely: The United States of America, Finland, The Netherlands, United Kingdom, Germany, Taiwan, Australia, Canada, France, Japan, New Zealand, Nigeria, Ghana, Botswana, Chile and South Africa. The aim is not to conduct a comparative study of the curricular of other countries but to establish the global trends. These countries were sampled because of the accessibility of literature. In accordance with the research aim and in particular with the second research objective, this chapter addresses the following question:

- Which international models or approaches exist in the implementation of Technology education?

Most countries have different rationale and approaches to the introduction of Technology education. Each country necessarily builds on its history of technical education and develops an approach within contextual limitations to suit the perceived needs of society and the individual (Williams, 1996:266; De Vries, 1999:3). A number of different types of framework have been proposed for examining Technology education in various countries. Four different types of justification or purposes were identified for the introduction of Technology education (Williams, 1996: 266; Black, 1998:3). These are:

- The personal development opportunities it provides for learners;
- The education for the technological culture in which we live, a significant rationale for Technology education in South Africa (Intrinsic value);

- The vocational dimension of Technology education is a rationale that comes and goes with the passage of time, and tends to correlate with period of economic depression; and
- Marxist philosophy (now being abandoned in Eastern Europe).

A curricular approach is the way Technology is taught in the classroom. It is a philosophy and definition of Technology, analyzing its assumptions and bias (Flowers, 1998:2). The author goes on to say that while there are many definitions of Technology, a number of them are oriented towards product design and problem solving approach. The curriculum model provides guidelines for what each learner should know and be able to do in order to be technologically literate (Oliver, Gilli, Mikos and Friday, 2005:4). The said authors are of the opinion that the curriculum model defines in measurable terms what it means for learners to be technologically literate. Gervase (2005:1) argues that a curriculum model aims to raise standards of Technology instruction by providing an outline that systematically matches what standards and critical concepts are learned with the appropriate course offerings.

3.2 APPROACHES TO TECHNOLOGY EDUCATION

Black (1998:3) and De Vries (1994:3144; 1999:3) proposed a number of categories of approaches to Technology education which have been previously cited in many contexts, including Williams (1996:266). Following the research on learners' attitudes towards Technology in twenty countries by De Vries, a variety of approaches/models were developed (De Vries, 1999:6). Each of the approaches enhances a certain view of Technology in the learners' mind and results in a particular view towards Technology (De Vries, 1999:6-7). Six different approaches were identified and these are:

- **Craft Oriented Approach**

Many countries started Technology using this approach. The main aim is to teach craft skills. Learners are given a drawing and they are required to make an artifact out of it.

The product or artifact has not been the results of the technological process (Design, Make and Evaluate). In South Africa this approach is mainly used at Technical colleges for the training of artisans. The social aspect of Technology does not come into play in this approach (De Vries, 1999:6).

- **Industrial Production Oriented Approach**

This approach originated in the Eastern European countries. The main aim of the approach is to prepare learners for the world of work in industry. The curriculum is dominated by Technology familiarizing learners with industrial processes, especially the use of tools and materials to address the needs of the socialistic society (De Vries, 1999:6).

- **Applied Science Approach**

In this approach, Technology is seen as the application of scientific knowledge. Science normally dominates Technology Education in this kind of approach. The process of transforming scientific knowledge into practical knowledge is often not explicit (De Vries, 1999:6).

Kimbell and Stables (1999:39) argue that integrating Mathematics, Science and Technology has three levels of interconnectedness. These are:

- Higher level: Fully integrated curricula
- Lower level: Systematical link of curricula
- Lowest level: Convenient connections between the curricula

Researchers such as Kimbell and Stables have undertaken some work in the integrating of Science and Technology both in the United States of America (USA) and the United Kingdom (UK). In the USA, the utopian ideal of full integration has been pursued for some years, but without conspicuous success (Kimbell, 1999:39). The level of Mathematics and Science that is needed even for complex technological tasks is not advanced. Technologists tend to see both Science and math as service disciples to be picked up as necessary according to the needs of the task. By contrast, Science and math curricula tend to prioritize the discipline for its own sake through understanding the language and elegance of math, or pursuing scientific enquiry.

Science is normally associated with Technology. This linkage is so common that Science and Technology are often assumed to share a common methodology and a common community of practitioners (Frey, 1995:59). Despite these perceived commonalities, Science is generally perceived to be superior to Technology. As educators implement Technology Education in public schools, they may find that the integrated curriculum is equated with Natural Sciences or competes with this learning programme. Now, even more, educators of Technology Education need a clear understanding of similarities and differences between Science and Technology (Middleton, 2000:3).

- **High Tech Approach**

The focus of this approach is on using complicated Technology equipment and kits. Examples include assembling and using automatic transmissions and robotics. Learners are able to use equipment and model operations without understanding the basic concepts. This approach creates in learners the attitude that Technology is there to be used without understanding how it works. The design process is limited in the sense that it deals with existing products (De Vries, 1999:6).

- **Design Approach**

The approach emphasizes the design process like the British curriculum system. The aim is to stimulate critical and creative thinking by giving learners open-ended problems to solve. The danger in this kind of approach is the lack of content where artifacts of an inferior level of sophistication are produced (De Vries, 1999:7).

- **Key Competencies Approach**

This approach is based on skills such as creativity, co-cooperativeness and working in teams that are required by industry. Industry needs such qualities for their future workforce. Technology Education is viewed as a discipline to develop these skills (De Vries, 1999:7). In the Pedagogical Technological College model approach, Technology is seen as a process of designing, making and using. The process is triggered by human needs as shown in Figure 3.1 below:

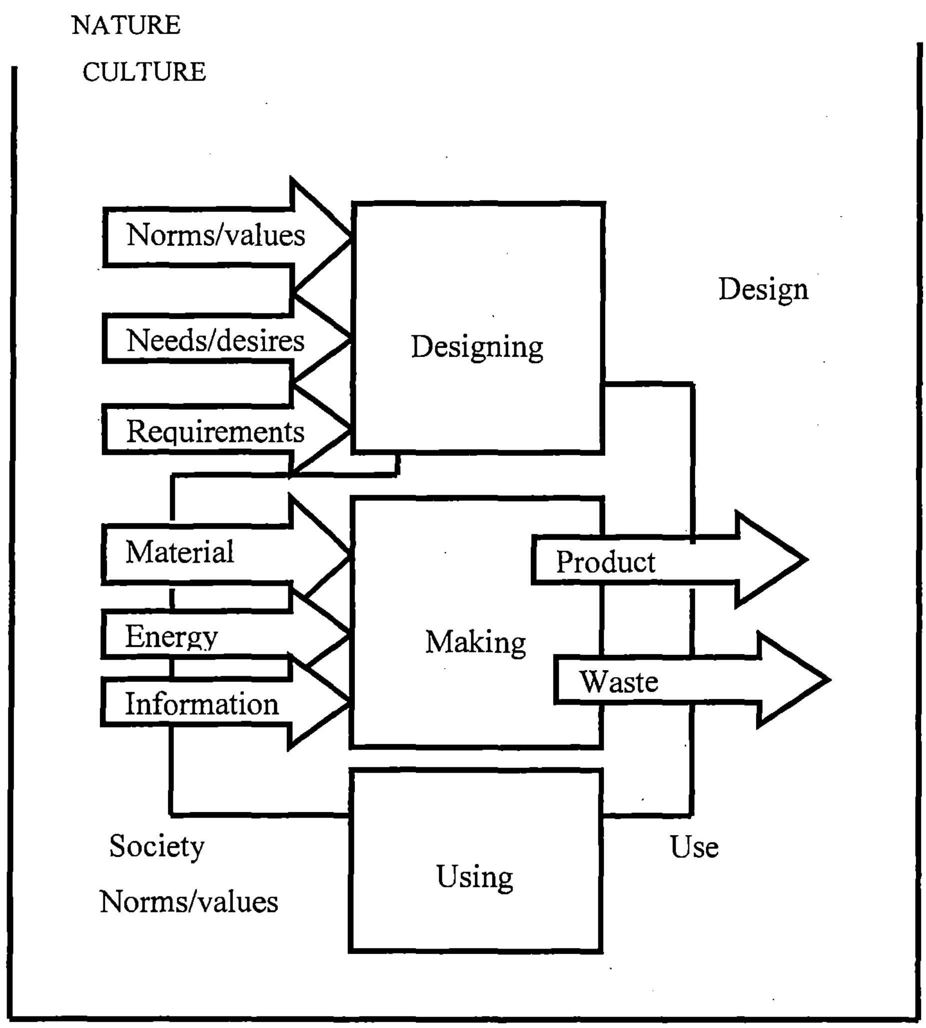

Figure 3.1: Schematic representation of Technology (De Vries 1999:8).

- **The Ort-Step model of Technology**

The model of Technology is presented in Figure 3.2 shown below in which the steps of the process are found. These comprise of Designing, Making (which comprises the use of tools and equipment, operating and testing); and Using (including maintenance and repair and evaluating and marketing). For designing the inputs are: human needs and wants; natural and technical resources and constraints (natural phenomena, the availability of materials and processes); economic environment; cultural resources and constraints (time, money, and people). When we make an artifact or product we use certain materials, energy and information. The off-cuts from the material used is termed waste.

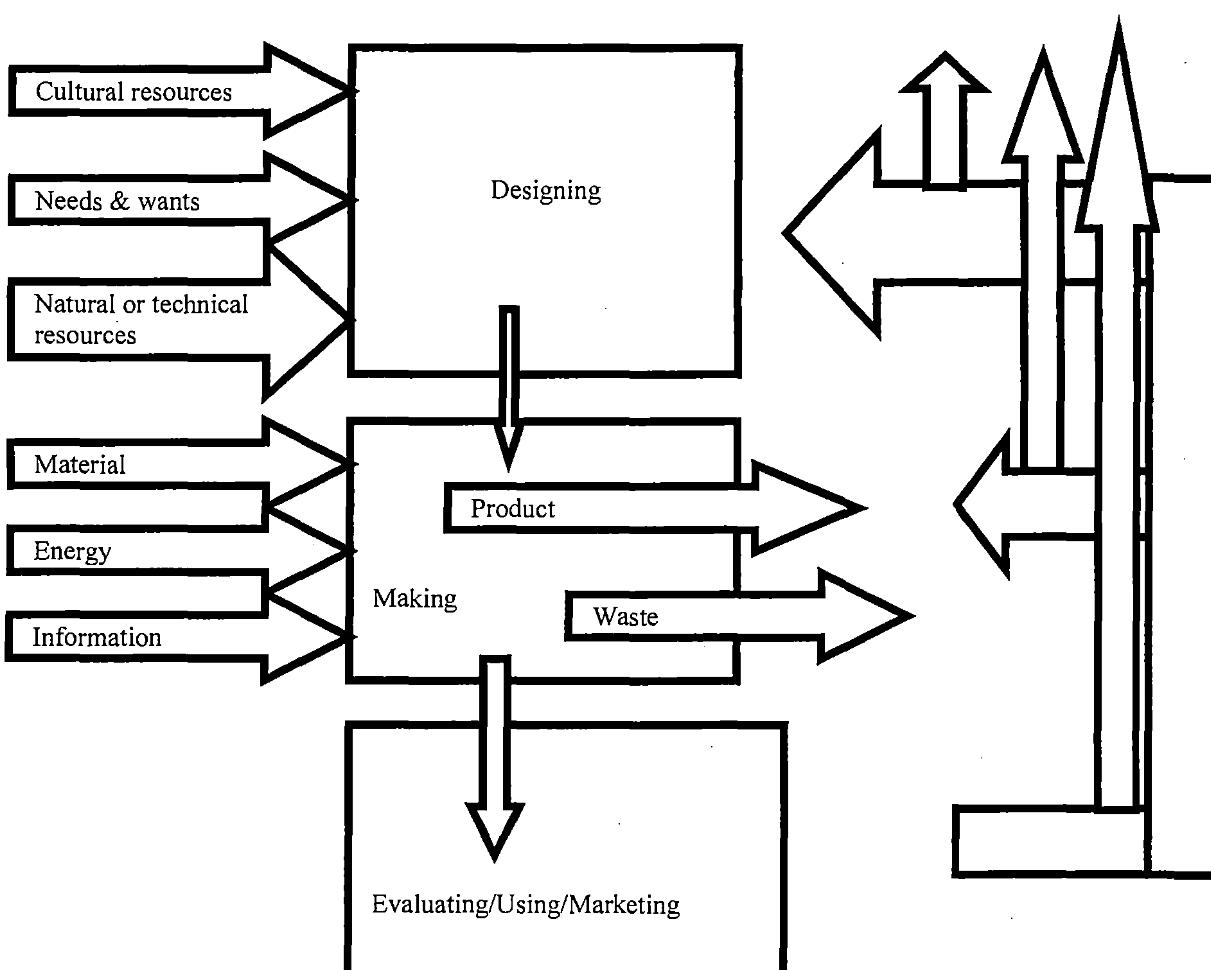

Figure 3.2: The model of Technology (Eisenberg and Waks 1996:4).

This approach is also similar to the Programme for Technological Careers Model (PROTEC) model or Systems approach model (Glover, Malahe, Middleton & Vawda, 1997:2). This is illustrated in Figure 3.3.

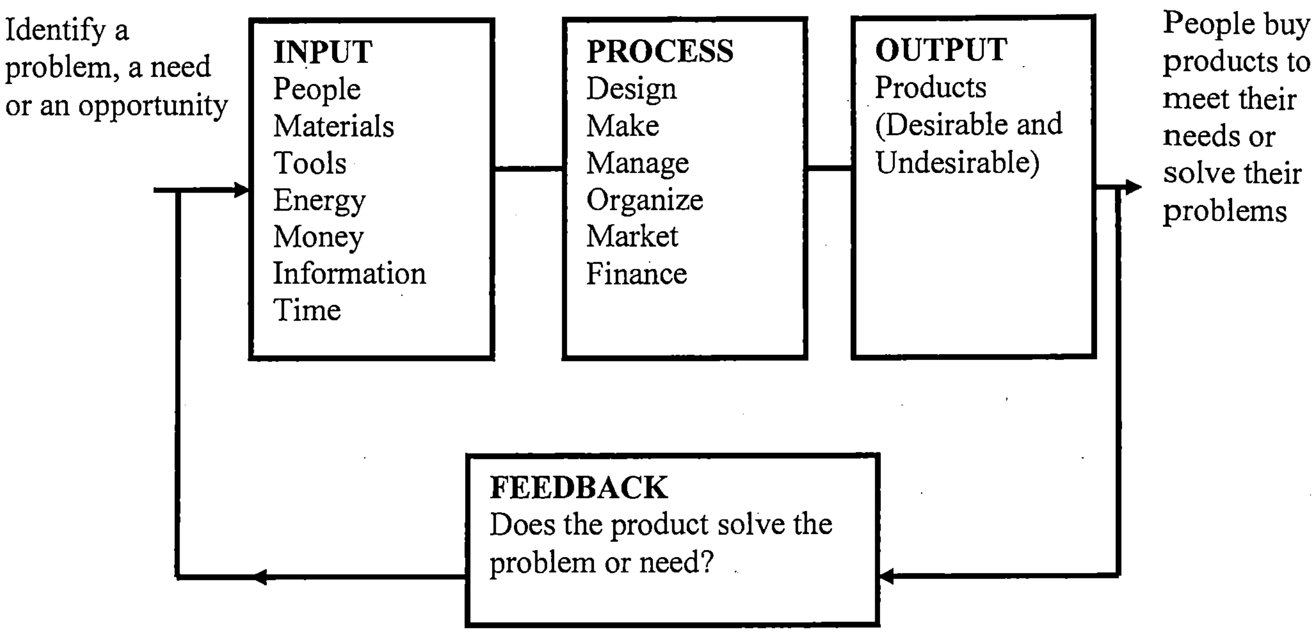

Figure 3.3: The Systems approach after Glover, Malahe, Middleton & Vawda (1997:2).

These approaches have different effects on learners' constructs and concepts of Technology. The following characteristics (De Vries, 1999:7) emerge as a result of the above-mentioned descriptions:

- The role of Technology is almost entirely absent in the learners' "natural" concept of Technology. This characteristic of Technology is only made explicit in the design, the key competencies and the Science Technology Society (STS) approach;
- The use of matter, energy and information usually is limited to matter in the learners' original concept of Technology. The energy component is made explicit if the applied science approach and both energy and information are made explicit in the technological concept approach;

- The relationship between Science and Technology is very unclear for learners when they enter Technology education and it is explicated most prominently in the applied science and the STS approach, although one-sided in both cases: the influence of Technology on Science is seldom dealt with;
- The learners do not recognize the process of designing, making and using originally. It becomes clear in the design and key competencies approach. The making process in isolation is present in the craft oriented approach;
- The relationship between Technology and society does not play a vital part in the learners' original concept of Technology. It is emphasized in the STS approach.

3.3 CURRICULUM MODELS IN TECHNOLOGY EDUCATION

Each of the approaches to Technology education described above must be implemented with a particular curriculum model. Different models are described for different countries.

3.3.1 The United States of America (USA)

In the USA, the educational system is decentralized with each state being responsible for its own education. The federal government provides some general control through funding guidelines. Some states pursue curriculum development and implementation at the state level, and others give broad guidelines with the actual curriculum work being done by the local school districts (Williams, 1996:269). The USA has a comprehensive system of schooling. Elementary school is from grade 1 to grade 6; junior high school is years 7 and 8, senior high school is years 9-12. Legally, the school leaving age is 16 (end of tenth grade), in the reality, however, the majority of learners do not leave then, but stay on to year 12 and seek to 'graduate' from high school (Kimbell, 1997:134).

The origins of the American Technology emanated from the craft, art and design culture like in the British case. The proponent of Technology as a school learning area was William Warner of the American Industrial Arts Association. He argues that industrial arts should not be narrow but should reflect Technology and be taught from pre-school to adulthood. The content proposed by Warner was Technology relating to power, transportation, manufacturing, construction, communication and management (Gradwell, 1996:240). In 1963 the vocational Act was introduced which allowed funding of curricular projects that show career education potential resulting in the growth of Technology Education. Lewis (1996:230) notes:

> *"The Industrial Arts Curriculum Project (IACP) was to begin to change school practice and curricular theorizing. The IACP did so through elaborate field-testing, and through commercialization of its product. Clearly the transition from industrial arts to Technology was possible and equipment and textbook manufactures began pushing the field, taking their cue from the new curricular ideas. However, there was a need to reconcile the competing versions of Technology. While the IACP offered manufacturing and construction as the organizers of the curriculum, De Vore and others were offering communications, production, power and energy, and transportation technologies as other organizer."*

Gradwell (1996:245) argues that during the American Revolution the scarcity of work, the high demand for work and the high price of labour, gave the American entrepreneur a greater inducement to replace labour by machines. Technological advances therefore formed the basis of change. To the machines came the people, first from Europe's shores and then from the farms that were once homesteads. It was time for a new dream. Domination replaced escape as the primary theme of the new freedom. Opportunity was no longer a matter of moving from one territory to another, but altering one's relationship to the machine – of domination where one has been dominated (Gradwell, 1996:245).

When Benjamin Franklin established his academy, he declared that education should ideally include learning areas such as surveying, navigation, bookkeeping and other learning areas, which had demonstrable usefulness. Dr. Benjamin Rush had similar ideas as well as he proposed that the curriculum should include learning areas such as modern languages, mathematics, history, logic, chemistry, philosophy, agriculture, government and manufacturing (Gradwell, 1996:255). The development of curriculum in the USA has to cope with the devolved structure that allows the states and the school districts to do their own thing. The project, entitled "Technology for all Americans" is pursing the following ambitious targets:

- The standards for Technology education will be developed with all kindergarten through twelfth grade learners in mind
- They will be organized around benchmark at grade four, eight, and twelve
- The project proposed to create educator enhancement and educator preparation standards, learner assessment standards and programme standards. (Kimbell, 1997:137). Only two states in the USA have compulsory Technology curriculum for learners. New York is the only state with a mandated junior high school Technology programme and Maryland has a mandated high school course.

The diversity in the USA makes it difficult to generalize, but it is probably correct to say that the bulk of the profession has not moved far away from an industrial focus identified with industrial arts and has not moved toward Technology. There are even fewer working with a focus on the process of Technology (Gradwell, 1996:255; Lewis, 1996:230). Developments in the USA are often the results of higher education and academic community deliberations than of grassroots origin. It takes longer for new initiatives to become common practice than if educators were more involved in the curriculum process. Williams (1996:271) summarizes forms of Technology education present in the USA as follows, from the specific to the general:

- Technology as a skill with emphasis on tool skills,
- Technology as a form that uses hands on and project activities,
- Technology as a learning area in its own right,
- Technology as an end in itself that provides conceptual frameworks for integrating content and skills learned in other learning area,
- Technology as a guiding theme that provides organizers for what learners are to learn, and

- Technology as a perspective or philosophical view point that includes a set of higher-level problem-solving skills.

The reality of Technology curriculum in the New York State is that there is virtually nothing happening at elementary level (primary school). There is a lot happening at intermediate level because of the mandatory curriculum, and there is very little going on in the senior high school since the Technology programmes are elective and relatively new (Kimbell, 1997:149).

3.3.2 Finland

In Finland, two technical learning areas are available in secondary schools – craft and technical work. These have not changed much from their introduction in 1886 and are generally out of date. But the system is on the verge of change with Technology being proposed as compulsory for all learners in both comprehensive and senior secondary schools (Williams, 1996:271). Technology is restricted to the Technology occurring mainly in the living environment of the learner. Cognitive activity is seen as the basis of manual skill development while thought and planning presuppose practical skills. These types of skills needed in everyday life are emphasized, such as creativity and critical ability to co-operate, responsibility, and ability to find things out independently and to arrive at justifiable conclusions. Practical work focuses on skills familiarization with technical terminology, understanding operating principles of tools and instruments, and problem-centered cognitive approaches particular to Technology (Williams, 1996:272). The dominant tradition in Technology is of industrial arts. Shop classes are more of industrial version of the woodwork and metalwork of former days in the UK. Learners will also be familiar with a range of electrically and pneumatically powered hand tools.

3.3.3 The Netherlands

According to Black (1998:5) and Rasinen (2003:7), Technology was introduced in 1993 in the Netherlands as one of 15 compulsory learning areas for all learners in the lower secondary school (12- to 14 year olds). The implementation was preceded by a two-year part time retraining programme for educators, coming from a variety of backgrounds for them to be prepared to take responsibility for the new learning area. The government also provided schools with funds to re-equip Technology laboratories. The learning area replaces earlier teaching based on craft skills with wood, metals, and plastics. Technology is studied from three different perspectives (Rasinen, 2003:7). These are:

- Technology and society;
- Technical products and systems; and
- Designing and making products.

Thinking and making skills are given priority (Lemmen, 1997:118). The Technology curriculum offers equal opportunities and appeal to both boys and girls (Huijs, 1997:107). According to Williams (1996:274), secondary education in the Netherlands is split into general and vocational, and the choice is made at the end of primary schools. In 1973 a general technique was introduced as a learning area, which basically gave learners the skills they needed for later vocational studies. The 15 compulsory learning areas that were introduced in 1993 were structured around attainment targets. The attainment targets for Technology were divided into three domains, each having various sub domains (Williams, 1996:275). The following are those sub-domains:

- Technology and society: daily life, industry, professions, environment,
- Dealing with technical products, working principles, technical systems, control Technology, using technical products, and
- Making functional work pieces: preparation of work, design making and reading technical drawings, working with materials and control of work pieces.

The curriculum, according to Williams (1996:276) was structured into six themes over two years to achieve the 180-hour time frame:

- Introduction to the learning area and the classroom, safety and basic skills,
- Introduction to computer use, mechanism and systems,
- Practical assignments on electricity in homes,
- Technology in my own room,
- Production lines, mass production, and
- Practical assignments on water in the home, heating, cleaning, clothing.

3.3.4 The United Kingdom (UK)

The United Kingdom comprises of four countries, namely England, Wales, Scotland and Northern Ireland. The education system in each of these countries is independent (Yamanski & Savage, 1998:1). This section focuses on Technology education in two of these systems because of the availability of literature. It is claimed that England and Wales were the first countries in the world to implement Technology education compulsory for all children between the ages of five and sixteen (Wilson & Harris, 2004:46).

It is also worth noting that beginning September 2002, Design and Technology was no longer a compulsory school learning area from age fourteen: the age, which marks the end of key stage 3 in the broadly based National Curriculum in England (Wilson & Harris, 2004:46). This latest development in Technology education in England, poses a challenge for this learning area, given its historical background. Historically, Technology education was perceived as a learning area for learners with less academic potential, who were supposed to acquire rigid technical skills (Hardwood, 2002:1). The learner enrolment in Technology education is increasing but there is a decrease in the number of universities offering Technology education degrees leading to a nationwide shortage of Technology educators (Gray & Daugherty, 2004:5).

3.3.4.1 Scotland

In Scotland the learning areas in the elementary programme comprise: language, mathematics, environmental studies, and expressive arts, religious and moral education. The attainment targets for environmental studies include understanding and using Technology in society, and understanding and using the design process. It must occupy a minimum of 25 percent of school time (Williams, 1996:276). Learning areas in the secondary syllabus related to Technology are scientific studies and applications, activities and applications. In the last two years of secondary school, the content of Technology is largely determined by the examination system. The learning areas that relate to Technology education are technological studies and craft and design, but these learning areas are not compulsory. There is a structure which permits an interdisciplinary approach to Technology that can be contributed to by a number of learning areas in the curriculum (Williams, 1996:276). Technology studies have the following goals in Scotland:

- To encourage the acquisition of problem solving skills,
- To develop learners' ability to apply a systems approach to practical problem solving,
- To allow learners to comprehend the evolutionary nature of Technology and the effect of Technology on the quality of life, and
- To highlight the role of Technology in manufacturing.

Studies in Technology consist of modular units in electronics, mechanisms, Technology and manufacturing and are composed of the themes of systems, communication, product analysis, energy and structures (Williams, 1996:276).

3.3.4.2 England

Technology was first introduced in England in 1990. However it experienced a lot of difficulties. It was revised in 1995, emphasizing the making of products. Technology was placed as a foundation learning area in the National Curriculum (Williams, 1996:276; Eggleston, 2002:14; Wilson & Harris, 2004:3). The National curriculum was revised in 2000 (Rasinen, 2003:5). A national examination is required, resulting in a General Certificate of Education (GCE) upon completion of compulsory education. Compulsory schooling is divided into four key stages. These are:

- Key stage 1 (grades 1-2, ages 5-7);
- Key stage 2 (grades 3-6, ages 8-11);
- Key stage 3 (grades 7-9, ages 11-14); and
- Key stage 4 (grades 10-11, ages 14-16)

Kimbell and Perry (2001:3) argue that Design and Technology (D & T) is about creating change in the made world and being capable of change making. Kimbell (1997:12) defines capability as *"that combination of skills, knowledge and motivation that transcends understanding and enables learners creatively to intervene in the world and improve it"*.

According to Reid (2000:39), Technology education implementation in England and Wales experienced the following problems:

- Very little content was specified; the guidelines were vague and open to interpretation; assessment was more difficult;
- The curriculum did not have a coherent knowledge of its own; and
- The learning area was difficult to implement. This implied bringing educators who had no real contact in the past and putting them under pressure to co-operate.

As a result of these implementation difficulties, a major curriculum review began in 1998 and the new curriculum was published in 1999. These early efforts in the UK made positive steps towards solving an international education problem.

3.3.5 Germany

In the former GDR, all learners went through a programme of activities in Technology. In years 5 and 6 there was a basic programme in technical drawing and material exploration. But from 7 years, the Technology programme was related to industry. The industry related programme was specifically designed to teach Technology through the vehicle of the industry. Technology was linked directly to local industry (Kimbell, 1997:114). There are generally three types of secondary schools. *Haptschule* (general secondary school, apprenticeship preparation, *realchule* and *gymnasium* (high school, university preparation), and about one third of all learners attend each type of school. Technology education does not exist in the gymnasium and not compulsory in the *realschule* (Williams, 1996:281). The aims of Technology education in Germany are to provide a functional knowledge about technical devices and processes and to teach Technology specific methodologies (Williams, 1996:281). The content includes:

- Systems – processing of matter, energy and information
- Methods of thinking and using Technology – representation and planning of Technology, production and use of Technology assessment of Technology, and
- Consequences of Technology-social, political and ecological.

Technology is taught through design and manufacturing exercises, technological experiments and assessment and evaluation.

3.3.6 Taiwan

The Republic of China was founded in 1911 and moved its seat of government from mainland China to Taiwan in 1949 (Lee, 1990:1). According to Fang and Yang (2001: 2) Technology is offered in the school system as follows:

In the elementary school:

- Fine arts / crafts grades 1 to 2 provided for 80 minutes per week; and
- Fine arts / crafts grades 3 to 6 provided for 120 minutes per week;

In the junior high school:

- Industrial arts grades 1 to 3 provided for two hours per week;
- Industry offered as an elective for two fourteen hours per week in grade 2; and
- Industry offered as an elective for twelve to seventeen hours per week in grade 3;

In the senior high school:

- Industrial arts grades 1 to 2 provided for two hours per week; at this level learners have to pass University entrance examinations to get further study opportunity.

In 1975 the curriculum standards of China were amended, art education and education were combined and named art and handicraft education (Huang & Chen, 2001:1). In Taiwan the name fine arts and craft arts were used before 1975 and 1995. The national curriculum in Living Technology for junior and high schools was announced in 1994 and 1995 respectively. In 1996 it was changed to fine arts and Technology education at primary school level. After the lifting of the martial law in 1987, people in Taiwan were offered the opportunity to get involved in public affairs, especially the revision of the national curriculum standard (Tsai & Yang, 1999:184). The new curriculum for junior high schools was implemented in 1997 and the one for senior high schools in 1999.

According to Huang & Chen (2001:1) the new curriculum had the following characteristics:

- Humanistic - emphasising normal teaching in accordance with the psychological development of learners. Piaget's development stages are taken into account to bring the learning area matter closer to the learner through simulations and play;
- Applicable – suggesting learners' works apply to their daily lives. Technology is taught within a particular context that is relevant to the learners to enable them to solve problems, design and make products;
- Prospective – corresponding to the current trend in Technology education in the world. Learners are exposed to international perspectives in Technology and the fact that Technology is very dynamic;
- Flexible – learner - paced and learner – centred. Learners are allowed to progress at their own pace to master the knowledge and skills taught;
- Interesting – offering diversified teaching materials and strategies to learners. By making Technology interesting learners develop a positive attitude towards Technology and this encourages learners to pursue technological careers;
- Individualized – emphasizing learners' learning diversity. Learning caters for the individual needs of learners permitting them to demonstrate the culmination of an outcome at their own pace ;
- Artistic – where learners' works are required to correspond to the artistic principles. Technology and art share the common process and emphasis is placed on the fact that products needs to be appealing to the customer; and
- Integrated – in accordance with Tyler's three principles of instruction: continuity, sequence and integration. Many opportunities are provided to link technology with other learning areas.

Educators are seen as key to the successful implementation of a new curriculum. The government has provided schools with additional funding for purchasing equipment (Tsai & Yang, 1999:186). Schools are sampled every year for evaluation and the report is given to educational authorities.

3.3.7 Australia

After the publication of a Statement on Technology for Australian schools in 1994, all educationally independent states and territories offered Technology (Williams & Kierl, 2001:155). Different states used various titles such as Technology education, Technological and applied studies and Technology and enterprise, but they all contain similar elements. States and territories of Australia are educationally independent and therefore have quite different educational systems, though the basic structure is six or seven years of primary and five or six years of secondary schooling (Williams, 1996:283). Technology is one of the eight learning area areas studied in schools. It is divided into four strands (Rasinen, 2003:4). These are designing, making and appraising, information, materials, and systems.

In Australia, Technology is often used as a generic term to include all the technologies people develop and use in their lives. Technology was designated as a key learning area, specified in four strands to include Designing, Making and Appraising, Information, Materials and Systems (Black, 1998:7). The guidelines for the learning area suggest that learners should:

- Build on their experience, interests and aspirations in Technology
- Find and use a variety of technological information and ideas
- Show how ideas and practices in Technology are conceived
- Explain technical languages and conventions
- Take responsibilities for designs, decisions, actions and assessments
- Be open-minded and show respect for individual differences when responding to technological challenges.

Williams (1996:284) and Williams and Kierl (2001:154) recognize the following trends in Australian Technology education:

- Recognition for a general type of Technology education to be a core and compulsory learning area for all learners in lower secondary studies;
- The lagging of primary developments in Technology compared to those at the secondary level;
- Vocational education has been the domain of colleges of technical and further education (TAFE).

The implementation of Technology education in Australia has been problematic. The biggest barrier is educators' lack of confidence in their skills, knowledge and experience of Technology education (Williams & Kierl, 2001:156). There is also a significant shortage of Technology educators in the short to medium term. Current interventions include special training programmes and government scholarships (Williams & Kierl, 2001:157). One of the features of the national curriculum is the 'learner outcome statements' that describe what a learner can achieve in Technology at different levels as they progress through their schooling (Kimbell, 1997:196). The planning framework for the year 7-10 curriculum is somewhat more complex since the secondary curriculum is more learning area – specific and involves the delineation of numerous statutory requirements. The formal requirements in NSW are that, within years 7-10, all learners should follow a course of study in design and Technology over 200 hours. Higher School Certificate (HSC), which apart from being a valuable school–leaving certificate is also designed to integrate with university entrance requirements. The course leading to HSC in design and Technology is made up of two components: the preliminary (year 11) course and the HSC course. The programme is built around a core of design strategies: designing, producing, evaluating, communicating and managing (Kimbell, 1997:198-206).

3.3.8 Canada

Canada consists of the following provinces: Newfoundland and Labrador; Nova Scotia; Prince Edward Island; New Brunswick; Quebec; Nunavut; Ontario; Manitoba; Saskatchewan; Alberta; Yukon; British Columbia; and North West Territories. Although there is non-agreement on how Technology should exist in Canadian schools, there is evidence that they respond to the local needs (Sharpe, 1994:117; Haché, 2005:1). The type of Technology, and the manner in which it is incorporated in schools, is largely determined by local budgets and the availability of educators. In the 1960s all provinces offered the similar industrial arts curriculum until the Technology education movement surfaced with views on introducing Technology in schools. Henry Ziel precipitated changes in the province of Alberta and Prince Edward Island (Haché, 2005:2). The province of Ontario adapted the British design Technology program while New Brunswick middle schools adapted the American based "Material and Manufacturing" style of Technology education. Other provinces were slow in adapting the changes to such an extent that they endorsed the name Technology education but continued to offer Industrial Arts programs (Haché, 2005:2). This happened throughout the 1970s and 1980s.

Canada is offering various Industrial Arts programmes and Technology full implementation has not been reached yet (Sharpe, 1994: 116). The emerging Technology programmes differ from province to province. This poses a challenge to pre-service educator education, as it has to respond to the developments that are taking place. There is also a misconception of overemphasizing the use of computers in the curriculum rather than recognition that information Technology is only but one of the areas of knowledge for Technology Education. Differences and diverse views on how to organize Technology education continue to be the national norm in Canada (Sharpe & Haché, 1992:239; Fardo, 2005:1). There are fundamentally two approaches that emerge in implementing Technology in Canada. These are:

- Views that promote Technology education as being founded in skill attainment; career selection; problem solving with the use of tools and acquire familiarity with the technological process; and
- Computers as a learning tool.

Chinien, Oaks & Boutine (2002:3) and Hill & Smith (1998:29) indicate that vocational education courses that prepare learners for industry are less prominent in secondary schools than they have been in the 1980s. Technology education programmes are laden with industrial type equipment and simulations that were often outdated and expensive to purchase. Qualified educators are difficult to recruit. This results in greater deployment of computer-based offerings in consort with Technology education programmes (Haché, 2005:5). Canadian educators are the agents of Technology change in Canada (Sharpe, 1994:116). Crafts, industrial art, industrial art combined with technological education, design Technology, computer education, science and Technology integration, Technology and vocational education hybrid continue to exist in Canadian schools (Yamanski & Savage, 1998:9). The provincial governments provide a basis for Technology education that fits into their setting and allow local interpretations.

3.3.9 France

After the French revolution and the process of industrialization, France's productivity was seen in a different light. The scientific era in France began during the Renaissance and the *Academie Francaise* was established in Paris in 1635 making France the first Nation to define scientific research as a career. Members who were supported by the king, established the French concept of the scientific as a state "*fonctionnaire*" thus leading the way for successive generations of scientists who would become instruments for advancing the interests of France (Gradwell, 1996:243).

France did not copy the British model of Technology but created something unique. The Polytechnique offered courses in Engineering and most young men were trained in this discipline. Not all schools strictly follow the national curriculum, but even in cases where the school is more autonomous there is a Science bias to Technology curriculum. According to Gradwell (1996:253), an upper level secondary Technology curriculum content includes the following:

- **External Study**: of objects and mechanisms including a critical analysis of performance.
- **Internal Study**: to determine an object's scientific principles, the function of subassemblies, how it is automated and the production of documents describing its use and maintenance.
- **Assembly and disassembly**: troubleshooting and repair.
- **Mechanical Attributes**: connecting, guiding, rotation, translation, transformation of movement, static and dynamic forces.
- **Industrial Design**: graphic representation and conventions. Pneumatic, hydraulic and electronic components.
- **Fabrication**: methods of moulding, hot and cold deformation, joining, separation, working and treating.
- **Automation**: IF, AND, OR circuits, components and Schematics.
- **Materials**: Mechanical, physical and chemical attributes and their modification by treating, transformation and use.
- **Metrology**: measurement and control from physical and geometric perspectives.

Technology education is a compulsory learning area for the four years of the junior secondary level, ages 11-15. Both boys and girls study it. Technology is offered for ninety to one hundred and twenty minutes per week (Rasinen, 2003:5; Joël, 2004:2). The first wave of Technology studies started in the period 1880 to1960, during which primary education was opened to the entire population. The second wave of implementation was during the period 1960 to 2000, when the junior high school filled the role of the middle school (Joël, 2004:2). Figure 3.4 shows the methods throughout the history of manual work in primary schools. The technical elements method involved a series of sewing stitches for girls and woodwork or metalwork for boys. The everyday items involved the making of objects such as boxes, Tablemats and pillowcases. In the geometrical elements method various shapes were drawn and created using paper as a material. The amusing things method involved the making of toys and dolls. In the logical elements method emphasis was placed on graphical representation of threads in braiding and weaving while the technical projects method involved the process of producing technical objects.

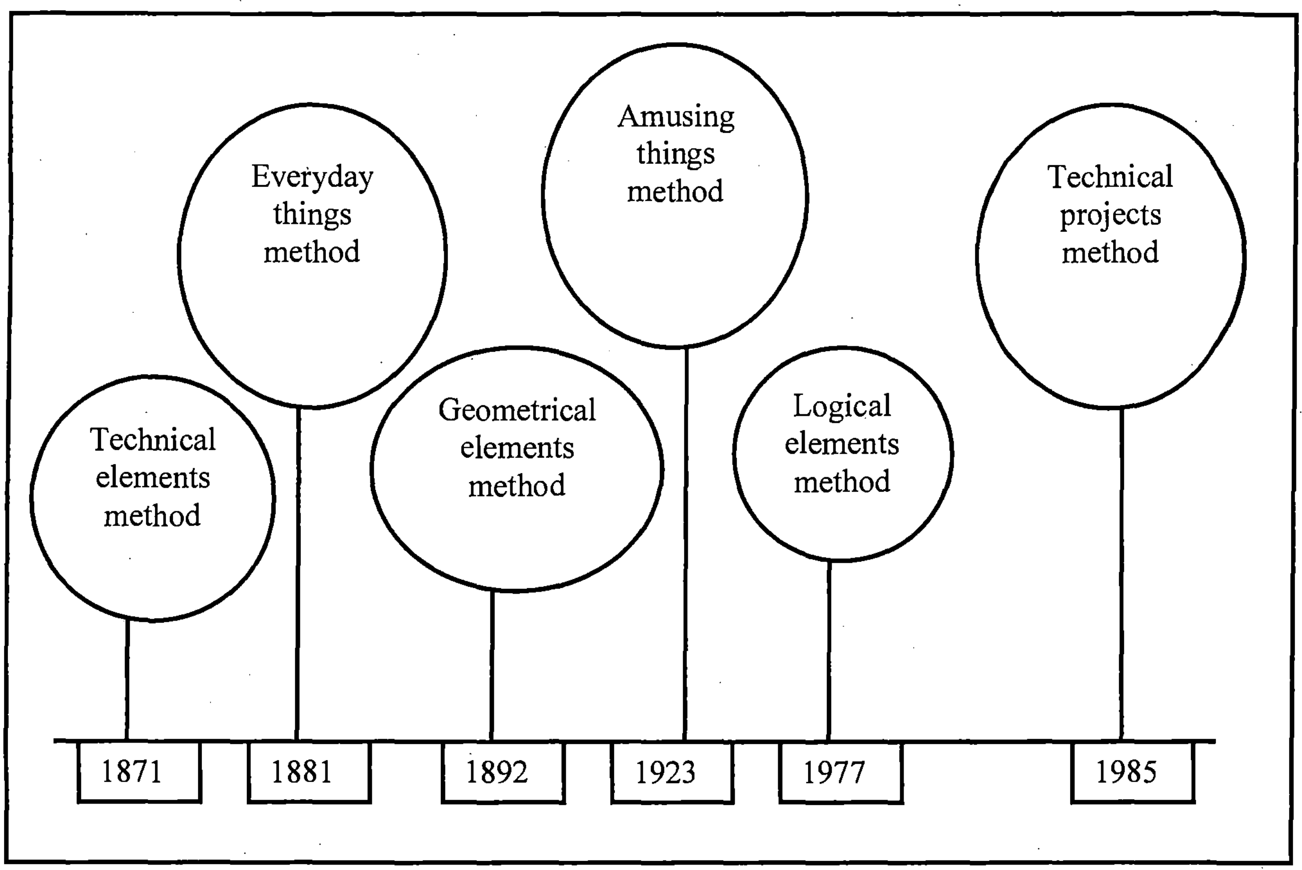

Figure 3.4: Successive methods throughout the history of manual work in French primary schools after Joël (2004:3).

However in the middle school Technology education was organized according to different methods from those of the primary school a shown in Figure 3.5 below.

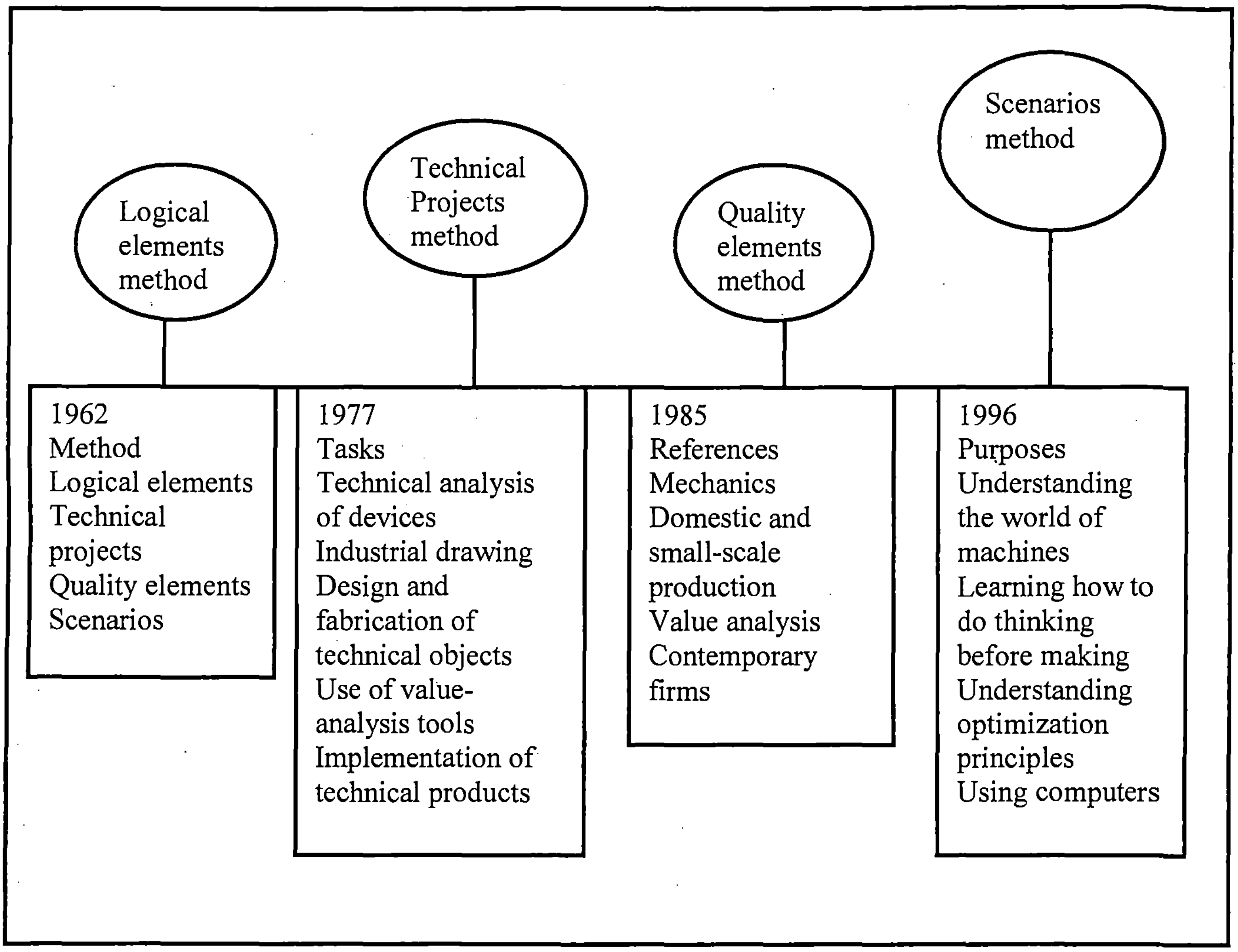

Figure 3.5: Methods used in the history of Technology education for French middle schools after Joël (2004:4).

The reason why Technology education was included within the compulsory school curriculum is linked to the question regarding firms, mass production, workshop activities and choice of field of technical practice (Joël: 2004:5). According to Ginestié (2002:99), the French schooling has two levels that is the elementary and secondary levels. The elementary school consists of three cycles, viz:

- The initial learning cycle (ages three to five);
- Basic learning cycle (ages five to eight); and
- Fundamental cycle (ages eight to eleven).

The secondary school consists of two cycles, namely:

- Middle school (ages eleven to fifteen); and
- High school (fifteen to eighteen for general education or fifteen to nineteen for vocational education).

According to Joël (2004:6), the history of Technology education reveals several principles for determining the progression of the curriculum. These are:

- It consists of repeating the same process in different technical experiences throughout the junior high school program;
- It consists of introducing school experiences gradually with more open-ended tasks: resources are increasingly scarce and technical projects are increasingly complex; and
- It consists of defining one generic technical area and then progressively introducing new and broader tasks.

From 1992 to 1999 Technology education was delivered through the Industrial Project Method (IPM). It is a very strong frame of reference in Middle schools (Ginestié, 2002:101). A brief description of the ten-stage model is highlighted below:

- A needs analysis validates the idea in terms of whether it fits with the needs of the user;
- A feasibility study by which these functions are transformed into technical functions with a description of the constraints applicable to each;
- Design is the phase to investigate technical solutions to answer to technical functions;
- Definition is the integration of use, functions, and structure into a global solution that defines the properties of the final product;
- Industrialization studies the organization of the industrial manufacturing of the product;

- Approval describes the internal and external processes to validate solutions in terms of normalization and standardization;
- Production is the phase of industrial manufacturing by which the company makes the products;
- Commercialization describes the product's distribution but also its advertising and marketing;
- Use concerns all studies about the product's use and maintenance; and
- Recycling studies the end of the product's lifetime.

Figure 3.6 shows the process involved in the IPM.

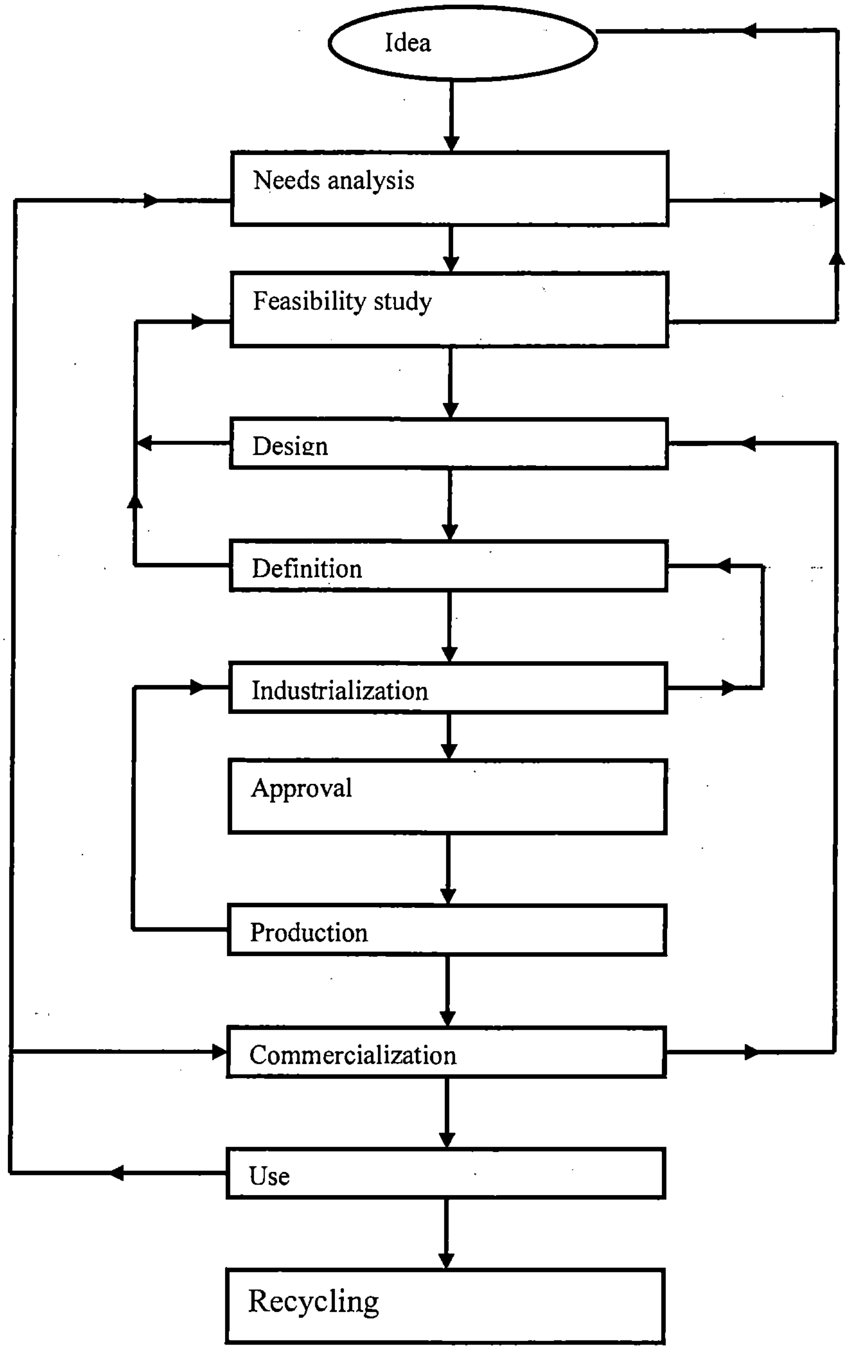

Figure 3.6: The Industrial Project Method after Ginestié (2002:103)

3.3.10 Japan

The structure of public education in Japan is based on the American model adopted after World War II as shown in Figure 3.7.

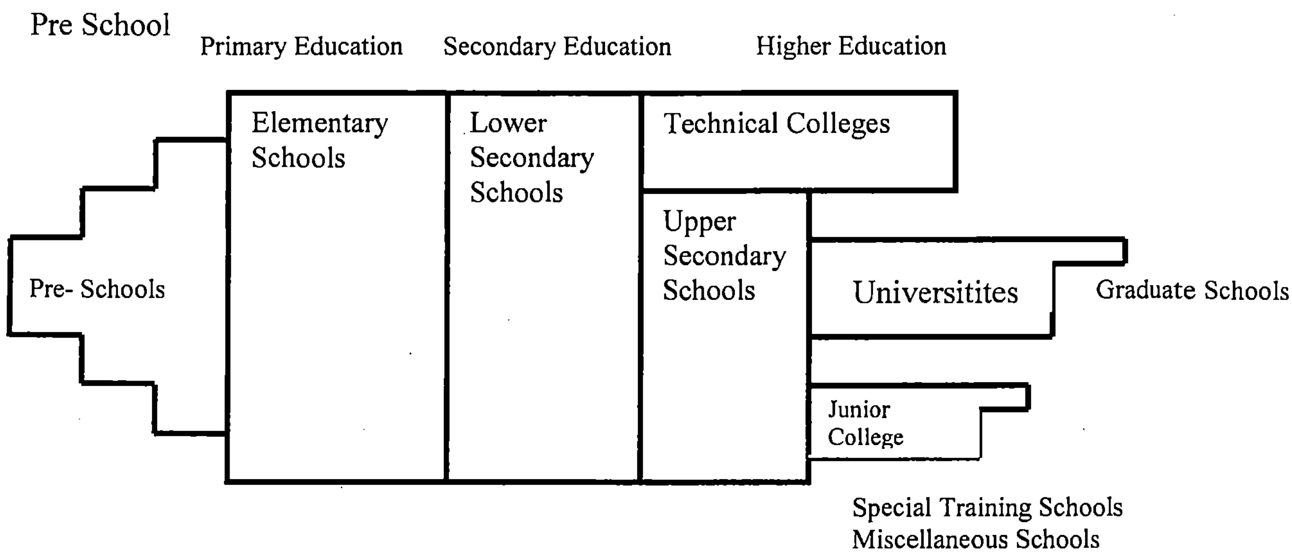

Figure 3.7: The education system in Japan after Murata and Stern (1993:29)

The elementary school (*shogukko*) is compulsory for the first six years and the lower secondary school (*chugakko*) lasts for three years (Murata and Stern, 1993:29). Changes in the Japanese Technology education can be viewed in the context of four eras:

- Economic reconstruction era;
- High economic growth era;
- Stabilized economic era; and
- International era.

These eras are shown in Table 3.1:

Era	Socio-economic conditions	Percentage enrolment in upper secondary	Percentage enrolment at college/university
Economic reconstruction	Shortage of housing and food	43% in 1950 51.5% in 1955	10.1% in 1955
High economic growth	Promotion of science and Technology; Rapid economic growth (10%)	57.5% in 1960 70.7% in 1965	10.3% in 1960 17.1% in 1965
Stabilized economy	Oil crisis (1971 &1974) Economic growth slows and stabilizes (3-5%)	91.9% in 1975 94.6% in 1980	34.2% in 1975 31.9% in 1980
International	Growth of micro-electronics and service industry; Internationalization of economy	94.1% in 1985 94.7% in 1989	30.5% in 1985 30.6% in 1989

Table 3.1: Socio-economic development and educational enrollments in Japan after Murata and Stern (1993:31).

Vocational education has been offered in both comprehensive and vocational secondary schools since 1958. The concept of the comprehensive school was an objective of the American Occupation education reform. This idea never became dominant in Japan (Murata & Stern, 1993:30). Japan improved its science and Technology following the successful launch of the Soviet satellite" Sputnik". In 1957 the government introduced Technology education (*gijutsu ka*) in all lower secondary schools (Murata and Stern, 1993:32). It had the following objectives:

- To help learners learn basic skills through productive experience;
- To foster skills for presentation, creation and rationale attitudes for problem solving; and

- To understand the relation between Technology and life and to foster attitudes for improving Technology and daily life.

In 1960, following Doubling the National Income Programme, the Japanese government established educators' colleges to respond to the shortage of technical educators. In the late 1980s the Ministry of Education (*Mambusho*) introduced new computer literacy courses in Technology education programmes. Textbooks used in compulsory schools and upper secondary schools are provided to learners at no cost. The national government provides subsidies to upper secondary schools equal to one third of the budget for facilities and equipment. As part of the Vocational Education Allowance Act of 1957, upper secondary vocational educators at public schools receive a special monthly allowance amounting to 10% of their monthly salary (Murata and Stern, 1993:35).

The following challenges are eminent in the implementation of Technology education in Japan:

- The entrance examination does not include content from Technology education. As a result parents regard the learning area as sub-ordinate;
- There is less time for instruction in Technology education as much emphasis is placed on entrance examinations; and
- Technology education is constrained by lack of resources, both financial and human.

The disadvantage of the implementation of Technology education in Japan is that it exists in the form of technical and vocational education. The design process is not evident in this type of approach. However, the curriculum responds to the needs of the country and its economy.

3.3.11 New Zealand

New Zealand's education system, a former British colony, has been influenced by the British school system (Reid, 2000:34). The schooling system is based on the New Zealand agricultural calendar, the breaks coinciding with haymaking in January; harvest/picking in May and lambing/calving in August. The technical high schools were established in 1910 in the major centers of the country. These types of secondary schools simulated the British tradition where middle class and academically strong learners went to the grammar schools and the working class went to the technical schools (Reid, 2000:34). In the technical high school, boys were offered pre-vocational streams of engineering, building or agriculture while girls were prepared in the commerce stream like typing, bookkeeping and domestic economy.

According to Reid (2000:35) the technical high school had the following drawbacks:

- Although technical education was commonly thought to give the learners who left school at the age of fifteen a useful start in industry, it was done at the expense of general and intellectual education;
- Pre-vocational courses were perceived to be for less able learners and had a low status;
- The Technology learned in industry did not help the learners in the world of work because equipment used was outdated;
- The teaching of technical learning areas required skilled teaching staff; and
- The curriculum did not encourage teamwork.

The curriculum in New Zealand underwent major reforms in 1990 under the banner *"the achievement initiative"* (Reid, 2000:40). A Ministerial Task Group was set up in 1991 and made a recommendation that a Technology curriculum be developed as an area in its own right. Consequently, the current Technology in the New Zealand curriculum was printed in 1995 and has been subsequently used in schools. However, the following problems were experienced with the implementation:

- The standard New Zealand primary classrooms do not have facilities to carry out some of the curriculum projects; and
- Re-training of educators is a problem as they come from diverse backgrounds, especially non-technical educators.

When the curriculum was designed, the planners explored ideas influenced by the curriculum reform in England and Wales. The development policy was a result of the wider community input and international research.

3.3.12 Chile

Technology education in Chile was introduced in 1996. It is a vertical learning area, compulsory during the first ten years of schooling for all learners, optional for learners of 11 and 12 grades (Elton, 2005:1). Technology is taught for two to three hours per week. There are no policies in place to ensure effective implementation. These include lack of inclusion of the learning area in initial and in-service educator education; research and monitoring. The absence of these policies had a negative impact on the performance of educators and the quality of learning of learners. Educators used the time allocated for Technology to teach other learning areas or were engaged with other activities not related to the learning area (Elton, 2005:1).

In the middle and upper school grades (5^{th} to 10^{th} grade), Technology is offered for two hours per week. Educators plan their lessons but lack of knowledge on the learning area makes their efforts meaningless. Initially the teaching of Technology was left to arts and craft educators. The reasons for this according to Elton (2005:2) are as follows:

- Simultaneously with the introduction of Technology education, handicrafts as a learning area was removed from the curriculum and its educators were given the responsibility of teaching Technology; and

- The first version of the Technology curriculum represented a slightly upgraded version of the handicraft learning area. This enabled educators to accept their new role without protesting the removal of their old learning area.

There is no strong partnership between industry and education. As a result, industry is not supporting the development of the learning area. Professional development of educators is the area that needs attention. Elton (2005:3) argues that an intensive in-service educator-training program needs to be put in place to solve implementation problems. This program should include:

- A collective knowledge about the learning area aims and contents;
- Knowledge about how to teach Technology;
- Awareness of the type of learning learners should acquire;
- Knowledge of what to look for when assessing learner performance and how to report back to learners and to the teaching plan; and
- Management and planning knowledge on enabling learners to reach the learning objectives.

Chile struggles to implement Technology because of non-commitment of various stakeholders in the curriculum. There is no clear distinction between Technology and the arts. The only commonality between Technology and the arts is the design process but the content differs. The only advantage with the approach in Chile is that they have build and developed on the knowledge and skills of art educators. This made it simpler for them to implement Technology on a larger scale (Elton, 2005:4).

3.3.13 Technology in Developing Countries

According to Lewis (2000:163), many countries are striving to establish Technology in their school curricula as a self-standing learning area. He further argues that school Technology needs to be relevant and contemporary. The need of Technology in the third world is more compelling than in the first world. Lewis (2000:166) is of the idea that Technology as a school learning area can be a vehicle for social transformation in the third world, narrowing the Technology gap between developed and undeveloped countries. He goes on to say that this gap could be narrowed through a combination of Technology transfer, reverse engineering and new creation.

There are normally two approaches to teaching Technology education in most countries. These include the process approach (England and Wales) and the content approach (American pre-occupation curriculum). Lewis (2000:168) contends that a combination of these approaches might be the way to view the learning area in the developing world. As in developed countries, the origins of Technology point to craft or industrial arts learning areas (for example woodwork; metalworking and drafting). Drawing upon the case of Nigeria, Williams (1996:280) indicates that Technology at the elementary level involves learners making, repairing and assembling technical objects. Lewis (2000:170) warns that the major obstacle to Nigeria's self-sustained social and economic growth is the lack of indigenous capacity to assimilate and create Technology. The lesson to be learned from Japan is that the first response of the third world countries to introducing Technology into the curriculum ought not to be to discard the old industrial arts curriculum.

Lewis (2000:174) contends that one major difference between developing and developed countries is that in the former, learners do not often get beyond the primary level of schooling. Thus serious considerations should be given in these countries to the inclusion of Technology education at an early stage.

3.3.13.1 Nigeria

Nigeria is a former British colony, which simulated the British education system until a new education policy was adopted in 1982 (Akubue, 1995:1-2). After its independence technical secondary schools were established to develop high-level technicians (Naidoo & Savage, 1998:3). Akubue (1995:3) is of the idea that Nigeria is among a growing number of countries recognizing the vital role of Technology education in national growth.

According to Williams (1996:280) the objectives of Technology in Nigeria at elementary level are:

- To provide a basis for development in Nigeria;
- To prepare learners for the circumstances they will meet in later life;
- To provide training in scientific and logical reasoning;
- To enable schools in Nigeria to produce people who are adapTable and who have a favourable attitude towards innovation;
- To develop learners whose daily activities will center around manual work and who will inculcate in others the right attitude to working with their hands; and
- To stimulate curiosity and creativity, and to develop the problem-solving ability of learners.

Nigeria is in the process of implementing Technology education. The objectives are very clear but implementation is not yet at an advanced stage. The challenge lies in implementing Technology education in a manner that does not compromise its goal (Khumalo, 2004:36). The disadvantage with the approach in Nigeria is that they do not differentiate between technical and Technology education. The design process is not evident in the craft approach. The wheels are turning very slow to implement Technology with emphasis on critical and creative skills. The advantage with the Nigerian model is that they have localized the curriculum to respond to the needs of the country.

3.3.13.2 Ghana

The education system of Ghana has undergone several stages of development. The most significant change is the phasing out of the O-level and A-level system based on the British model and introducing a new senior secondary system (Sedgwick, 2000:1).

From the mid 1970s until 1990, the education system in Ghana consisted of the following phases:

- Six years of primary schooling
- Five years of secondary education
- Two years of A-level schooling

In 1990, the additional reforms created a new three-year senior secondary system alongside the O-levels and A-levels while lengthening tertiary education to four years. Technical education is used to equip learners with mechanical skills, with little or no emphasis on critical and creative thinking (Naidoo & Savage, 1998:3). Technical education still exists in Ghana. Although there is an attempt to shift to Technology education the disadvantage with the approach in Ghana is that they do not implement Technology fully because the form of Technology education is dominated by technical and vocational education. The attempt to shift to Technology education is therefore taking place at the snail's pace.

3.3.13.3 Botswana

After Botswana's independence in 1966, vocational education was introduced at secondary school level. The curriculum was modified to include traditional crafts learning areas such as woodwork, metalwork and technical drawing. Finally, Design and Technology was introduced into the curriculum, shifting from traditional craft learning areas (Ndaba, 1994:109). Botswana modified the rational borrowed from UK to suit her local context.

In 1987 technical studies was offered in the junior secondary schools. Design and Technology (D&T) is not taught in primary schools in Botswana. The learning area is introduced to learners when they reach junior secondary level (Setabo, 1996:1). It was introduced as craft, design and Technology in 1988 and in 1996 as Design and Technology (Williams, 1996:280). At the senior secondary school, D&T is offered as an optional learning area. At this level the learning area is taught to those who want to become educators of D&T.

D&T was introduced with the goal of encouraging learners to think of design as a logical process in which a number of steps can be identified. These include investigate-design-make-evaluate. The aim of introducing Technology in the curriculum was to inculcate the following skills identified by Williams (1996:280):

- Enquiry and exploratory skills;
- Communication skills;
- Manipulative and evaluative skills; and
- Discriminatory skills.

In 1990 Design and Technology (D&T) was piloted in five Senior Secondary Schools (SSS) and sixteen community junior secondary schools (CJSS). It has replaced the traditional learning areas and full implementation has been achieved at CJSS. When D&T was introduced workshop equipment were already available as they were originally used for traditional craft learning areas. The new secondary schools have been custom designed for D&T environment. The implementation of D&T in Botswana was not smooth as they encountered problems with educator shortage. Qualified educators for D&T had to be recruited from Britain and other neighbouring African Countries. The wheels of training local educators were turning very slow as they produced twenty five educators per annum for CJSS and only eleven educators in eight years for secondary schools (Molwane, 1993:118-122; Ndaba, 1994: 109-114).

Another problem encountered with Technology implementation was that the feeder schools (CJSS) were offering a completely different curriculum to that of the secondary schools. The CJSS curriculum is based on the American model of Industrial Arts while the secondary school curriculum is based on the British model of Craft Design and Technology (CDT). The past school vocational education is based on the German system. The challenge for Botswana is to take the notion of D&T, which was borrowed in the United Kingdom and place it in the local context. The advantage with the approach in Botswana is that there has been a complete shift from technical to Technology education. The learning area is sustained by ensuring that an annual budget is put in place for Technology and by allocating personnel for support.

3.3.13.4 Technology in South Africa

Prior to 1994, the education system in South Africa was organized along racial lines. The learning areas which are the forerunners of Technology such as technical learning areas were not promoted particularly in rural schools where the majority of African learners are educated (Stevens, 2002:2). Very little provisioning was made in these schools and the few that offered learning areas with a practical orientation were found in urban areas, reserved for white children (Stevens, 2002:2). Technical education has its roots in the mining industry that had links with the South African College (now the University of Cape Town) in 1894 (Schafer, 1999:72). Schafer further contends that after the Higher Education Act of 1923 was passed technical and vocational education were taken over by then Union Education Department. The university was seen as an exclusive institution for whites only to acquire technical skills in mining engineering and associated skills. In 1948, the Nationalist party came into power and promulgated education acts that accommodated the majority of Africans. Chisholm (2003:2) is of the opinion that technical education was used to provide learners with hands-on skills but at the same time preparing them for supervisee roles in the apartheid era. Technical education was offered in technical and comprehensive secondary schools as well as in Technical colleges. Whites were prepared in higher education institutions for supervisory roles.

It was an education issue that sparked the "Soweto uprising of 1976" leading to continual unrest in black schools fifteen years thereafter. The government initiated a commission into education but rejected the recommendations of the Human Science and Research Council (HSRC) in 1982 (Stevens, 2002:3). The commission recommended a shift on formal education to a more appropriate skills-based vocational curriculum. The Walters report of 1990 recommended significant changes to the curriculum especially the changing of basic techniques and technical orientation to craft, design and Technology after the British model (Stevens, 2002:3). The Education Renewal Strategy (ERS) of 1991 made similar recommendations of introducing Technology as one of the seven learning areas in the General Education and Training Band (Anckiewicz, 1995:247). A national task team was appointed in 1994 to spearhead the introduction of Technology in 1994. Their project was called Technology 2005 (T2005) and was tasked to develop curriculum materials and pilot them in all provinces (Stevens, 2002:7). Before the project committee came with the recommendations on how Technology education could be implemented in South Africa, Technology was pronounced as one of the learning areas of Curriculum 2005 (C2005). National pilots were conducted from grades 1 to 3 and 7 and 9 in the second half of 1997 in preparation for full-scale implementation in 1998. The implementation was supposed to be completed in 2005 in grade 12 hence the name C2005 (DoE, 2000(a):3). Many problems were encountered during the implementation of C2005 and necessitated a review in 2000 (DoE, 2000(a):20). At the time of the review, the first outcomes-based education had not been fully implemented to all grades because full implementation was set for 2005. The existence of Technology education was threatened with extinction. The review committee suggested that Technology should be either integrated with Economic and Management Sciences (EMS) or Natural Sciences (NS) (DOE, 2000(a):21).

The inclusion of Technology as a separate learning area in the Revised National Curriculum Statement (RNCS) came from the cabinet. The cabinet rejected the recommendation of the review committee to drop Technology in the curriculum. This is a good indication that there was a political will to promote Technology education (DoE, 2000(b):6). Howie (2001:44) lists the following problems encountered with implementation of C2005:

- Educators taught the new learning areas through their old objectives and content based approach;
- In cases where schools and Technology educators embraced learner-centred approaches, the original vision of C2005 was lost in the process of implementation;
- Very few educators had first-hand knowledge of the kind of Technology education envisaged in the policy;
- Very few schools had the capacity to manage Technology as a new learning area;
- The attention paid to integrating Technology with other learning areas, led to the loss of progression of concept development from grade to grade;
- Continuous assessment (CASS) was interpreted by some educators as frequent testing, and that resulted in the inevitable problem of accounting and record keeping in the classroom, distracting educators from teaching and resulting in less learning taking place in Technology;
- The training progress and support for Technology educators were inadequate and often did not model the approaches they were promoting in teaching Technology; and
- Within C2005, the implementation of Technology was criticized for its top-down bureaucratic approach to the policy document and for not recognizing the educators' experience and professional insights as inputs to their learning.

Stevens (2002:8-9) lists the following factors as having a constraining influence on development of Technology in schools and in educator education in particular:

- The transformation of the South African curriculum in the form of C2005 made it difficult for the new learning area to attract the necessary attention and resources to establish itself in the curriculum and in schools;

- The loss of non-governmental organizations (NGOs) who performed a vital role in championing Technology in providing educator education programmes;
- The ending of the T2005 project meant that Technology lost its most direct channel of communication with the education authorities;
- The major upheavals and changes in the tertiary education landscape has dangerously destabilized educator education programmes especially on the supply of Mathematics, Science and Technology (MST) educators;
- The focus on MST learning areas towards the late 1990s has, ironically, not favoured Technology. Technology is reduced to computers; and
- There is no general Technology learning area at secondary level (FET) in South African institutions. The creation of such a curriculum may inevitably inspire the development of similar tertiary interdisciplinary courses, which may assist in alleviating the shortage of suitably educator trainees.

In a research conducted by Stevens (2002:10) on Technology educator education survey in South African tertiary institutions, the following findings emerged:

- A majority of the tertiary institutions are offering educator education in Technology but there are significant exceptions, such as some of the prestige universities scaling down their educator education programmes in favour of research;
- The teaching staff on Technology education courses represents a mix of technical/vocational and academically trained personnel. This represents an opportunity for a rich tradition to emerge. A significant number of institutions employ part-time lecturers to deliver the courses. Some employ partners to provide education to Technology educators nearer their places of work;
- Some institutions offer only in-service programmes and some only pre-service programmes, but many offer both, attempting to respond to the critical shortage;
- Many of the programmes suffer from a severe shortage of staff. There are very few institutions with more than three Technology education staff members, thus limiting the opportunities for research and development of the field;

- There is a wide range of interpretation of what counts as relevant content educator education in Technology;
- There is a wide range in length and duration of courses, even where equivalent qualifications are offered; and
- Very few institutions have access to well resourced Technology facilities.

The RNCS commenced in January 2004 for grades R –3; grades 4-6 in 2005 and grades 7, 8, 9 in 2006, 2007 and 2008 respectively. It is anticipated that, the first group of learners who have been exposed to Technology education through the implementation of RNCS, will exit the education system in 2008 (Howie, 2001:47). In the FET band, The National Curriculum Statements (NCS) is being implemented in grades 10 -12 in 2006, 2007 and 2008 respectively. In 2002 the Minister of Education published a draft National Curriculum Statement for comment by the public. The input by stakeholders led to the development of Civil Technology, which was omitted in the original policy for Technology learning areas (DoE, 2003 (b):1). The age of learners in this band ranges from 16 to 18 years. (DoE, 2004:7).

3.14 SUMMARY

In this chapter, literature has indicated that the implementation of Technology education is becoming a common phenomenon internationally. Technology as a new learning area in most countries studied does not have a history in the general education. In the FET band, it has its roots in technical and vocational education such as in Japan, Ghana, Nigeria, Taiwan and USA. The tradition has also been gender biased. In most countries hand skills rather than intellectual skills, which are required to prepare learners for Higher Education Institutions, take priority. Globally there is lack of consistency in the FET band regarding the essence of Technology education. This is exacerbated by the challenge of lack of human and physical resources. In all countries studied, even developed countries have problems with human and physical resources. The provision is normally not sufficient to enable educators to complete the desired projects. Some equipment used by schools are outdated and do not simulate the equipment used by industry. This defeats the purpose of Technology to be contemporary. However, in developing countries like Ghana and Nigeria the implementation of Technology education was seen to be affected by its own sets of political and socio-economic factors. These led to the delay of implementation of Technology education.

In most countries studied, Technology at the primary level is not a separate learning area, but it is integrated with other learning areas. At the secondary level it is a learning area on its own although integration with other learning areas is visible. In the primary school it is allocated a period of two hours per week and in the secondary school it is allocated 180 hours. In South Africa the shortage of human and physical resources has been identified as a challenge facing the implementation of Technology. However, in England and Wales, where Technology has been implemented for a number of years, it is taught as a separate learning area at the primary level. Educators are being supported through in-service training to update their knowledge and skills.

It is also evident in the countries studied that Technology at junior and senior secondary schools is taught by specialized learning area educators although integration is emphasized universally. The researcher is in total agreement with a picture of effective practice espoused by Williams and Kierl (2001: 157).

- Effective Technology education is guided by curriculum frameworks and curriculum statements and is supported by resource material and the local school administration;
- The Technology programme is linked with other curriculum areas and the community;
- A range of different learners' learning styles are catered for through open ended tasks that are placed within contexts that are meaningful for learners;
- Learners are encouraged to use a range of processes in their Technology activities and reflect on the adequacy of processes followed; and
- The assessment of learners is an intrinsic part of the learning experience by being explicit and fair, and providing feedback useful for future development.

According to Williams (1996:286) there are a number of trends in Technology education, which are obvious in a number of countries. These include the movement from:

Educator as information giver	Educator as facilitator of learning
Educator controlled learning	Educator learner partnership
Educator centred learning	Learner centred learning
Time, age and group constraints	Individualized learning
Materials-based organization	Needs based activity
Product centred	Process centred
Elective area of study	Core learning area and
Social irrelevance	Socially contextualised

Table 3.2: Trends in Technology Education after Williams (1996:286)

Given this identification of the types of trends, it goes without saying that there is diversity throughout the world in Technology education. This diversity ranges from an instrumentalist approach (Finland) to a humanistic approach (Scotland), a focus on content (USA) to a focus on the process (UK), an economic rationalist perspective (Botswana, Taiwan) to a more liberal philosophy (STS in the USA), a staged and well supported implementation of change (South Africa) to a rushed and largely unsuccessful implementation (England) and a discreet learning area (Australia). A hybrid of these approaches would be good for the implementation of Technology in developing countries because they would have learned from the mistakes of developed countries.