

## **CHAPTER 2**

### **REVIEW OF LITERATURE: CRITICAL ISSUES IN THE IMPLEMENTATION OF TECHNOLOGY EDUCATION WORLDWIDE**

#### **2.1 INTRODUCTION**

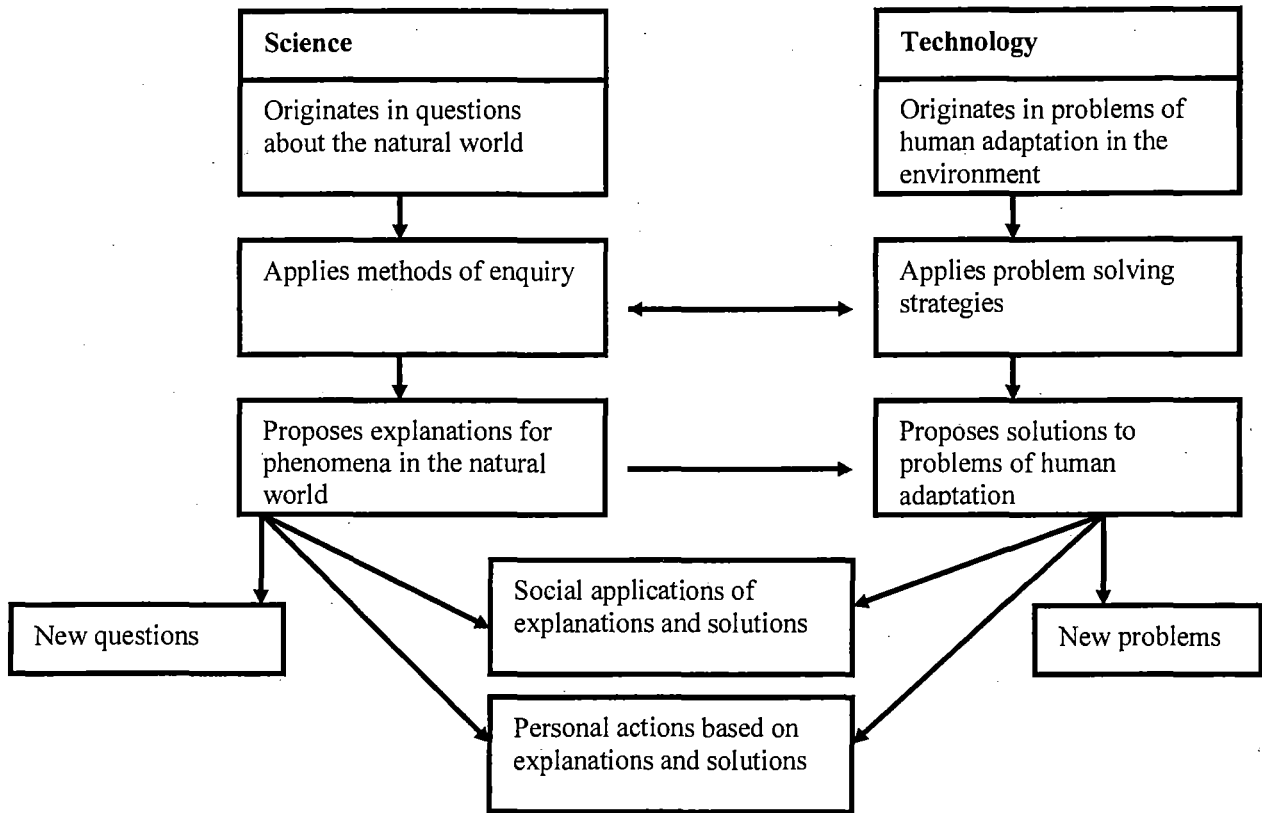
This chapter aims at identifying the crucial issues in implementing Technology education internationally. In accordance with the research aim and in particular with the first research objective, this chapter addresses the following question:

- What are the critical issues in the implementation of Technology education in schools worldwide?

This question is subsequently dealt with.

#### **2.2 THE RELATIONSHIP BETWEEN TECHNOLOGY AND SCIENCE**

Technology is often confused with science. It should however be noted that Technology is also not the application of science (Jarvis & Rennie, 1998:272). Technology activities can provide contexts for introducing science concepts and demonstrating that Science is relevant and socially important. Technology can be used for teaching Science and vice versa (Ginns, Norton & McRobbie, and 2005:47). Driver, Leach, Millar & Scott (1996:47) point out that many people see Science in an instrumental way, as a means of improving the human condition and finding cures for diseases. In general, they cannot differentiate Science and Technology. De Vries (2005:149) is of the opinion that technological knowledge has a normative component that scientific knowledge does not have. He argues that if we have knowledge of the computer that comprises normative judgements: it functions well or it does not function well. For scientific knowledge truth is the ultimate condition. For Technology education the normative component is important. Learners must learn to make judgements about effectiveness, as this is a prominent characteristic of Technology education that makes it distinct from scientific knowledge. Technology uses knowledge from a variety of disciplines including science. Clarke (2005:2) highlights the following distinctions between Technology and Science:



**Figure 2.1: Technology- Science Relationships (Clarke, 2005: 2)**

De Vries (2006:3) argues that a barrier for enhancing the relationship between Science and Technology is the background of teachers. In many cases, Technology teachers have a non-Science background. This had an influence on the nature of Technology education. Eisenberg and Waks (1996:5) argue that Technology and Science are related in the sense that Science provides knowledge of natural phenomena that are used in Technology. On the other hand Technology provides Science with new fields of research that can lead to new inventions. Eisenberg and Waks (1996:5) highlight the following differences between Science and Technology:

Science	Technology
Explore existing phenomena to reach new knowledge	Design new products that did not exist before
Curiosity driven	Need/want driven
Works with an idealized and simplified world	Works with the real complex world
Looks at the truth, accuracy and the ideal as criteria	Looks at effective solutions, effective and within acceptable tolerances as criteria
Looks for uniform knowledge, that applies everywhere in the same way	Looks for solutions that are optimal for a specific situation

**Table 2.1: Technology-Science relationship Eisenberg and Waks (1996:5)**

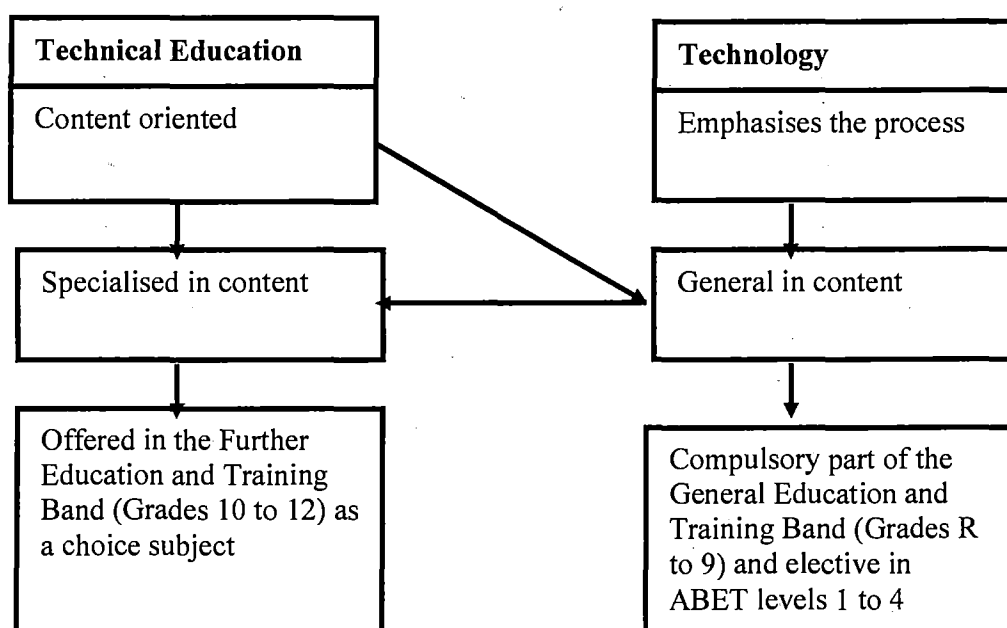
Given these fundamental differences, it goes without saying that Technology education should be different from Science education as it has its own body of knowledge and skills (Ankiewicz, 1993:126; Stein, Campbell, McRobbie, & Ginns, 1999:105) and should therefore be different from Science. Ankiewicz (1993:126) argues:

*‘The subject Technology should be viewed as a subject with its own epistemology, philosophy, aims, identity, structure, method of inquiry, curriculum, didactics and opportunities for the promotion of problem-solving and other higher order cognitive skills.’*

The researcher is in total agreement with Gardner and Hill (1999:217) when they say that we need to understand the difference between subject matter integration and subject matter specialist. They argue that other countries have adopted different responses to the integration/specialization issue. These include the United Kingdom, Australia and New Zealand where Technology studies have been identified as subjects in their own right, throughout all the years of schooling. Integration is still desirable, however it should be without being carried through to the point where the distinctive character of Technology may be lost.

### 2.3 THE RELATIONSHIP BETWEEN TECHNOLOGY EDUCATION AND TECHNICAL EDUCATION

In developing the technological capability of learners, a lot of knowledge and skills is drawn from technical education to enable them to engage meaningfully in the technological process (HEDCOM, 1996: 12). The term vocational education refers to the education that is aimed at preparing the learner for the technical or commercial field (HEDCOM, 1996:28; UNESCO, 2007:1). Technical subjects like woodwork and metal work have a content that is specific to certain occupations; e.g. carpentry and welding. All these subjects have a specialized content. More recently, the designation Manufacturing, Engineering and Technology has been used to describe these subjects (DoE, 2005:6). The relationship between Technology and Technical Education are shown in figure 2.2 below:



**Figure 2.2: Technical Education – Technology Relationship**

In the FET band subjects that fall under Manufacturing, Engineering and Technology are: Civil, Electrical and Mechanical Technology as well as Engineering Graphics and Design. In developing technological capability in learners, an ever increasing base of knowledge and skills needs to be acquired for engaging in the technological process. Much of this knowledge and skills which need to be acquired, form part of the content of various Manufacturing, Engineering and Technology subjects.

Traditionally Technical education has been content oriented, whereas, Technology education strongly emphasizes the technological process. Technology education is general in content while each Manufacturing, Engineering and Technology subject is specialised. A further difference is that technical subjects are taught only at high school, particularly in the FET Band, whereas Technology education is offered as a compulsory part of the GET band (HEDCOM, 1996:29).

According to Makgato (2006:490), curriculum reform in Technology education seeks to modify the traditional workshop based technical subjects. Technical education provides specific skills that are tailored to the needs of industry, with very little attention to problem solving, creativity and design skills. It is very important that there is collaboration between GET and FET Technology educators to ensure a good foundation and closing the gap between the two bands.

#### **2.4 THE RELATIONSHIP BETWEEN TECHNOLOGY EDUCATION AND ENTERPRISE EDUCATION**

An important aspect of Technology as a learning area is its linkage with economic and management sciences. It prepares school leavers for entry into the world of work and the economy. According to Technology 2005 Project (1996:29), Technology in particular should:

- Educate, enable and encourage learners to be enterprising in the variety of situations of adult life as consumers, workers and citizens;
- Enable learners to understand the workings of the local and national economy and participate actively in the workplace and the technological sector;
- Expand learners' understanding of the variety of post-school educational opportunities (such as learnerships, universities of Technology);
- Encourage an appreciation of the role and opportunities in the small, medium and micro enterprise sectors of the economy; and
- Encourage a sense of gender equity at all levels of participation in the economy as a whole and in Science, Engineering and Technology sector in particular.

There is little in the way of useful career development activity in schools, especially in the areas of Science and Technology (DoE, 2001(a):7). In order to improve the participation and performance by girls the Department of Education intend to consider the following:

- A quota system, especially in the dedicated/specialized schools;
- The establishment of girls' schools specializing in Mathematics and Science; and
- Special incentives for girls to study Mathematics and Science (DoE, 2001(a):17).

It is against this background that Mottier (1996:299) argues in favour of creating a positive learning environment for girl learners. Being aware of gender stereotypes, and avoiding them as well as taking into cognisance the differences in pre-school socialization could attain these. Technology education offers learners the opportunity to make artifacts (products), cost and market them. In this way Technology has a special role to play in preparing learners for entry into the economy and the world of work.

## **2.5 TECHNOLOGY EDUCATION AND ITS RELATIONSHIP WITH OTHER DISCIPLINES**

Technology education is the process of educating the learner to become technologically literate. The technologically literate person is a person who can look beyond the obvious and apply creative, innovative thinking to a problem (Clarke, 2005:3). He goes on to say (2005:6) that:

*“Technology education is a complex, multi-dimensional facet of the total education program. It is an essential component of general education. It assists students to understand the relationship of technology to science, society, and the world of work. It deals with the fundamental issues of Technology as a product, technology as a process, and also with Technological systems. It has an integrating influence which helps students understand the totality of the educational experience”.*

Technology education helps learners develop understanding, skills and attitudes needed for them to be users and consumers of Technology. It provides learners with

the opportunity to design; make and evaluate products, processes and systems. It also affords them the opportunity to assess the role of Technology in society as well as using Technological knowledge and skills. Technology education makes a cross-curricular contribution by enhancing the development of the learner in a number of ways (DoE, 2002:5; Clarke, 2005: 4) including:

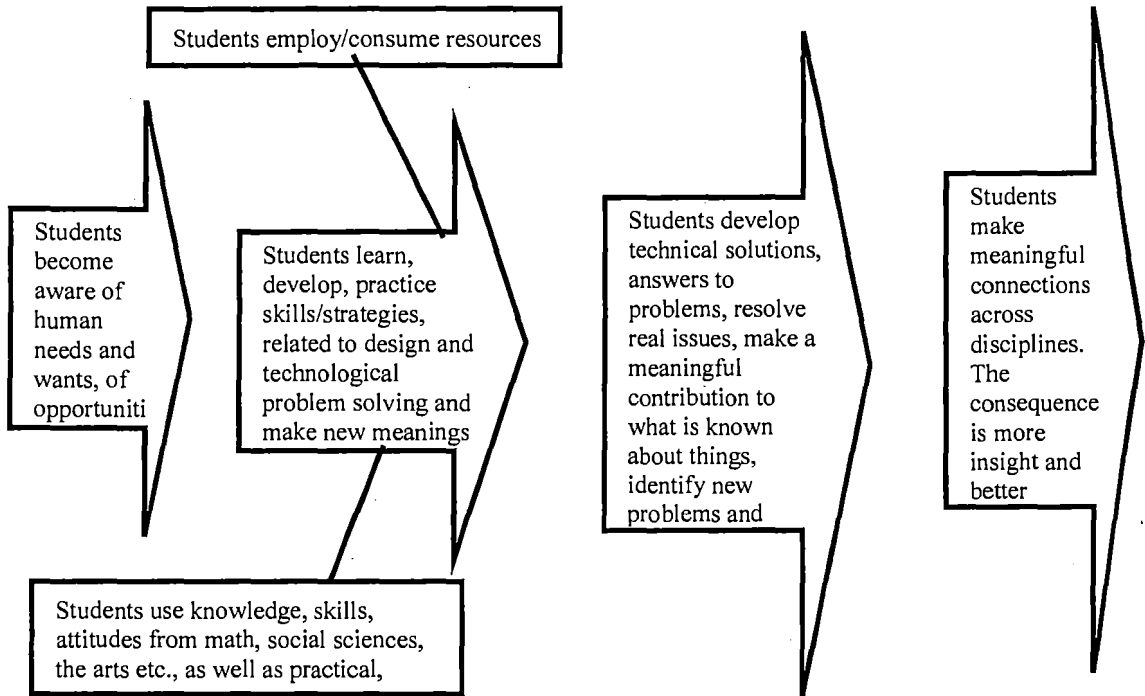
- Learning by solving problems in creative ways;
- Learning while using authentic contexts that are rooted in real situations outside classrooms;
- Combining thinking and doing in a way that links abstract concepts to concrete understanding;
- Enhancing communication skills to develop proficiency in understanding and using the language of Technology;
- Fostering self-esteem by acquiring knowledge, interests, and motor skills related to life and careers, and by encouraging pride in quality work and
- Developing work habits and career understandings by developing basic skills in various Technologies.

Technology education concerns technological knowledge and skills, as well as technological processes. It involves understanding the impact of Technology on the environment, the individual as well as on the society. The Technology 2005 Project researchers (1996:ii) suggest that Technology education promotes capability that should be reflected in:

- The effective use of technological products and systems;
- The ability to evaluate technological processes from functional, economic, environmental, ethical, social and aesthetic points of view; and
- The ability to design and build appropriate products to functional and aesthetic specifications set either by the learners or by others.

Technology education develops comprehensive meaningful connections to, and among other disciplines. Gardner and Hill (1999:215) are of the opinion that the lack of interest shown by learners in Technology is the failure of society to cultivate awareness in the early years of schooling. By providing learners with opportunities to

make these connections, technology education may contribute to their success in other disciplines. The following model as illustrated in Figure 2.4 shows the scope of interaction that Technology activity develops with other disciplines and knowledge areas.



**Figure 2.3: Interaction of Technology education with other disciplines (Clarke, 2005:2)**

Learning through collaboration is considered a valuable learning mechanism in Technology. Stables (2000: 39) asserts that collaboration promotes critical thinking. Group competencies are the basis for the world of work. The term collaboration is explained by Hennessy and Murphy (1999:1) as

*“learners actively communicating and working together to produce a single outcome, talking and sharing their cognitive resources to establish joint goals and referents, to make decisions, to solve emerging problems, to construct and modify solutions and evaluate the outcomes through dialogue and action.”*

Collaboration refers to an instruction method in which learners work together in small groups toward a common goal (Gokhale, 1995:1). In South Africa, the initial study on learning Technology through collaboration was conducted by the Technology education research unit of the University of London (Stables, 2000: 39). Her evaluation findings highlighted two factors about teamwork. These are:

- The more you work in a team, the better you get at it;



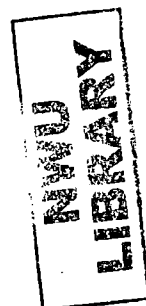
- Working in teams helps you to value your fellow workers more as you identify the strengths they contribute.

## 2.6 THE TECHNOLOGICAL PROCESS

Vandeleur (1999:35) asserts that design, problem solving, decision-making and critical and creative thinking play a crucial role in the technological process. The design process is learning area specific to Technology whereas problem solving and decision making are general in nature. Design is the ideal methodology to use as a vehicle to achieve the desired outcomes in Technology (Williams, 2000:2). It is seen as a problem solving approach to solve practical problems (Crossfield & Daugherty, 2005:5). Mallet (1997:3) found out that the procedure followed by teachers in teaching Technology is dependent on their perception of what is involved in the teaching of the design process. Design is therefore fundamental to the teaching of Technology and Technology is incomplete without it (Warner & Morford, 2004: 1). The researcher is in total agreement with the following statements about the design process by Warner and Morford (2004:2):

*“To become literate in the design process requires acquiring the cognitive and procedural knowledge needed to create a design, in addition with familiarity with the process by which a design will be carried out to make a product or system. Using design as the fundamental tool to examine and create Technology involves the development of the intellectual infrastructure for such an approach. “Technological design is a distinctive process with a number of defining characteristics; it is purposeful; it is based on certain requirements; it is systematic, it is iterative; it is creative; and there are many possible solutions. These fundamental attributes are central to the design and development of any product or system, from primitive flint knives to sophisticated computer chips”.*

Williams (2000:1) argues that technology education is characterised as an activity rather than content. There is also international consensus about the activity rather than the content. Learners need to view Technology as having both the content and the process (integrated). Theory and practice of Technology is carried out using the technological process. The design aspect of Technology develops the cognitive skills while the make aspect develops the motor skills. *“Design is an ideal methodology to*



use as a vehicle to achieve the desired competencies. The process involved on designing are not linear, they do not always start from human needs, and they do not always proceed in an orderly way. They are reiterative, spiraling back on themselves, proceeding by incremental change and occasional flashes of insight.” (Williams, 2000:5).

Figure 2.4 shows the different processes that constitute the Technological process.

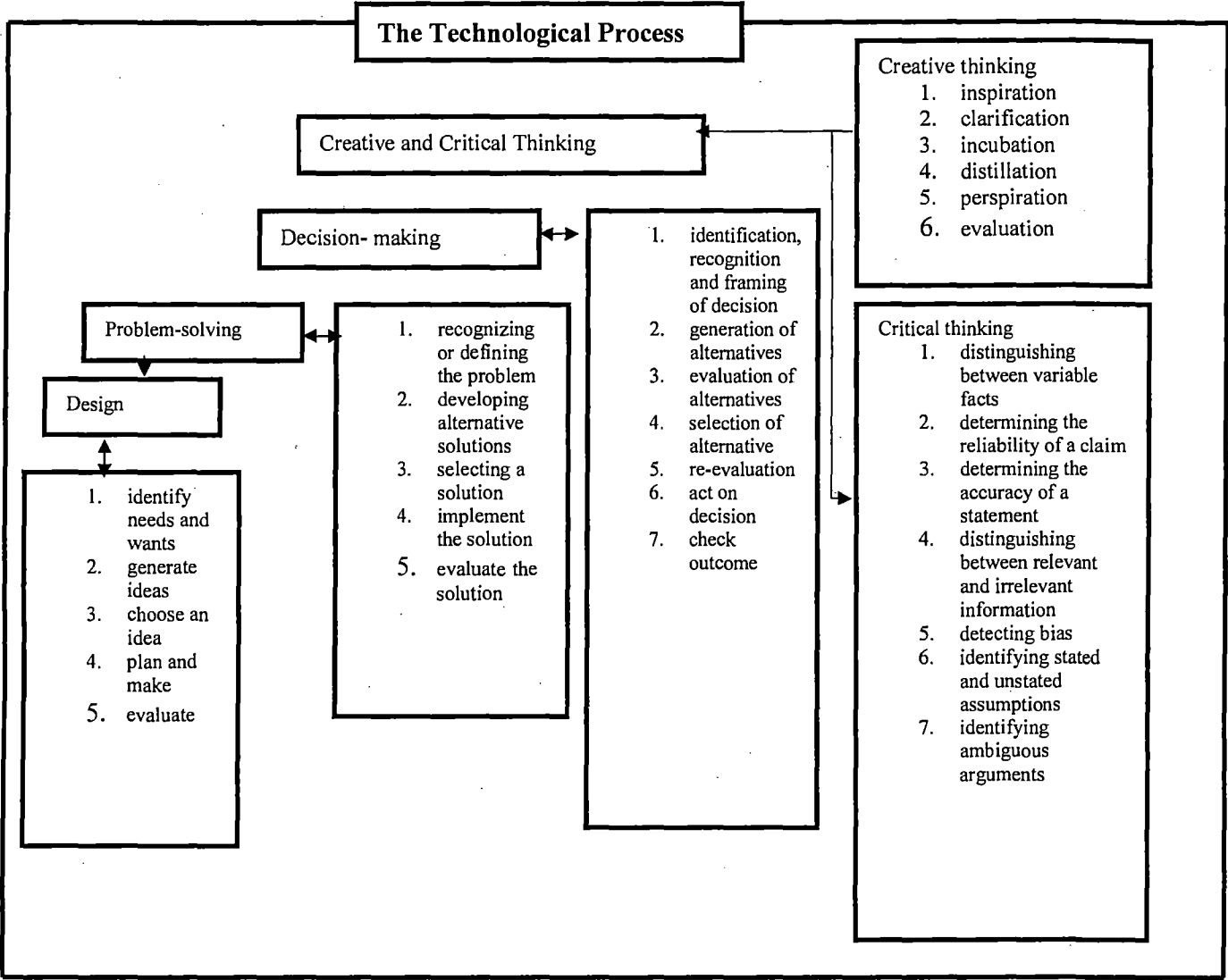
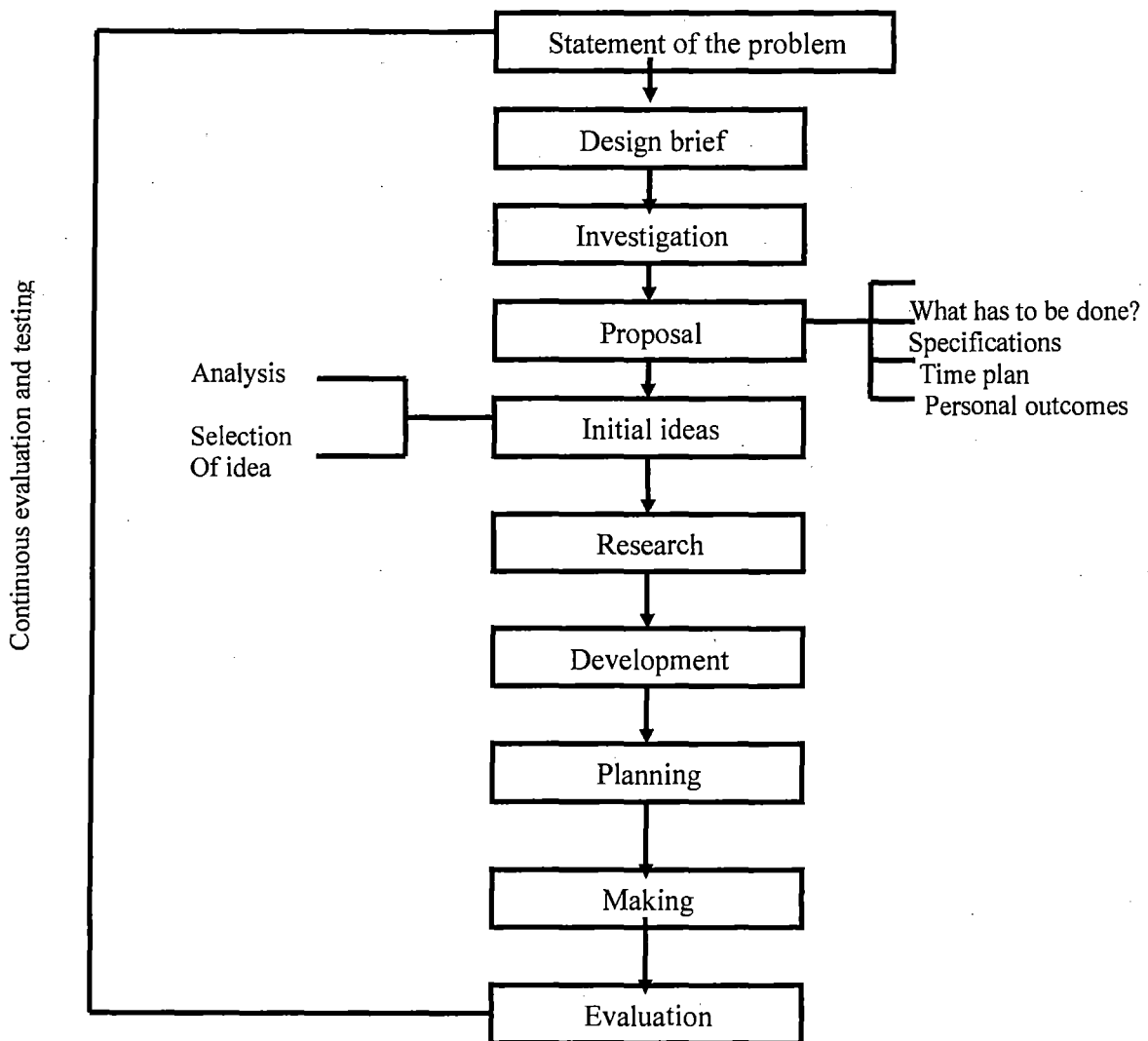


Figure 2.4: A model of different processes that constitute the Technological process Johnsey (1995:208); Halpern (1997:190); Petty (1997:15); Vandeleur (1999:36).

Although the processes of critical and creative thinking, decision-making and problem solving can be described, it is very difficult to separate them because they are interwoven in nature. Many decisions are involved in solving a problem. Similarly, generating satisfactory solutions often requires considerable creativity. In a study conducted by Atkinson (1999:4), it was discovered that there is a positive correlation between student's design and their level of motivation.

Bauer (2000:12) on the other hand suggests that the home environment influences student's achievement in design. Figure 2.5 below shows the steps of the technological process.



**Figure 2.5: The Technological process RAU (2003:128)**

The above model aims to provide the sequence in which the technological process happens. The process consists mainly of 10 stages. The first stage is the identification

of a problem, need or want. The solution need not be mentioned at this stage. For example, people cannot cross the river because it is muddy and slippery. The second stage is the design brief. It is a short and clear statement that gives you the general outline of the problem to be solved as well as the purpose of the proposed solution (DoE, 2002:64). For example: I must design and make a device that will help people cross the river easily and safely.

The third stage of the technological process is the investigation one. In this stage learners use a variety of methods to research about the problem and collecting information. Information may be obtained from the library, Internet, role models, journals among others (DoE, 2002:36). The fourth stage is the proposal phase. During this stage the following four aspects are considered:

- What has to be done? Learners elaborate on the detail and formulate an idea on what has to be done;
- Specifications are a list of musts. The parameters and constraints as stipulated in the original brief are identified;
- Time plan is very crucial in the completion of any project. It is an estimated plan on which the project could be completed (RAU, 2003:131); and
- Personal outcomes is what we expect to gain from a specific project e.g. qualification or remuneration.

The fifth stage is the generation of initial ideas. Ideas and possible solutions are recorded in the form of labeled freehand sketches (RAU, 2003:131). Each idea is recorded on a separate page with their advantages and disadvantages. The sixth stage is the research phase, which refers to more specific investigations on the chosen idea. The seventh stage involves development in which the chosen idea is refined for practical implications. Planning involves making detailed drawings of the model solution that is supported by a list of material requirements. Stage nine involves the making of the product or artifact. The last stage involves testing and evaluation of the product to see if it meets the specifications and solves a problem.

Davids (1997:12) highlights the fact that the technological process is of utmost importance in Technology Education and proposes that the process could be structured at the senior phase level as depicted in annexure 1.

Van Dyk and Van Dyk (1998:21) summarize the afore-mentioned process as shown in the Table below:

<b>The Technological Process</b>	<b>Elements</b>
Needs analysis and description	Identify a need or problem Write a design brief Analyse the problem Draw up specifications
Design and development	Do research Generate ideas Develop ideas and select the best Communicate your ideas
Planning and making	Know how to choose materials, equipment and processes Work out costs Making
Testing, evaluation and presentation	Test, evaluate and present

**Table 2.2: The Technological process (Van Dyk and Van Dyk, 1998:21)**

There is a particular procedure that is followed in Technology education to solve problems. This has been seen as a series of steps that learners have to follow as they make projects. It has been indicated that these steps are not necessarily linear but they are cyclic in nature. There are also certain cognitive skills that are inherent in the technological process like critical and creative thinking, decision making, problem solving and design. In Technology learners are offered the opportunity to reflect and develop ideas as well as testing their ideas in a practical context. All the technological processes described above have the similarities of design-make and evaluate. They only differ in the approaches that have been adopted by different countries.

## 2.7 METHODOLOGY OF TECHNOLOGY EDUCATION

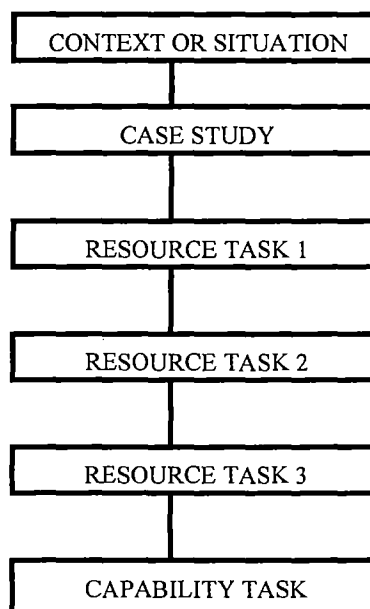
Teaching methodology in Technology needs to support progressive use of knowledge, skills and resources to:

- Design technological solutions to problems;
- Work collaboratively in groups; and
- Plan, manage and assess their own activities

(DoE, 1999:3). The teaching of Technology is made up of a number of tasks. These are:

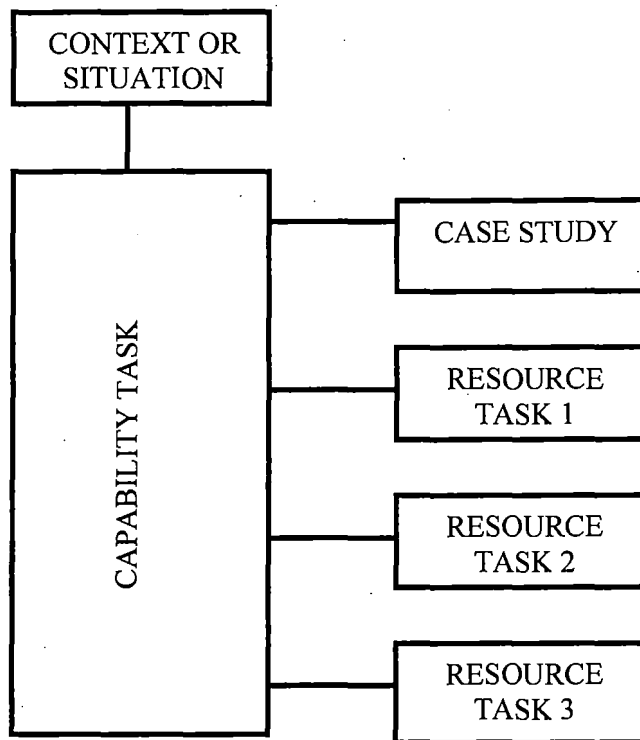
- Case studies;
- Resource tasks; and
- Capability tasks.

Case studies aim to link classroom experience with societal problems. Resource tasks are enabling tasks that aim to develop specific skills and knowledge. Capability tasks are open-ended tasks that enable learners to use knowledge, skills and resources to meet human needs and wants by designing, making and evaluating processes, products and systems (DoE, 1999:4). The Technology methodology is therefore activity based and involves collaboration. Figures 2.6 and 2.7 show ways of structuring Technology activities.



**Figure 2.6: The linear model of structuring Technology activities (DoE, 1999:4)**

Figure 2.7 shows the alternative way of structuring Technology tasks.



**Figure 2.7: The alternative model of structuring Technology activities ( DoE, 1999:4)**

In Figure 2.6 a problem or situation was set for learners to work on. A case study is introduced to simulate how problems could be solved in their immediate environment. Learners are then given a series of enabling tasks before they could attempt the capability task. In Figure 2.7 and the capability task are given to learners. Through the case study and a series of resource tasks learners will work towards the capability task.

Williams (2000: 2-3) distinguishes the scientific and technology methods as follows:

Scientific Method	Technology Method
Define the problem	Identify the problem
Gather information	Write the design brief
Form a hypothesis	Investigate
Make observations	Design
Test the hypothesis	Make
Draw conclusions	Evaluate

**Table 2.3: The scientific versus technology method Williams (2000:2-3)**

Kimbell and Stables (1999:34) and Williams (2000:2-3) support the notion that the scientific method is not a creative method. Laboratory exercises are a verification of the activities since instructions are followed step by step towards a pre-determined solution. They echo the sentiments that in these fashion learners construct knowledge in certain ways. However, they do not support the idea of constructivism as appropriate to Technology education because the development of knowledge is not the primary goal of Technology. Knowledge is only developed to the extent that it assists in the completion of a task. They believe that the level of mathematics and science that is needed even for even complex technological tasks is not advanced. These subjects are picked up as necessary according to the needs of the task. This therefore suggests that learners should not be intimidated in the teaching and learning of Technology Education. They however need basic mathematics to complete a number of tasks.



## 2.8 TECHNOLOGICAL LITERACY

Hall (2001:4) defines technological literacy as an appreciation of the scientific method. It is a powerful way of knowing, the ability to distinguish technology from Science but also to see the connections and an understanding that the world we live in is increasingly technological, not only in regard to products, but in the whole organization of modern life. Mawson (2005:2) argues that curriculum development has tended to be influenced by two differing approaches. These are functional technological literacy and critical technological literacy. This researcher identifies functional technological literacy as a set of abstract, value-free skills, which can be defined, measured and learned. These skills are functional to personal and economic development. It covers a wide range of technical specialized information providing learners with opportunities to gain practical ability, as being developed through doing hands on experience. He further argues that critical literacy identifies three interacting components of technological literacy that is, technological knowledge and understanding, technological capability, and Technology and society.

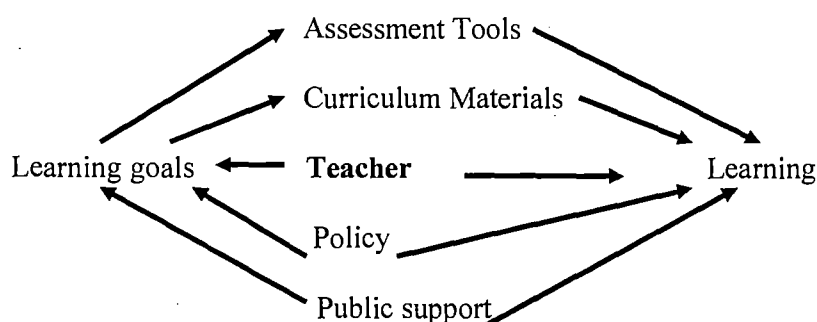
Kellner (2001:69) affirms that literacies are socially constructed in educational and cultural contexts. He further argues that we need multiple literacies for our multicultural society. These literacies need to meet the challenge of new Technologies. Sarlemijn and De Vries (2005:19) distinguish the following three types of Technologies:

- Scientific knowledge that is involved in experience-based technologies has been derived from engineering practice. This knowledge is practical and concrete.
- Macro-technologies, where scientific laws and concepts involved are the result of a mathematical deduction from basic equations. Steam engines were developed without knowledge of gas laws but theory helped in improving them.
- Micro-technologies, where scientific theories that are involved become even more abstract, as they deal with microscopic structures we cannot see (For example nano- technology).

According to Cajas (2002:183) the standards movement has made explicit a set of coherent learning goals for technological literacy (concepts and skills). For learners to achieve these goals it is necessary to:

- Develop tools to assess Technological literacy;
- Create research-based curriculum materials;
- Change pre-service and in-service Technology teacher education;
- Establish policies that can help states, districts, schools, teachers and parents to use standards based resources to improve student understanding of Technology ideas and skills; and
- Create public support for Technological literacy.

Figure 2.8 shows the technological literacy model, which summarises the above stated concepts.



**Figure 2.8: Technological Literacy model Cajas (2002:183).**

## 2.9 TECHNOLOGY TEACHER TRAINING AND SUPPORT

All technology educators need professional development where appropriate knowledge, skills and beliefs concerning the study of Technology can be obtained. In-service training is a mechanism by which educators could be given the opportunity to develop their skills and knowledge. Educators in the public school sector are exposed to technology education for the first time in their careers and therefore have to be helped (Potgieter, 2004:205). According to Dow (2001:8) a lack of appropriate support in the form of pre-service education, in-service training or suitable resources were identified as barriers in implementing Technology. Reitsma (2006:606) is of the

opinion that in-service training of teachers is problematic, because of time and financial constraints.

Wellbourne-Wood and Williams (2002:261) are of the opinion that there is a shortage of Technology educators in many countries. The reasons for this vary from country to country. Some of the reasons include insufficient numbers of trained teachers; the expense of teacher education programs; the length of time it takes for certification and access of students to the teacher education institutions. The said researchers also argue that Technology teacher training is not well catered for in the higher education sector.

Teachers need to be constantly exposed to new knowledge and the current trends in the school milieu. Researchers, Engelbrecht, Ankiewicz & De Swart (2006:291) propose the following models for continuing professional teacher development (CPTD),

- Centralised CPTD model in which educators from different schools gather at a central venue for a workshop. This type of workshop is normally managed by a competent person to ensure that the quality of materials and presentations are good.
- School based CPTD model that is co-managed by the school personnel and a service provider to fulfill the immediate needs of the school. This may be problematic because of the lack of financial support and changes in the staffing establishment of a school.
- The school focused CPTD model that is aimed at addressing the needs of school personnel. It is based on the training needs that have been identified by educators. It has the following advantages:
  - It contributes directly to the improvement of the quality of education of the educator and school;
  - It allows for collaboration between colleagues, principals and school management team and support for professional growth and transformation; and
  - Of educators are given the responsibility to be trained in the development of learning programmes.

- Cascade CPTD model where a big number of educators are trained from different schools. The message is cascaded from top to bottom. This model was used in the training of educators on Outcomes-Based Education. This process involved the training of officials from the provinces by the National Department of Education. These master trainers then cascaded the information to educators in their districts or regions. Educators who were trained were supposed to cascade the message down to their colleagues. However, each time the information is cascaded, it becomes distorted. This is not a good method to deliver effective training.

Stein, Campbell, McRobbie and Ginns (1999:12) suggest a comprehensive teacher development model for technology education. The model is shown in Figure 2.9 below.

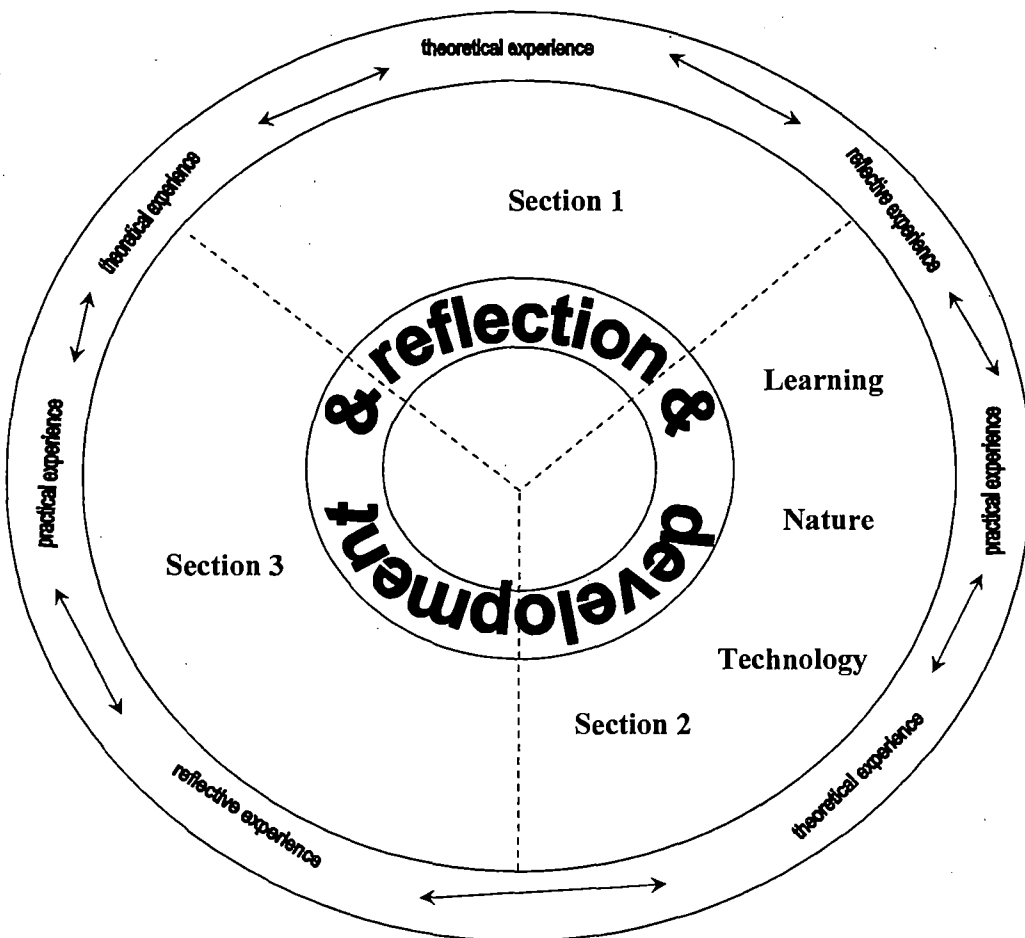


Figure 2.9: A professional development model for Technology education (Stein, Campbell, McRobbie and Gins 1999:4).

The professional development model is divided into three sections. Section one entails personal constructs and prior experiences of educators in Technology as well as learning in general. It also includes educators' construct knowledge (that is educators' views of Technology and Technology education). Section two comprises three interacting aspects of knowledge. These are:

- Learning in Technology;
- Nature of Technology; and
- Nature of Technology education (Stein, Campbell, McRobbie & Gins, 1999:13).

This section refers to the need for educators to develop an understanding of the key learning area as an entity in itself. The rationale for the inclusion of this section is to acquaint educators on the purpose and place of Technology in the whole curriculum.

- Section three of the model addresses the question of Technology tasks. According to Kimbell (1996:96), Technology tasks exist in real houses or hospitals or shops. These influence student abilities taking into cognisance their learning abilities, cultural and social contexts. Contexts are empowering for both teachers and learners (Stein, Campbell, McRobbie & Gins, 1999:13). The three parts of section two of the model interact with each other. They help to empower teachers in creating a background picture against which to highlight practical implementation strategies and activities in the classroom.

## **2.10 ASSESSING TECHNOLOGY**

Research carried out by Moreland and Jones (2000:284) suggests that Technology educators do not yet understand assessment. They argue that an understanding of technological practice, concepts of Technology education and an understanding of Technology pedagogy are significant in shaping teacher development programmes and developing suitable assessment practices. They are of the idea that assessment serves the following purposes in the school system:

- To improve student learning;

- To improve the quality of learning programmes;
- To report on individual and group achievement;
- To award a qualification in the secondary school; and
- For accountability and monitoring of educational standards.

Leung (2000:149) is of the opinion that assessment incorporates emerging ideas in the understanding of learning, including the construction of meaning, the importance of prior knowledge, and the strategies for representing knowledge. He perceives teacher feedback as a key element to effective formative assessment. Moreland and Jones (2000:287) makes the point that the more complex the learning situation, the more sophisticated the feedback needs to be. In Technology feedback is very critical because progression in learning consists of a greater number and a more complex array of variables. The said researchers see formative and summative assessment as being mutually exclusive. Formative assessment is seen as occurring during the learning experience and summative assessment occurring after learning. They further outline six resources that competent educators bring to assessment. These include knowledge about the content or substance of what is to be learned; attitudes towards learners and learning; skill in devising tasks; knowledge of criteria and appropriate standards; skill and expertise in previous similar tasks and expertise in giving appropriate, targeted feedback. They warn that the feedback to students therefore must be studied in the light of this repertoire of resources.

*“A holistic mark results from an assessor observing the technological process or the product and any supporting materials, and assigning a single mark to represent the whole technological achievement. If a student is assessed as highly capable, that student is not necessarily the one with outstanding individual skills, but the one who is best able to integrate and successfully apply to the task at hand his/her conceptual understanding, modeling facility and procedural capability” (Fritz, 1996:183).*

Assessment allows for desired outcomes of learning to be achieved through a variety of paths. These paths could be tailored to the individual needs and interest of learners.

When developing assessment tasks teachers should:

- Identify outcomes to be assessed;
- Identify the outcomes which provide evidence whether the student has achieved the assessment standards;

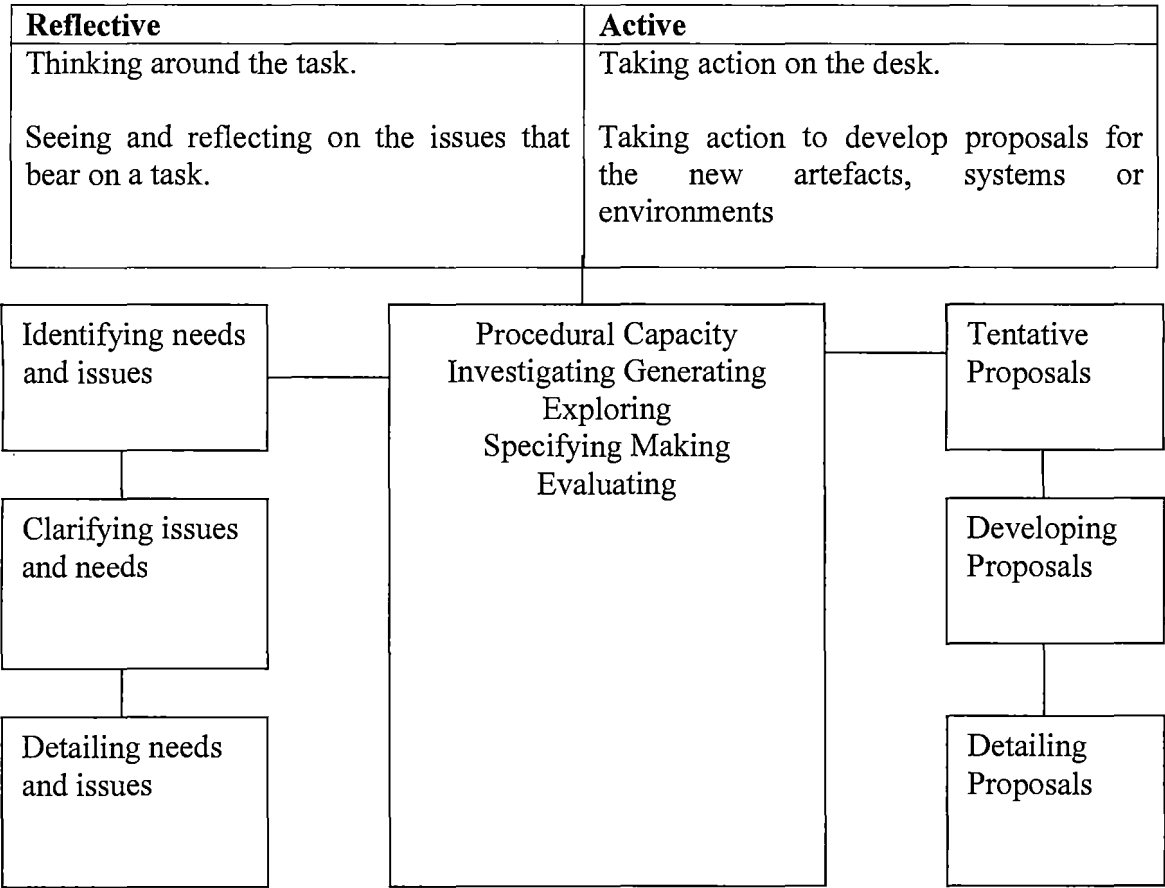
- Determine the particular syllabus content to be covered by the assessment task;
- Construct activities that provide students with the opportunity to demonstrate the relevant outcomes; and
- Not award marks or grades for anything that is not expressed as an outcome.

(Fritz 1996: 185).

### **2.10.1 Normative and Criterion referenced Assessment**

The contrast between Criterion Referenced Assessment (CRA) and Norm Referenced Assessment (NRA) can best be explained by an analogy with athletics. CRA indicates the times achieved by learners in a race and also adds other aspects of their performance such as style so that comparisons can be made to past performance and averages derived for their age and condition. NRA simply records which learners were first, second and third - and last - and offers no other information (Eggleston, 1992:46).

The Assessment of Performance Unit Model differentiated between two aspects of capability, viz Reflective and Active



**Figure 2.10: The APU model (Eggleston, 1992: 47)**

Capability at the reflective level allows learners to identify needs and issues related to the situation. They would then clarify issues and needs as well as detailing them. At the active level learners would develop tentative proposals relating to identified needs and issues. They would also develop proposals related to issues and needs that have been clarified. Detailed proposals and working drawings of identified needs are presented. Capability at both levels takes place within the confines of procedural knowledge (i.e. they develop procedural capacity to investigate; generate ideas; specify; make and evaluate)



### 2.10.2 Common errors of measurement

According to the Scopes Project - Algonquin College and Protec (1997: 12), there are seven errors of measurement in Technology and these are:

- **Leniency or Harshness Error:** Some assessors tend to make judgements which are, on the average, much more favourable or more lenient than judgements made by other assessors. Conversely, other assessors may make judgements which are consistently more unfavourable than the judgements of other assessors. These errors are sometimes referred to as "leniency" and "harshness" effects and are analogous to the phenomenon, which students in traditional settings encounter, in "easy" or "hard" graders.
- **Errors of Central Tendency:** Many assessors are reluctant to commit themselves one way or the other and as a consequence tend to make most ratings near the average or centre of the scale. This type of error often referred to, as the error of "central tendency", is particularly troublesome in situations where some discrimination among individuals in a group is needed. In the individual assessment situation, errors of central tendency will result in a lack of discrimination and lowered reliability and validity.
- **Halo Effect:** In situations where a student is being assessed in several different specific areas, a favourable overall impression may result in unjustifiably favourable judgements in all areas. This type of error is often referred to as the "halo effect" although the reverse can also occur. That is, an unfavourable overall impression can result in unjustifiably unfavourable judgements in specific areas.
- **Initial Impressions:** An error similar to the halo effect can result from the initial impression an assessor has of a student. In some situations it has been shown that a favourable or unfavourable "initial impression" will unjustifiably affect later judgements of specific areas of performance.

- **Stereotypes:** Strongly held attitudes or beliefs can cause misperception and error in judgement. A good example is the judge who is influenced by a "stereotype" of members of a particular class or group. It should be pointed out that such errors could be favourable or unfavourable to the student depending on the type of stereotype held.
- **Contrast Effect:** The quality of the previously rated student will often affect judgement. An average student may tend to receive lower than average ratings if the previous student was outstanding and higher than average ratings if the previous student was poor. This type of error has been referred to as the "contrast effect"
- **Similarity of Background:** The degree of similarity between a judge and the person being assessed with respect to background, attitudes and ethnic group has been shown to affect judgements with greater "similarity" tending to produce more favourable judgements.

Technology is taught in a variety of contexts as well as in multi-cultural classrooms. Assessment therefore needs to be objective rather than subjective for its successful implementation. It should be criterion referenced and educators need to guard against the errors of judgement when making assessments. If assessment is not done according to the above prescripts it may discourage the learners thus creating a negative attitude towards Technology. Technology needs to be properly taught and assessed (Tholo, 1999:44).

### **2.10.3 Assessment of Technology Product and Portfolio**

Assessing a Technology product is very difficult, as this needs some criteria against which it will be evaluated. It involves the assessment of both the product and the process. Walstra (1997:32) designed the criteria to assess the product and the process. The process is normally recorded in a project portfolio. The different facets to be assessed are shown in annexure two.

Studies have revealed that various issues related to the implementation of Technology, the difficulties they experience often being related to the newness of the learning area, their lack of familiarity and explicit knowledge of Technology is their lack of emphasis on the product rather than the process (Stein, Campbell, McRobbie & Ginns, 1999:106). Pupils' Attitudes Towards Technology (PATT) studies initiated in the Netherlands and later extended to other countries (De Vries, 1996:4; Kimbell & Stables, 1999:22) show that learners mainly see Technology as a collection of products. This one-sided image of Technology lacks the process awareness.

## **2.11 EDUCATORS' ATTITUDES TOWARDS TECHNOLOGY**

The mindsets of many educators need to change, so that principles of democracy which include among others; gender-sensitivity may be realized in a true sense. If education is to reach its noble goals, there ought to be movement towards a stage where the females feel very much part and parcel of the environment in which they are confident enough to handle Technology (Nkotsoe, 2004:3).

It is only when such educators show confidence that even female learners could be encouraged to follow such line of education and eventually conquer the world of work in Technology related occupations which were initially associated with males. In addressing the whole imbalance, Wolters (1989:9) suggests that from the perspective of attitude formation, it is important to start Technology education at an early age. This means that it is appropriate to pay attention to Technology in the initial training of primary school educators and/or as part of an in-service training. Learners ought to be taught a "broad concept of Technology" because there is a positive relation between having a broad concept of Technology and positive affection towards Technology (Nkotsoe, 2004:4).

Research studies have revealed that the past experiences of primary and secondary educators greatly influence their understandings of Technology. In particular, research conducted into primary educators' understandings of Technology indicated that they possessed narrow views of Technology (Mawson, 2002:9). These views influenced the ways in which they attempted to implement Technology. In her findings the said researcher indicated that primary educators tended to conceptualise Technology as

having to do with computers, or very technical and advanced machinery that they could not possibly incorporate into their classroom without expertise.

Mawson (2002:9) also found out that the subjects they teach influence secondary educators' perceptions of Technology. Educators' understanding of the differences between Science and Technology is also a problem. Many educators see Technology as the application of Science and therefore need assistance to clarify and reflect on their own perceptions of Technology. It would seem to be important for educators implementing Technology to develop perceptions of Technology that is in accordance with the purpose of the Revised National Curriculum Statements (DoE, 2002:4).

## **2.12 EDUCATOR SUPPORT IN TECHNOLOGY EDUCATION**

Teaching Technology makes a unique contribution to the education of all learners. It prepares them to work in a rapidly changing Technological world by introducing them to the design methods, technical understanding, planning and manufacturing skills needed to produce practical solutions to real problems (Sheffield Hallam University, 2004: 1). This requires educators to be supported from time to time to ensure mastery of the process.

### **2.12.1 Key areas to be addressed in helping educators**

The task of providing professional development for teachers who have not received formal training in the teaching of Technology Education is massive. The experience of Stables (1997:2) in the UK where there has been a considerable input of resources, although nowhere near enough to meet teachers' needs suggest key areas which are:

- **Developing their confidence**

In a study conducted at Goldsmiths' college, it was discovered that there was a relationship between teacher's confidence and level of support given to learners. Lack of confidence related to lack of children's making (second stage of the design process). This concern is a very real one and is the reason behind why much primary Technology in-service work should be focused in this area (Stables, 1997:13).

- **Providing the teachers with hands on experience**

An approach that breeds both confidence and skill in supporting children's making is one which provides teachers with opportunities for hands on practical work themselves. This is common in in-service courses in England and was a feature of the early work done with teachers involved in project update in the USA (Stables, 1997:14). The value of such activity also provide a reference point for planning classroom activities, how long will the activities take, what resources are needed, what will the children be taught, will it be best for them to be taught as individuals or groups. Teachers are able to see how best to manage the activity.

- **Building on and adopting previous experience of teachers**

Once teachers become involved in a Technology activity, they realize how much they can draw both on their general skills and also on work from other areas such as Mathematics, Science and Art (Stables, 1997:12). Science provides explanations of how the world works, Mathematics gives us numbers and procedures through which to explore the world, and languages enable us to communicate within the world. Design and Technology is more than just a subject, it is a learning experience which is unbounded by fixed bodies of traditional knowledge and transcends the academic/practical divide.

Working from strength is important, but within this it is necessary to help teachers see how previous work might need a shift in emphasis to develop as a Technology project. Working from teachers strengths allows them to make a start on a Technology project, and from this to build their confidence to embark on activities without feeling they have to know all the answers.

Ter-morshuizen, Thatcher and Thomson (1997:7) assert that key areas which need to be addressed, in order to help teachers move forward include:

- Developing the teacher's understanding of the inescapable features of Technology.
- Helping to see that some of the work they already do can be adopted to allow technological activities to grow for them.
- Building on teacher's previous experience and developing their confidence.

- Identifying a broad range of manageable activities as a starting point.
- Providing opportunities for teachers to share good teaching practice.

## **2.13 CHALLENGES FACING SCIENCE AND TECHNOLOGY IN SOUTHERN AFRICA**

Policy directed growth in Science and technological skills is needed in this country. South Africa will have to focus on removing the barriers to available technologies that result from human attitudes to Technology (UNESCO, 1998 (b): 9). It is in this respect that educationalists are playing such a vital role in our society. This is especially so for Science and Technology teachers. Providing training to teachers is therefore essential in equipping them for this vital task.

Some of the challenges facing African countries are policy related in nature and call for political intervention. The review of the Science and Technology educational curriculum from school level to tertiary level needs to be addressed. Some African countries have developed Science and Technology policies in an effort to assist in their economic development. However, these countries' efforts at development are thwarted by a lack of co-ordination. In various countries what has held back development efforts has been the inability of political leaders to commit their countries towards formulation and implementation of Science and Technology policy. Many African countries are faced with tremendous challenges like poverty, disease, and unemployment. As a result their meager revenue is used to address some of these pressing issues rather than Science and Technology policy (Yolowe, 1998:3).

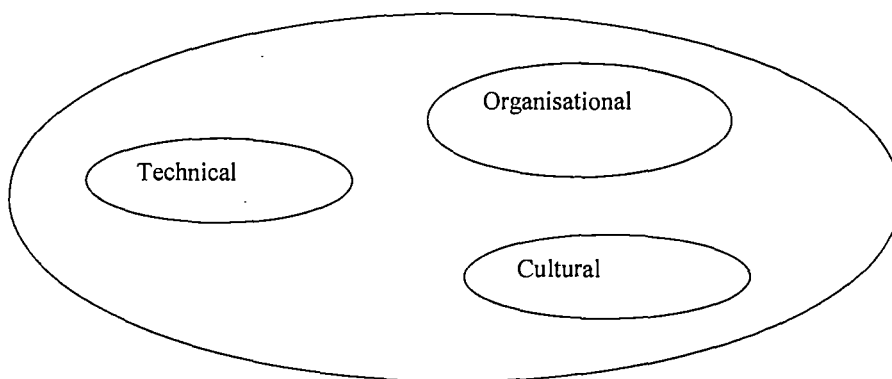
## **2.14 RESOURCES IN TECHNOLOGY EDUCATION**

It is very difficult to offer Technology effectively without the required resources (Ter-morshuizen, 1999: 18). Elmer and Goodhew (1996:2) found the importance to distinguish between high and low Technology, which has implications on the resources that will be used. In a pilot study they conducted in South Africa, they recommended the need to make Technology accessible through the use of easily

available materials, in a country where the majority have been deprived and resources are limited (Elmer & Goodhew, 1996:2).

According to Pacey, (1993) in Elmer and Goodhew (1996:2), Technology Practice consists of three simultaneous aspects. These are:

- Technical: Knowledge and skills used in conjunction with materials to design products or artifacts.
- Organisational: Economics and sociology of Technology and the use of its outcomes and
- Cultural: the value that underlie the choice of problems and the evaluation of outcomes.



**Figure 2:11: Technology Practice (Elmer & Goodhew, 1996:2)**

## **2.15 SUMMARY**

In this chapter, the literature has indicated that the implementation of Technology as a learning area is problematic. In South Africa Technology was nearly dropped from the curriculum. The main reason advanced by the review committee was that educators are not well trained in this learning area and that there is also a shortage of resources to teach the subject. Another reason was that of curriculum overload, meaning Technology is not important to be a self-standing learning area. The Council of Education Ministers rejected this recommendation and pronounced Technology as one

of the eight learning areas of the Revised National Curriculum. The main challenge in Technology is therefore to train educators and provide resources to schools.

The Technology learning area has the potential to create technologically literate learners capable of innovation, design and enterprise. The inclusion of Technology in the general curriculum on an equal basis with Science and other learning areas goes a long way to signal a new acceptance of Technology as a high status field of study.

There is still some confusion as to what Technology education entails; its content and distinctive features because of its attachment to Technical and Science education. There is an agreement by most countries on the process but not on the content depending on the approach. Comparing Science, Technical and Technology education has cleared this confusion.

The design process was seen as a major vehicle through which Technology is taught. This methodology allows for critical and creative thinking. Technology was also seen as a process rather than a product. Technology should therefore be taught within a particular context that is familiar to the learner. This includes the context in the home environment, industrial environment and community environment. Concepts such as assessment tools, curriculum materials, policy, and public support, learning and learning goals were seen as crucial for both the learner and the educator.

Continuous professional teacher development was seen as the panacea for delivering the curriculum to stipulated requirements and sustenance of the learning area. Assessing progression of learners was seen as a crucial factor in implementing Technology effectively taking into cognisance the capability of the learners. Assessment of Technology brings many challenges in that both the product and the process should be assessed. Various assessment models were discussed to address the appropriate and current assessment practices.

In the literature, the support given to educators was seen to be crucial to implement the curriculum to defined standards. Another crucial factor was the resources required to facilitate the learning area effectively as well as the perceptions of educators and learners towards Technology. Each country implements Technology differently



depending on its needs. The ensuing chapter deals with the different curricular approaches in implementing Technology internationally.