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Development of Principles for the Integration of Technology Education in the Primary Curriculum in Botswana

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Development of Principles for the Integration of Technology Education in the Primary Curriculum In Botswana

By

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USE OF THESIS

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ABSTRACT

Design and Technology is being taught in secondary schools in Botswana. This innovation began in junior secondary schools in 1989 and senior secondary schools in 1993. However it has not yet been introduced in primary schools. There have been some Design and Technology attainment targets which are outlined in the primary curriculum, but it is proposed that these do not fit well into the curriculum structure. This study seeks to investigate the principles upon which Design and Technology can be integrated into the primary curriculum in Botswana. Data for this study was collected through a review of related literature and a survey of people who have knowledge about curriculum design and structure. This study is intended to guide curriculum designers to develop a technology curriculum that will be used in primary schools in Botswana. It is hoped that this study will assist and guide the development of technology education in Botswana and also contribute to technology education as a whole.

DECLARATION

I certify that this thesis does not, to my best knowledge and belief

I. Incorporate without acknowledgement any material previously submitted for a degree or diploma in any of the institutions of higher learning;

II. Contain any previously published materials or written by any other person except where due reference is made in the text;

III. Contain any reformatory materials.

[redacted]

Signature: ________________

Date ______________________

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Chapter One: INTRODUCTION TO THE STUDY

The focus of this study has been to investigate ways in which technology education can be integrated into primary education in Botswana. The intention has been to survey experts and the literature to find out how countries like Britain and Australia have been able to integrate technology into their curriculum. This chapter presents the introduction to the study, which comprises the background and the significance of the study, its purpose and the research questions.

Background of the study

Botswana is situated in the middle of Southern Africa, sharing borders with South Africa in the south, Zimbabwe in the northeast, Zambia in the north, and Namibia in the west. The mean altitude of Botswana is approximately 1000 meters above sea level and the country covers 582 000 square kilometres. The projected population of the country by 2001 is 1 691 000 (Ministry of Finance 1997:3). There are currently 752 primary schools (702 are government schools and 50 are private), housing about 330 676 students. There are 12 535 teachers in primary schools (Ministry of Education, Statistics Office, 2001), most of whom have not attained any formal technology education training. Botswana education structure comprises seven years of primary education, three years of junior secondary which together provide ten years of basic education, and two years of senior secondary education.

In April 1992, his Excellency the President of the Republic of Botswana appointed a commission to examine the education system and suggest ways in which it could be improved. One of the recommendations was that all citizens should have ten years of basic education, that is, from year one (standard one) to year ten (form three). A range of subjects was recommended including Design and Technology. A curriculum blueprint was then developed based on the recommendations. According to the recommendations, in primary education, packaging of subjects needed to be considered to allow for two levels. These levels are lower primary (standard/year one to four) and upper primary (standard/year five to seven).

Significance of the study

Design and Technology is offered in secondary schools but it has not yet been introduced in primary schools. This poses a problem because a developmental curriculum in design and technology is not yet evident as part of the ten years of basic education. The primary curriculum is structured so that packaging of subjects allows for two stages in primary schools (upper and lower). In lower primary, music, physical education, design, art and craft are to be collectively called Creative and Performing Arts. In upper primary, Creative and Performing Arts consists of design and technology, art and craft, music, home economics, physical education and business studies.

As a result, this packaging is inconsistent as those subjects in the lower primary which make up the Creative and Performing Arts, are not the same as in the upper primary. In fact, the lower primary does not have design and technology; instead there is design, art and craft. Also, the packaging has not taken into consideration some important aspects of the curriculum such as content development and delivery, assessment, approach, manpower and size of classes.

Purpose of the study

The purpose of the study is to investigate how technology education can be integrated into the primary curriculum in Botswana. Having realised the importance of technology education in primary schools, curriculum planners might not be aware of the best method of integrating technology education in primary schools. There is need to consider ways of best integrating the subject. This study has focused on formulating principles, which will assist in integrating the subject into the primary curriculum of Botswana. The following questions have been addressed in order to identify the principles:

1. **What is the rationale for introducing technology education in primary schools in Botswana?**

Technology plays a very important role in society today. Its importance in primary education relies on its economic and social importance and the role it plays in culture and environment. To trace how technology can be integrated into primary education in Botswana it is important to investigate its importance and its impact on society and education.

2. **How has technology education been integrated into Australian and British curriculum?**

The reasons why the study focused on technology education in Australia and Great Britain was to narrow the scope of the study. The other reason was because the Australian and British technology curriculum are similar to that of Botswana.

3. **How can concepts of Appropriate Technology be incorporated into technology education at primary level in Botswana?**

Botswana is a developing country and people have been using their own technologies which they found to be appropriate for them. The principles of appropriate technology are important in the curriculum as they help guide an integration of technology that is relevant to the society.

4. **Upon what principles should the integration of technology education into primary education in Botswana be based?**

This is the main question of the study. The principles that this study has developed are those which will guide the integration of technology education to the primary curriculum in Botswana.

Definition of terms

In this research there are terms which are used frequently used. These needs to be defined as used in the context of the study.

1. Technology

"...the know-how and creative processes that may assist people to utilize tools, resources and systems to solve problems and to enhance control over the natural and made environment in an endeavor to improve the human condition." (UNESCO, 1985 in Curriculum Council, NSW).

2. Technology Education

"Technology Education is an integrated, experience-based instructional program designed to prepare the students to be knowledgeable about technology- its evolution, systems, technologies, utilisation and cultural significance" (www.techedlab.com).

3. Appropriate Technology

Technology that "is used to solve technological problems by providing sustainable solutions which are beneficial to the local community and which are sensitive to the need to reduce pollution by using renewable sources of energy and re-cycling materials whenever possible." (Dunn 1979)

Chapter Two: LITERATURE REVIEW

Introduction

This chapter has five sections that are used to categorise the literature relevant to this study. These areas are the philosophy and rationales for technology education; curriculum designs applicable to technology education; technology education in primary schools; the curriculum frameworks of Britain, Australia and Botswana and appropriate technology. The literature provides both the context and data for the research.

Technology has existed for a long time. Its definitions date back to at least the 1615 edition of New English Dictionary as "a discourse or treatise on an art or arts: the scientific study of the practical or industrial arts." Today there is a different interpretation of the concept and the idea of human adaptation to the environment is relevant. Komacek (1993) described technology "as the use of tools, materials and processes to meet human needs and wants; furthermore it is what is used by people to increase their ability to make or achieve something." These definitions, though written it different eras, have elements that can explain how technology can be useful to human life.

As outlined by Houliston (1992:5), technology education "... creates within the minds of students an ability to come to grips with the reality and philosophy of life and living, introducing them to problem solving methodology which can be used in every aspect in life." Technology education has the potential to impart to students some necessary skills for dealing with life. The problem solving approach used in most programs in technology education makes it an appropriate tool to use in this preparation. The aim of technology education as noted by Williams and Williams (1996:7) is to provide the learner with a relevant framework for the content and skills utilised in solving technological problems.

Philosophy of Technology Education

For a better understanding of what technology education means and its importance to everyday life it is useful to look at how it is being interpreted. The philosophy of technology education has been derived from two philosophies: the philosophy of "technology" and the philosophy of "education." Williams and Williams (1996:28) have

cited three main functions of education that philosophers have outlined. These are the transmission of culture and way of life, the improvement of the social environment and the provision for the needs of individuals.

Williams (1996) believes the philosophy of technology education revolves around issues such as values, determinism and technology as a discipline. These three issues are of vital importance when designing the curriculum. With technology and values, Pitt (1987) noted "if we are to get on about the business of dealing with technology in a way that increases human potential and decreases misery, disaster and human suffering, we need to agree on the basic set of values to avoid debilitating battles that value conflict seem to encourage"(p 32).

The issue of technological determinism is very important in that it is what teachers believe technology to be doing to the society and this influences the way they teach the subject. There is a disagreement amongst scholars about the ability to control the influences of technology. For example, Pannabecker (1991), noted that "technological determinism maintains that technology is predetermined to develop in a particular way because of certain conditions and events, without the possibility of human intervention" (p 36). Another school of thought views technology as a tool "that reduces chaos, it brings order and generally can centralise human efforts for the benefit of the public welfare" (Williams 1996:36).

The second issue is the view of technology as a discipline. The goal behind presenting technology as a discipline is to achieve a level of credibility for the area as well as providing a framework for the study of the area. Technology now is a core subject in the curriculum of many countries in the world and it has the following characteristics of a discipline (Dugger 1994).

1. It has principles in that it has the capacity for being generalised and applied to more than one situation. Examples of principles of technology are principles of mechanisms, rules of structures and laws of energy.

2. It has a body of knowledge in that it can lay claim to a pertinent body of knowledge and skills generated through thinking and action involved in creating products, environments and systems. Technology is inter-disciplinary in that subject matter can be derived from other disciplines. For example, environmental technology borrows from environmental science, biology and agriculture.

3. It has a distinctive methodology that it employs in the development of its principles, practice and knowledge that helps legitimise it as a discipline. The technology method is sometimes referred to as 'design method.' The design method involves a number of skills and activities that result in an acceptable solution to a problem. The design process involves students in the process of recognising the need, investigating and researching, suggesting solutions, producing, testing and evaluating.

The philosophy of technology education deals with questions about epistemology, axiology and metaphysics. Epistemology focuses on 'what is knowledge,' axiology relates to 'what is value' and metaphysics deal with issues of 'what is the nature of man.' The role that technology plays in a given society and the methodologies and content employed determines the philosophy of technology education. But a curriculum that accurately suits the scope and nature of technology education is the one that teaches:

1. how technology functions in a person's everyday life;
2. how technology creates a new technology;
3. how technology produces products and services;
4. how people use technology to meet their human needs and wants;
5. how people assess the impact of technology on themselves, the environment and culture.

Frey (1989) has done a philosophical examination of technology education. He states that technology is more action than theory and he developed considerations of technology as an object, as knowledge, as a process and as volition. These considerations assist in the development of a suitable curriculum for technology education.

When technology is defined as objects, what is envisaged are objects like tools, computers and modern machinery, along with concepts of machines and structures. These tend to mislead when trying to use them to define technology because they are examples of objects of technology. This is due to the fact that technology has long been treated as a field that is characterised by artefacts and the use of tools whereas it can be applied in a variety of applications such as computer technology.

The body of technological knowledge is based on practice. There are different types of technological knowledge as noted by Mitcham (1994), in Williams (1996). These are:

1. Artisan "know-how" which has been acquired by intuition or imitation;
2. Articulated rules of thumb or recipes about successful making or using skills;
3. Laws about relationships, which have been derived through experience and observation;
4. Theories that relate several concepts and laws together in practice. For example, the behaviour of materials under certain conditions and processes.

Processes as well as objects are technology outcomes. Technological processes are developed based on factors such as the environment, culture and time specifications. For example, the process of using cow dung to generate domestic gas is an idea that was found to be appropriate to environments with a lot of cattle.

The notion of technology as volition links together the elements of technology regardless of how they are conceptualised. These elements are such things as machines, processes, knowledge and materials. In technology human intervention is a distinguishing characteristic, for example the decisions made outside the restrictions governing design, production and use of resources such as time and money.

Rationale for Technology Education

Apart from the philosophical examination of technology education there are rationales which justify the teaching of technology education in schools. These include the economic, educational, pedagogic, cultural, environmental and personal rationales. In the economic rationale, technology is seen as a key to economic development of the nation. Students should acquire technological skills so as to provide for the manpower needs of society. The argument is further supported by the fact that technological innovations which have been going on since the 1940s have meant that the needs of industry and the type of manufacturing processes employed have changed radically, and thus the need for skilled manpower to cope with the changes (Jones, 1997).

The educational rationale for technology is that it is a unique mode of human operations and worthy of study on its own merits. Technological achievements are as equally a part of our culture as literacy, scientific or artistic achievements. The importance of technology education in schools rests upon the growing awareness of the cognitive

complexity inherent in combining knowledge with action. Technology education develops in students problem solving abilities and enhances personal qualities.

The pedagogical rationale states that technology provides the context for integrating knowledge and skills across the other learning areas extending to out of school experiences. It provides a source of understanding which can contribute to better learning. Technology education allows students to work from their background knowledge and skills. For example, students experimenting on making mud bricks which they have seen their parents or neighbours making before coming to school. This motivates students to learn even more to solve problems in an individual and innovative way. Jones (1997: 49) stated that "it is how acknowledged that intelligence and cognitive complexity are manifest in doing as much as in knowing." This implies that students' practical skills and knowledge will expand rather than becoming diluted. In this case, schools need to integrate knowledge and skills in a way as to enable them to apply the acquired skills and knowledge in real life situations. For example, the knowledge and skills learnt through appropriate technology may create in students the necessary skills and understanding to solve their everyday technological problems.

The development of technological solutions that meet human needs and interests provide motivation since students can realise the applicability of technology to their real life situations. They see themselves as part of the community because they can solve existing problems. Apart from providing motivation, technology education helps students explore its impact in their environment. This encourages them to take responsibility for their environment. Knowing the impact of technology education on the environment better equips students to cope with changes caused by technological advancement.

The cultural rationale for technology education is that technologies have been developed by different cultures. These cultural technologies are appropriate because they are within the cultural context of the community. Technology education should have these technologies as a starting point since they are familiar to students. In Botswana there are citizens of Zimbabwean origin whose livelihood consisted of manufacturing wood and metal products. Though this may seem like artefacts they make for a living, it has however continued for generations to become part of their culture.

Learning environments which address the needs of students are more likely to be appreciated by students. Therefore, technology education must develop students' technological literacy and awareness, they should be aware of their responsibilities in the technological society and become empowered to be active in response to the new technological changes. "Technology education provides a means of addressing the personal needs if appropriate recognition is given to assess regardless of gender, ethnicity, or academic ability" (Jones, 1997:51). The students, through learning technology skills, should be able to take risks, make sound decisions, be innovative and develop strategies to deal with problems. Furthermore technology education inevitably confronts conflicting constraints and requires judgements to be made by choice. These are influenced by values.

Summary

Technology education in schools is seen as a key to the development of the society. The technological skills the students learn help them cope with everyday life. Technology education helps to produce skilled manpower which is in high demand in the world today. This is due to the rapid changes in technological innovations which are prompted by development. Technology is a unique mode of human operations and is worthy of study, technological achievements are a part of culture. The problem solving skills that technology education imparts to students helps them deal appropriately with societal problems. It enables students to understand the restrictions particular technologies might have and therefore be in a better position to identify problems for which technology might provide solutions.

Epistemological issues of philosophy of technology education focus on technology as a body of knowledge that is based on practice. Mitcham (1994: 38) claimed that the knowledge of technology is "know how, a recipe about successful making, laws about relationships and theories which relate to several concepts and which qualifies technology as a body of knowledge." The issue of technological axiology teaches the students to an extent about their values and technological processes. The role technology plays in a given society, metaphysics, and the methodologies employed determine the philosophy of technology education of a particular society.

Curriculum Design

Stenhouse (1975), in Bynes (2000:1) noted that "curriculum should provide a basis for planning a course, studying it empirically and considering the grounds of its justification." Bynes (2000:1) used Stenhouse's notion and suggested different curriculum principles for each of the categories. These categories are planning, empirical study and grounds of justification.

1. In planning there must be:

    - Principles for selection of content, that is, what is to be learned.
    - Principles for the development of the teaching strategies, that is, how is learning going to take place.
    - Principles for making discussions of the sequence of what is going to be learnt.
    - Principles on which to diagnose the strengths and weaknesses of students and to differentiate the above general principles to meet the individual needs.

2. Empirical study should involve:

    - Principles on which to study and evaluate the students' progress.
    - Principles on which to study and evaluate the teachers' progress.
    - Guidance regarding the feasibility of implementing the curriculum in different educational contexts.
    - Information of the variability of effects in differing contexts, different students and an understanding of the causes of the variation.

3. In relation to justification there must be:

    - A formulation of the intention or aim of the curriculum which is accessible to critical scrutiny.

- The sum total of instructional and learning events, using certain materials and making certain pedagogical choices that are deemed to support appropriate educational goals.

According to Bynes (2000), there are four major components that make up the curriculum. These components are instructional sequence, pedagogy, materials and assessment, which curriculum development has to take into consideration. The instructional sequences of the curriculum, which are sometimes referred to as 'courses of study,' are achieved after determining the basis for selection and sequencing of content. This raises the issue of whether the curriculum is by design or by default. Pedagogy is defined by Simon (1981: 95) in Grimmitt (2000: 1) as "a theory of teaching and learning encompassing aims, curriculum content and methodology. Another is: a science of teaching and learning embodying both curriculum and methodology." He goes on to say, "The fundamental concern of pedagogy is to relate the process of teaching to that of learning on the part of the child." Pedagogy is very important in curriculum because it is part of the process of implementation and resource development. This is the area where designers think about how the curriculum is going to be put into effect.

The other two components of the curriculum are materials and assessment. Materials enable the designers to think about what is going to be used to facilitate the implementation of the curriculum. In primary technology, the materials may include tools, teaching aids, learning materials like books, workbooks or modules for students to follow. Assessment is a way of evaluating the goals and objectives of the curriculum. There are two types of assessment, formative and summative which provide information about student progress. In technology education, assessment would be done in both practical work and theory

The formation of a suitable curriculum is achieved after investigation into the different curriculum designs. A curriculum design provides the rationale for an approach to education. Zuga (1989:35) points out that "learning about a variety of curriculum designs and processes will result in a more informed technology education teacher, capable of making more accurate curriculum decisions." From the writing of Zuga, (1989), Williams and Williams (1996) and Kramer (1999) there can be developed six (6) different designs related to technology. These are:

1. competency based design;
2. outcome based design;
3. academic design;
4. intellectual process design;
5. personal relevance design;
6. social reconstruction.

The competency-based and the outcome-based curriculum models provide the basis of structuring the curriculum. Using one of the two models a curriculum framework can be developed. For example, Botswana's curriculum is competency-based while the Western Australian curriculum is outcome based.

Competency- based design

Competency based design emphases competencies as key organisers of content. It is a design where content is selected on the basis of achieving the objectives, and then the methodologies and other variables are designed according to the objectives. Assessment techniques are designed to measure the attainment of set competencies.

Tyler (1949), noted that the decision about objectives is made first, then other curriculum decisions follow, such as those relating to materials, content, methods, and tests. Taba (1962), working on Tyler's notion, proposed steps for developing a competency-based curriculum:

1. Diagnoses of the needs;
2. Formulation of objectives;
3. Selection of content;
4. Organisation of content;
5. Selection of learning experiences;
6. Organisation of learning experiences;
7. Determination of what and how to evaluate.

The distinguishing characteristics of organising technical instruction in a competency curriculum include a performance rather than a subject orientation. The subject matter relates directly to technical activities. In this type of curriculum, efficiency is the most important notion. Herschbach (1992) noted that in a competency-based curriculum "efficiency is a concept fundamental to the design of instruction based on the competency pattern: instruction is efficient to the degree that course objectives are

mastered." In a competency curriculum model, instructional efficiency is achieved through appropriate teaching methods, well-structured activities and materials designed to guide learning. If the objectives, which should guide the lessons are well structured, then instructional efficiency is likely to be achieved.

Botswana curriculum is a competency-based curriculum. In this design, competencies are the key elements for content. Content is selected based on achieving set objectives, and efficiency is an important notion of the curriculum.

Outcome-Based Design

During the late 1980s a different school of thought regarding curriculum design emerged. The believe was that competency-based curriculum alone could not be the most appropriate model for education. City (1985) and Spady (1988), in Kramer (1999) were among the first to come up with the idea of combining competencies with mastery of learning. This approach was called an outcome-based approach. The notion about outcome-based approach is that "clear statements of education and training outcomes, based on competencies, become the basis of flexible and integrated instruction strategies and assessment" (Kramer 1999:1). In an outcome-based design, competencies are combined with mastery learning, which Block (1971) noted "promotes the idea that all learners can achieve the desired teaching outcomes if given favourable learning conditions, such as flexibility in the time provided and alternative ways of learning." in Kramer (1999:2).

The rationale for using outcome-based curriculum has its basis in enabling learners to achieve high quality outcomes when given appropriate teaching, learning resources and time. There are three basic questions asked by Kramer (1999:3). The first is "how do we want to define an educated person in our society in the future?" Traditional models of curriculum design do not address this. It is necessary to relate the classroom to real life and for our learners to know world changes and be able to adapt to them is very important as technology changes are rapid.

The second question is "how do we know outcomes are achieved?" Outcomes are based upon the fact that learners can be assisted to create definite and reliable evidence of achievement. The other advantage which serves as the rationale is that students learn differently and at different rates. There is yet another notion that what is learnt is more

important than where and how it is learnt. The third question is "how do we teach and learn in the process of creating good evidence of achievement?" There is need to know the kinds of teaching and learning opportunities that exist to learn everything needed for the achievement of the outcomes.

The other four curriculum models: academic, intellectual process, personal relevance and social reconstruction provide the philosophical source of the curriculum. These models provide curriculum designers with the end result of the curriculum which was developed using either a competency or an outcomes model.

Academic Design

The Academic Design focuses on knowledge, which is grouped into broad concepts/fields and organised logically. The curriculum is characterised by separate subject disciplines. The rationale for this approach is that the core knowledge is found in the academic subjects that are mainly intellectual. Zuga (1989: 42) noted that "the design refers to organising concepts of the disciplines and subject matter in a way that concepts of a subject such as technology education are identified for the purpose of generating contrasts which cut across traditional skills and processes."

The content of the disciplines in the academic design are structured in ways that are appropriate to the specific discipline. McNeil (1981) identified the following structures:

1. Organisational structure - defines how disciplines differ from one another and establishes boundaries for the discipline.
2. Substantive structure - the type of questions to ask in inquiry, the data needed and how data is interpreted.
3. Syntactical structure - the manner in which the discipline grows and develops by gathering data, dealing with it, and generalising results.

Intellectual Process Design

This type of curriculum design deals with the development of cognitive processes such as thinking and problem solving or human processes such as creativity and self-confidence. It involves building on what students already know. It facilitates information processing and deep thinking through the use of meta-cognitive processes.

If education is aiming at developing the whole person, then for technology education to be valid, this design can be an appropriate design for curriculum development. Zuga (1992: 43) noted that "in technology the instructor identifies a problem solving model as the basis of the subject-matter and particular activities related to industry and technology for improving or teaching about critical thinking." Assessment is therefore an integrated part of the learning process, based on the development of these intellectual processes.

Personal Relevance Design

The Personal Relevance approach is learner-centred. The students partly or entirely dictate what is to be learned through their expression of interests. The goal of such a curriculum according to Petrina (1992) is a self-actualising, autonomous, authentic, healthy, happy person. Concepts which form the basis of this type of curriculum, in McNeil's view (1981) are:

1. All individuals participate in the curriculum and the learning process;
2. There is integration of material being learnt and integration in the humanistic approach taken;
3. The subject matter is relevant to the participants;
4. The person is an object of learning;
5. The goal is to develop the whole person with the society.

Based on its humanistic philosophy and the recent changes in technology education, the personal relevance design can be considered when developing technology curriculum. For example, the criteria of personal relevance are paramount in the selection of student projects.

Social Reconstruction Design

The Social Reconstruction design focuses on the application of knowledge to real life situations. Zuga (1992:44) notes that there are two sides to this design. She states, "One variation of the design could focus on social reconstruction with the assumption that the future of the society can be changed as a result of educational activities of the current generation." This assumption calls for a curriculum that incorporates social activities for the purpose of changing the.environment. The other variation is that "focus should be on social adaptation with the assumption that students are the raw materials of the

society, and they need to be shaped to conform with the existing values" (Zuga. 1992:44). This suggests focussing on the information that students need in order to fit into wider society.

Summary

While the models for designing the curriculum framework are competency based and outcome based, the academic, intellectual, personal relevance and the social reconstruction designs provide the philosophical nature of the curriculum. For example, the South African curriculum, though outcome-based, has followed the social reconstruction philosophy because of the post-apartheid era. The curriculum is meant to help draw together the society that was torn apart by racial segregation.

The competency-based curriculum is characterised by an "ends-means model." Objectives are the ends of instruction, that is, they are first identified. The content is designed to address the objectives and the instructional elements are then designed to assist the students to attain the objectives. These characteristics are shared with the academic and intellectual process designs. The academic design refers to organising concepts of the disciplines and subject matter in a way that the concepts of a subject such as technology education are identified for the purpose of generating contrasts which cut across traditional skills and processes. The intellectual process design focuses more on the thinking and problem solving or human processes such as creativity and self-confidence.

In contrast, the social reconstruction and the personal relevance designs have less emphasis on predetermined content. Curriculum development in the two designs is used in a broad sense, referring to both identifying the content and developing the instructional materials, learning activities and evaluation. This happens because content selection is influenced partly by what is known about the learners, their learning differences, background, ability, interest and learning style. Less concern is given to learning particular knowledge, so little distinction is made between the content and the delivery system of instruction. Egan (1978), in Herschbach (1992:16) noted that "what students are expected to learn is the product of the instructional activities, and may vary between learners. This is because it is thought that instructional content cannot be fully specified until students' characteristics and interests are taken into account."

Technology Education in Primary Schools

One area of importance of technology education in primary schools is students' cognitive development which is described by Kodat (2000:1) as "the process whereby a child's understanding of the world changes as a function of age and experience." Jean Piaget in Kodat (2000:1) stated four stages of cognitive development of children. The movement from one stage to the next occurs when the child reaches certain maturity and is exposed to certain experiences. The four stages of cognitive development are sensorimotor stage (ages between birth and two years), preoperational stage (ages between two and seven), concrete operational stage (ages between seven and twelve) and formal operational stage (ages from twelve through to adulthood). Most primary students are in the concrete operational stage

During the concrete operational stage children develop the ability to think logically, and are able to manipulate things. Technology education, through its ability to develop students' problem solving skills, is an ideal vehicle for children at this stage. At the concrete operational stage, technology can enhance the students' skills to deal with problems in their surroundings. The notion that technology is a unique mode of human operations, its impotence as a subject in schools resting upon the growing awareness of the cognitive complexity inherent in combining knowledge with action, give the basic argument of the importance of technology education in primary schools. Through skills learned in technology education students are able to deal more effectively with life.

Teaching technology using a cross-curricular approach (integrating technology with other subject areas like science, mathematics and/or art) in primary schools is common. Jarvis (1993: 16) noted that the advantages of a cross-curricular approach include that "the children are likely to appreciate the relevance of what they are doing, should see the opportunities for real technology in context, and will have covered real and relevant background knowledge."

Lewis (1981:76) suggested that "the good candidates for correlating technology include Agriculture, Home Economics, Art and Science... the correlative approach is suited for both elementary (primary) and secondary." He states that the advantages of this correlation are that primary school teachers are generalists and that they are expected to teach all the subjects to a particular class.

The suggestion put forward by technology education curriculum writers is that learning technology in primary school should be enjoyable. The Western Australian curriculum (1998:301) gives an example of an enjoyable activity. Students can play using blocks or recycled materials to learn about shapes. In this activity students are asked to make shapes using the different materials. Activities planned for students at this level must be motivating and play orientated.

For technology education to be successful in primary schools in Botswana, it has to be implemented in such a way that teachers who have not gone through formal training in the subject area can implement it successfully. Very few primary school teachers have been trained in technology education but they are expected to teach it. The theory noted by Jarvis (1993) that technology should be integrated into the already existing subjects to make the implementation easier is very important because teachers will not see technology as an extra work for them but instead as a way of enhancing what they are already doing.

It is stated in the Australian Statement on Technology Education (1994:5) that technology programs in primary schools "give students a broad foundation for further learning. They are taught by class teachers, sometimes in association with the specialist or resource people, with varying allocations of time to allow for different activities."

Curriculum Frameworks

The Australian Statement on Technology Education

In 1994, Australian Statement on Technology Education for Australian schools was introduced. It was to guide the Australian states on how to integrate technology into their curriculum. This was in response to the commonly agreed National Goals for Schooling in Australia developed by the Australian Education Council in 1989. The goals laid down by the council outlining the importance of technology as listed in the Statement on Technology Education for Australian Schools (1994:4) are:

1. To respond to the current and emerging economic and social needs of the nation, and to provide those skills, which will allow students maximum flexibility and adaptability in their future employment and other aspects of life.

2. To develop in students;

   - Skills to analyse and solve problem;
   - Skills of information processing and computing;
   - An understanding of the role of science and technology in society, together with scientific and technological skills;
   - A capacity to exercise judgement in matters of morality, ethics and social justice.

The content of the technology program outlined in the Australian Statement on Technology Education was to integrate theory and practice including much that has scientific, ethical, mathematical, graphical, aesthetic and historical effects for all Australians, irrespective of gender. Four independent strands for learning Technology in schools were set out. These were Designing, Making and Appraising, Materials, Information and Systems.

Apart from the four strands there are four bands, which categorise students as to their level of schooling. Bands A and B are for primary schools, and C and D are for secondary schools. The strands are covered in all the bands and the difference between the bands is the depth of the content. In order to measure student achievement, eight levels are used as assessment tools for progression. That is, students are expected to have achieved a certain outcome before progressing to the next level.

During Band A, students learn through participation in activities based on experience, personal interest and aspirations. They become increasingly aware of how technologies affect people's lives. Students at this band develop confidence in handling simple processes and products. Much of their work is spontaneous. They become more deliberate in their approach to the development of their designs and production.

In the design, make and appraise strand during Band A, students observe and explore needs. They observe and compare their products with others and assess their work and processes against initial specifications. "Much of their work is based on trial and error" (Curriculum Corporation, 1994:14). Students use modelling and drawing to convey their ideas. They become more critical of the quality of production by using techniques and equipment more accurately to realise their designs. Emphasis is placed on working collaboratively.

The Australian Statement on Technology Education (1994: 15) notes that "in their investigating, devising, producing and evaluating activities, students communicate their plans and actions in many ways. For example, they use sketches, pictures, diagrams, models, charts and role-play; follow simple oral and written instructions; write about the processes and products they create and debate alternative ways of doing things; and use appropriate names for equipment, techniques and functions." In this way students promote what they have done and resolve differences through discussions.

During Band A, the Information strand includes gathering and storing relevant information. Students consider resources, techniques and equipment needed for their tasks and they become increasingly aware of how information processes and products are designed and produced for a particular audience. They recognise how meanings and images can be affected by the form and structure of information and information products.

Also, students begin to understand the characteristics of materials and how to use them. They investigate the nature of materials and explore ways of using the materials. While investigating, students can determine the suitability of materials and establish methods of working them. They manipulate materials with increasing accuracy and control, becoming aware of time, resources, constraints and safety. Materials likely to be used during Band A are paper, wool, plastics, data, fabrics, construction blocks, sand and foil. Equipment used during this band includes needles, staples, adhesive tape, glue and hammers.

Furthermore, students investigate the application of systems, their components and control. They learn how to build systems and use a variety of energy sources. They consider resources, techniques and equipment for building simple systems.

According to the Australian Statement on Technology Education (1994) during Band B, students realise how technology affects people and their environment. They investigate why technology develops and start to appreciate the application of technology. At this band students begin to realise the elements of designing, making and appraising processes and that they are interdependent and they do not occur as a set of sequences.

The information strand in this band is achieved through students creating, organising and presenting information and its products. They understand the meaning of information as influenced by its form, style and presentation. The students' skills of

manipulating, transmitting and transforming increase on students. At this band they can gather, store, process, format and retrieve information in symbolic, graphical and numerical forms.

Now, students can select and use materials to meet their functional and aesthetic requirements. They consider the social and environmental implications of using particular materials, both natural and synthetic. Students in this Band examine economic and environmental factors in using, disposing and recycling materials. They apply skills and techniques learnt to work safely with materials and to achieve the intended specifications. Their manipulation skills and accuracy are also more precise.

More complex systems operations are evident in this Band. Students investigate the origin, nature and operation of systems. They then determine simple cause and effect relationship in systems. Systems are organised, assembled and disassembled and their performance is managed and controlled. In doing so, students become increasingly adept at choosing and using techniques to manage and measure the performance of systems and assembling them. (Australian Statement on Technology Education 19?4).

Most Australian states followed this statement until around 2000 by which time they had developed or were in the process of developing individual frameworks.

Western Australia (Technology and Enterprise)

Technology and Enterprise is defined in the Western Australian Curriculum (1995:290) as the "learning area that relates to the process of applying knowledge, skills and resources to satisfy the human needs and wants, extending capabilities and realising opportunities." The curriculum framework is outcome based. The focus on outcomes represents a shift from a focus on educational input and time allocation to the one that puts more emphasis on desired results. Technology has seven learning outcomes: technology process, materials, information, systems, enterprise, technology skills and technology in society.

The curriculum covers stages of child development from early childhood to late adolescence. These development stages are then tied to learning outcomes to give a clear picture of how children learn in different phases. As outlined in the Western Australian Curriculum Framework children at the early childhood stage, kindergarten to year three (K-3), display curiosity about aspects of life such as how things work. They

develop awareness of themselves as members of their families and community. During this stage children have experiences about the technology available in their homes. The school should stimulate and condition children to help them connect their existing skills, knowledge and experiences with new ones.

During this stage, the technology process is learned through thought and action, and trial and error. Students should be guided through questioning to recognise the stages of the process. They learn about different materials through handling, identifying and classifying. Their selection of materials for particular purposes may be on the basis of texture, flexibility, strength, smoothness or shape.

Students gather and store information from a variety of sources such as verbal information, texts and audiotapes. They develop the skills of specifying, gathering, sorting, and analysing information. The learning and teaching of information should enable students to describe simple ways in which people use, construct, present, store and transmit information. Students are given the opportunity to identify, assemble, use and control simple systems. While they investigate systems in their immediate environment it is important that they should be guided.

Later in the middle childhood, from year four to seven (4-7), children begin to see themselves as members of the community. They must be encouraged to work collaboratively as they are at the stage of appreciating other people's views. There is more emphasis on linking the different subjects where there is similarity as well as linking technology with other areas like Arts, English, Science Maths Social Studies and Music.

Implementation

Most Western Australian primary schools integrate technology with other subjects like science, maths, art, social studies and music. Co-ordinators are selected to initiate the introduction of the learning area. These co-ordinators serve as specialist teachers in their respective schools. The criteria for selecting a specialist is on the basis of their interest and willingness to work with other teachers. For example, in Safety Bay Primary School, the programme was introduced in 1996. The co-ordinator used staff meetings to make sure that teachers were aware of the programme. Other officers such as tertiary personnel and education department personnel monitored the programme and offered

support where required. This was mostly provided to in-service the teachers in areas which needed attention.

Initially, teachers' regarded the Technology and Enterprise learning area as if they had been given extra work to do. To avoid this mentality adequate teaching and learning materials were provided to them by the co-ordinators. In-service was also provided to increase the teachers' confidence in teaching the learning area.

New South Wales (Science and Technology. K-6)

New South Wales Science and Technology in the primary education curriculum is offered from kindergarten through to year six. The subject is covered in three stages (although there is an additional stage called "early year one" for pre primary schools/ kindergarten). As a two-year process, stage one is covered in years one and two, stage two is covered in years three and four and stage three is covered in years five and six.

The aim of Science and Technology is to develop in the students competence, confidence and responsibility in the subject, leading to an enriched view of themselves, society, the environment and the future with an enthusiasm for further learning in Science and Technology.

Objectives

On completion of their primary education, students should have developed knowledge, understanding and skills in the following content strands:

- Built environments
- Information and Communication
- Living things
- Physical Phenomena
- Products and Services
- Earth and its Surroundings
- The process of investigation that people use to develop reliable understanding of the natural and man made environments
- The process of Designing and Making that people use to satisfy their wants and needs
- The technologies people select and use, and how these technologies affect other people, the environment and the future.

Students should have engaged in learning experiences that would enable them to develop positive and informed values and attitudes towards themselves, towards others and towards science and technology.

Stage Statements

The stage statements, according to the New South Wales Outcomes and Indicators (1991:11), "provide a holistic description of student achievement at the end of a stage." At the end of key stage one, during years one and two, students are developing their vision and applying the scientific and technological understanding to different situations. Students start recognising how people create products, services and environments to meet their basic needs. They can interpret, create and recognise the purpose of investigation and seek further information as a result of their own curiosity. During stage one, students begin generating ideas and are able to choose the most appropriate for their needs. Through discussion with peers in class, students are able to label and explain their drawings. Students at this stage start manipulating some materials such as cardboard and paper that are available in their classrooms, and they use different tools to shape and deform these materials.

During stage two students become more independent in investigating something that has aroused their curiosity. They are able to seek clarification through questioning and researching from other sources of information. They start differentiating between natural and man-made materials and thus are in a better position to select appropriate materials based on their properties.

At stage three, which is covered during years five and six, students demonstrate a willingness to initiate their own investigation. The students use appropriate language of their choice. They are aware of the skills and processes involved in designing and making, investigating and using technology. Their display of designing skills involves using two and three-dimensional drawings.

The content strands listed above which differ in complexity are covered in each of the three stages to achieve a set of outcomes through certain processes. These processes are investigating, designing and making and using technology. A set of indicators is used to measure the level of attainment of a strand. For example, taking the content strand built environments, the processes are such that in stage one, the students create, modify or model built environments to suit the needs of users. The outcome that will be achieved

at the end of the process will be that students are able to explore and identify ways in which built environments suit their users. Indicators include students being able to describe an immediate environment, working collaboratively to build a house etc.

Queensland (Technology)

The Queensland years one to ten (1-10) syllabus, which was trialled in 2000, is outcome-based. It has organising ideas, level statements and associated learning outcomes that are organised into four strands. These are: technology process, which comprise investigation, ideation, production and evaluation; information; materials and systems.

Technology practice focuses on ways in which people respond to technological demand with information, materials and systems. The technology practice strand has four elements which are used to organise the learning outcomes. The elements are:

Investigation

- During investigation students identify and analyse needs and wants, opportunities and possibilities by collecting resources and examining how other people have solved the problems in order to determine their suitability.

Ideation

- Ideation is a stage where students generate a range of ideas and select the best one to solve the problem.

Production

- At the production stage students implement actions and make proposals, which may include prototypes or models.

Evaluation

- Evaluation is the stage where students test, evaluate and appraise their actions to determine their effectiveness in meeting the requirements of the problem.

The information strand focuses on the nature of assessment and the use of information. The organising ideas of the information strand include an understanding of the nature of information (this is recognising, seeking comparing and evaluating information). The students will develop techniques to generate, manipulate, store, present and access information

The materials strand enables students to be able to use different types of materials to develop their practical and theoretical understanding of materials. The organising ideas of the strand are an understanding of the nature of materials and techniques used to manipulate materials.

The systems strand focuses on ways of organising different components to work together. Students should be able to develop their understanding of systems by exploring, analysing developing and maintaining systems, and develop techniques for assembling and controlling systems.

In order to achieve the set outcomes the curriculum is structured into six (6) levels. These levels indicate the progression of increasing sophistication and complexity in the learning outcomes. There is a foundation level (before level one) which has been developed for students demonstrating a level of understanding that is lower than level one. For students to proceed to a higher level they must have achieved a reasonable level for set outcomes of the previous level.

Victoria (Technology)

The Technology Curriculum of Victoria has three (3) strands which are information, materials and movement/systems. The curriculum is spread over six levels. Levels one to three (1-3) are for primary schools, levels four to five (4-5) are for middle schools and level six (6) is for high schools. The strands in levels one to three (1-3) are information, materials and movement. In levels four to six (4-6) the strands are information, materials and systems. There are set outcomes and indicators for each strand in the six (6) levels.

During level one, students discover how information technology is used in schools and at home. At this level they learn about computers and their components. Students learn information through all four phases of the technology process. They investigate the nature of information, design information products, produce them and they evaluate them. This enables the students to identify, develop and modify simple information products. Indicators of this strand are for example, students being able to name three different types of information.

Students are introduced to materials through play and structured activities. They are encouraged to identify characteristics of common materials such as, paper, cardboard

and fibre. They are presented with a variety of problems that focus on materials and movement/systems. This makes them aware of the fact that materials are used to create moving parts. When working on the problems, students use the four phases of technology process, that is, investigation, design, production and evaluation.

The same process is followed in levels two and three. The difference is the depth of content. For example, during level two the students deal with more sophisticated computer programs and develop more accuracy in working with materials and movement.

South Australia and Northern Territory (Design and Technology)

The South Australian curriculum is articulated through three strands that are covered in all the four curriculum bands. These reflect the process of thinking and doing that constitute quality technology education. The four curriculum bands are early, primary, middle and senior years band. Learning across the bands pertains to the constructivist view of learning. The difference across the bands include changes in the kinds of and range of purposes, contexts, concepts, processes and reflection on learning. The strands are:

1. **Critiquing**- the key idea of this strand is to develop students' understanding about people, diversity and the technological world. Students learn to question by assessing their own and others' products, processes and systems.

2. **Designing**- in this strand the key idea is students being able to recognise and use different ways of thinking, preparing and planning that are helpful in achieving and presenting their designs. They learn that designing is possible to effect change.

3. **Making**- the key idea in this strand, making, is to develop students' confidence in their capacity to utilise materials and equipment to make products, processes and systems and, in so doing, reflect on how they work.

Standards

The South Australian curriculum has five performance standards. They are meant to depict the developing capabilities of students. They also serve as broad descriptions of expected growth and performance of students. These standards are

- Standard One - which is measured at the end of year two.

- Standard two - which is measured towards the end of year four.
- Standard three - which is measured at the end of year six. (This is the final year for primary education).
- Standard four - this is measured at the end of year eight
- Standard five - which is measured at the end of year ten.

The standards are used as a way of measuring students' achievement of the desired outcomes in each of the three strands. For example, in the strand critiquing, one of the developmental learning outcomes is that children develop trust and confidence. The standard used for this strand is that students can describe the role of functional characteristics of specific items of traditional, ceremonial and contemporary clothing from diverse cultures.

The key competencies as described in the South Australian curriculum framework (2000: 7) are "skills that underpin the transition from school to work, training and lifelong learning." There are seven (7) key competencies outlined in the framework which are covered in each of the bands. That is, the first band reflects all the key competencies.

- Key Competency 1: collecting, analysing and organising information;
- Key Competency 2: communicating ideas and information;
- Key Competency 3: planning and organising activities;
- Key Competency 4: working with others in teams;
- Key Competency 5: using mathematical ideas and techniques;
- Key Competency 6: solving problems;
- Key Competency 7: using technology;

Britain

In the British curriculum, Design and Technology is taught in four stages to students aged between 5 and 16 years. The four key stages are broken down in the curriculum to clarify what needs to be covered in each stage. Stages one and two are meant for primary and stages three and four are for secondary schools. The curriculum focuses on attainment targets. That is, the knowledge, skills and understanding that students of different maturity and ability level are expected to have achieved at the end of each key stage.

The British primary program aims at developing students' intellectual skills. Students should be able to make critical analyses and reason independently. In key stage one for Design and Technology the theme is knowledge, understanding and skills. Students should be able to develop, plan, and communicate ideas. They achieve these goals through generating and developing ideas, then planning and communicating them using different media. The other theme is being able to work with tools and equipment, materials and components in order to make quality products. The third theme is to be able to evaluate the work produced. This system is common in each of the other three stages.

The program of study for key stage one is meant to develop students' designing and making skills with knowledge and understanding in order for them to design and make projects. This is achieved by giving students the opportunity to develop their capabilities in Design and Technology through assignments which encourage them to design and make products, focused practical tasks and activities in which they investigate, disassemble and evaluate simple products.

The students' knowledge of materials is enhanced by giving them the opportunity to work with a variety of materials, investigating the characteristics of materials and applying skills, knowledge and understanding of other learning areas where appropriate.

Students should be introduced to design and make by directing them to draw their own ideas and to clarify them through discussion. They develop their own ideas through shaping, assembling and rearranging materials and components. Furthermore students develop their designing skills through sketching, modelling and by using actual materials with temporary fixings. They should be able to measure, mark, cut and shape materials, assemble, combine and finish products. At the end students should be able to evaluate their products and suggest future improvements.

The knowledge and understanding is focused on mechanisms; to use mechanisms like wheels and axles to create movement. Structures relate to how they can be strengthened and stabilised, products and applications relate to how things work. There is also emphasis on quality of their products, health and safety, and vocabulary.

During key stage two the same programme outline is followed but differs in depth. For example, during key stage one, students have their design skills enhanced through sketching whereas during stage two they use information sources to help them in

designing. Another component of knowledge and understanding during key stage two is that students must have control of how mechanisms can be used to produce different movements, and how electrical components can be used to produce functional results. This component is mechanisms in key stage one and it is called systems and control in key stages three and four.

The Design and Technology learning area has two attainment targets. They are designing and making. Each of these targets has eight levels. According to the National Curriculum (1995:13) "the level descriptions describe the types and range of performance that pupils working at a particular level should characteristically demonstrate." By the end of key stage one most of the students are expected to range in between levels one and three in both attainment targets. By the end of key stage two most students should range between levels two to five.

The curriculum is designed to allow for Design and Technology to be integrated with other learning areas. For example, in key stage two, basic electricity is done in science but it is a Design and Technology topic. The key stages comprise eight levels which students are expected to have attained by the end of each key stage.

Botswana

The Botswana primary curriculum is currently competency based. The primary education spans seven years. It is split into two levels: lower primary, which is from standard/year one to standard/year four (1-4), and the upper primary, which is from standard/year five to standard/year seven (5-7). Packaging of some subjects in the lower primary is done to facilitate project teaching and integration. Music, physical education, design, art and craft are combined and collectively called creative and performing arts. In upper primary, creative and performing arts comprise design and technology, art and craft, home economics, physical education and business studies. Nothing has been stipulated as a method of teaching the packaged subjects.

Lower Primary (Year One to Four)

Creative and performing arts, of which design, art and craft is a part, is intended to develop students' creativity, aesthetic skills, psychomotor skills and the love for the arts. At the end of the first four years of primary education the students should have developed (as outlined in the primary Curriculum Blue Print, 1996:15-16) the following:

- Problem solving and demonstration skills through designing, creating and performing situations;
- An awareness of the effects of art, music, physical education, design and technology on society in everyday life;
- An understanding of every commercial transaction;
- Critical thinking, inquiry, initiative, interpersonal skills and resourcefulness;
- The ability to express oneself creatively through design, making and performing within and about one's environment;
- Technology and performance literacy in the Arts;
- Healthy and safe working habits;
- Demonstrated psychomotor skills through manipulating tools and materials.

Upper Primary (Years Five to Seven)

By the end of their upper primary, students should have acquired knowledge and understanding about Creative and Performing Arts. The students should have developed creativity, practical/manipulative skills, attitudes and communication in creative and performing arts.

Summary

Technology education in primary schools in each of the three countries in this study is divided into developmental levels. The British primary technology curriculum is covered in key stages one and two. Technology education in Botswana curriculum is also spread across two levels. These are lower and upper primary levels. Most of the Australian states have technology in their curriculum spread out through levels or stages. The major difference between the Australian and the British as compared to the Botswana curriculum is that the Botswana curriculum is competency-based whereas the Australian and British are outcome-based.

The outcome-based curriculum which has been adopted by Australia and Britain, has its origin in two curriculum approaches; competency-based and mastery learning. Notions of competency-based approach that have been evident in outcomes noted by Kramer (1999:1) are that "clear statements of education and training outcomes, based on the relevant and useful competencies, become the basis of flexible and integrated instruction strategies." The mastery learning approach which also forms the basis for an outcome-based approach focuses on the need to create favourable learning conditions

with regard to time, teaching strategies and learning success. Block (1971) quoted by Kramer (1999:2) described mastery of learning as "promoting the idea that all learners can achieve the desired teaching outcomes if given favourable learning conditions such as flexibility in the time provided and alternative ways of learning." The model optimises the quality of teaching and the quality of understanding by students.

The other aspect evident in the Australian curriculum is that technology education content has been divided into strands. These strands serve as the guideline as to what is expected of the students. In Victoria the strands are information, materials and movement/systems. These are achieved through four faces of technology process which are investigation, designing, production and evaluation. Taking the information strand as an example, the students investigate the nature of the information, and then they design, produce and evaluate information products. Other strands are materials and movement/systems. In this case students are introduced to materials are encouraged to identify their characteristics. These materials include paper, cardboard etc. Apart from the strands the curriculum is spread through six progression levels. These levels are progressive. The first three levels relate to primary schooling and are covered in six primary school years.

Most of the Australian states have the strands, levels and outcomes except South Australia which uses key competencies. The South Australian curriculum is spread across four bands. Early years band and primary band are covered during primary schooling. Instead of the levels the South Australian curriculum has standards that are used to measure students' performance. The first three standards are measured during primary schooling. Standard one is measured at the end of year two, standard two is measured at the end of year four and standard three is measured at the end of year six. Apart from strands and standards the South Australia curriculum contains key competencies. These are skills that underline the transition from school to work, training and long life learning.

Implementing the primary schools' technology curriculum is commonly carried out by a cross-curricular approach, that is, technology is integrated with other related subjects. Subjects which have a technological flavour in primary schools include science, mathematics, social studies, art, music, home economics, agriculture and computer science. Technological strands like evaluation can be used as a way of enhancing

written and spoken English. This is particularly important for those situations when students do not have English as their first language.

Introducing technology education as an additional subject requires specialised personnel. Training staff can delay integration as it will be time consuming. But at the same time, teachers are expected to know exactly what is expected of them before they can implement the learning area. For those teachers who are already in the field there must be some in-servicing to guide them as to how they can implement technology education. To make in-servicing easy and manageable, some teachers are chosen from schools and trained to serve as specialist teachers in their respective schools. Technology education personnel support these teachers so that they gain more confidence.

Appropriate Technology

Dunn (1979: 3) described Appropriate Technology as technology that "is used to solve technological problems by providing sustainable solutions which are beneficial to the local community and which are sensitive to the need to reduce pollution by using renewable sources of energy and re-cycling materials whenever possible."

The effects of colonialism forced much of the developing world to train citizens to replace the expatriates. This led to young and growing governments of the world to embark on training people in developed countries. The technologies adopted were sophisticated and not appropriate to the majority of the people but limited to the few elite. Even today students in developing countries do not value the use of some of the technologies available in their communities. For example, some fail to appreciate the beauty and practicality of the mud/earth houses built by their elders. This needs to be reviewed. Education should be structured in such a way that locally produced materials enable the rural population to increase their production.

Appropriate technology is important because it aims at improving the people's quality of life and maximise the use of local and renewable materials. This notion forms the basis of the importance of appropriate technology in Botswana's education because appropriate technology is simple and user friendly. It is suitable for students in primary schools as it is one of the teaching strategies in education to start from simple and progress to complex technologies.

If students can learn appropriate technology at an early stage, they can develop the sense of environmental tolerance. Nyerere (1974: 156) has noted that appropriate technology education is the proper tool "to transmit from one generation to the next, the accumulated wisdom of knowledge of the society, and to prepare children for their future membership of the society and their active participation in its maintenance and development." Other advantages of appropriate technology to education are that technology education that is appropriate is that which is in the context to the students. It deals with locally available materials and resources that are familiar to students, it is cost effective and teachers, especially in rural areas can rely on these concepts.

Appropriate technology is used to solve technological problems by providing sustainable solutions which are beneficial to the local community. It provides solutions which reduce pollution by using renewable sources of energy and recycling materials whenever possible (Dunn 1979, http://www.personal.u-net.com 2000). There is need to use local skills, thereby using the knowledge and experience which already exist in the local community. In this way these skills can be passed from generation to generation (Nyerere, 1974).

McCullagh (1977: xiii-xiv) outlined the following characteristics of appropriate technology which are listed in the appropriate technology source book:

- Low Capital cost;
- Use of local materials whenever possible;
- Create jobs, employing local skills and labour;
- Are small enough in scale to be affordable by a small group of farmers;
- Can be understood, controlled, and maintained by villagers wherever possible without a high level of Western style education;
- Involve decentralised renewable resources, such as wind power, solar energy, water power, methane gas, animal power and paddle power;
- Make technology understandable to the people who are using it and thus suggest ideas that can be used in further innovations;
- Are flexible so that they can continue to be used or fit changing circumstances.

Summary

The use of locally available materials and renewable sources of energy cuts the overall cost and reduce the greenhouse effects that are caused by using some non-renewable

sources of energy. For example, the use of solar for cooking devices, like the one which was developed by the Botswana Technology Centre reduces pollution caused by the burning of coal which emits sulphur dioxide and nitrous oxides. "The use of appropriate technology should be economically viable on a long term basis for the community, and provide suitable employment opportunities" (http://www.personal.u-net.com 2000:1). Solutions provided by appropriate technology should bring advantages to the community. These advantages include health and safety, education and training, employment and income for local people. (The appropriate technology investigation model is in appendix two).

The Conceptual Model

The purpose of this study is to develop principles of curriculum design to guide the curriculum development in Botswana. The principles must be such that they will intermesh with the country's current curriculum context. The study used the following concepts when formulating principles: competency based design and appropriate technology are the inputs to the curriculum, and the principles are to develop the students intellectually, and to be personally relevant to them. These concepts have been reviewed earlier in this chapter.

Botswana's primary curriculum is competency based. In this design, competencies are the key elements for content. Content in this design is based on achieving set objectives, and efficiency is an important notion of the curriculum. The important factor for designing this curriculum is formulating objectives and their priority.

Appropriate technology is a very important approach to technology for Botswana. For a curriculum to be implemented throughout the country, in different environments, notions of appropriate technology must be taken into account. Appropriate Technology is defined as an approach to technology in which technological problems are solved by "providing sustainable solutions which are beneficial to the local community and which are sensitive to the need to reduce pollution by using renewable sources of energy and re-cycling materials whenever possible" (Dunn 1979:3).

The intellectual process design deals with the development of the cognitive processes such as metacognition and problem solving or human processes such as creativity and self-confidence. In technology education, problem solving is one of the key elements

and the intellectual design is focused on the development of problem solving skills. It must be taken into account when designing the curriculum. When formulating the technology education curriculum subject matter and activities to be included in the curriculum are made using this design.

Personal relevance design is learner-centred. Students partly or wholly dictate what is to be learned through their expression of interests. Goals of such a curriculum are to produce a self-actualising, autonomous, authentic, healthy, happy person. All individuals participate in the curriculum and learning processes. In technology education, students are encouraged to come up with their own designs and hence the importance of this approach.

The principles of technology curriculum design developed in this study are those which match the context of the curriculum of Botswana. The principles are appropriate to all environments irrespective of state of development or distance from the main centres. Evidence of personal development, must be demonstrated together with intellectual/cognitive development of the students. *Figure 1* illustrates this.

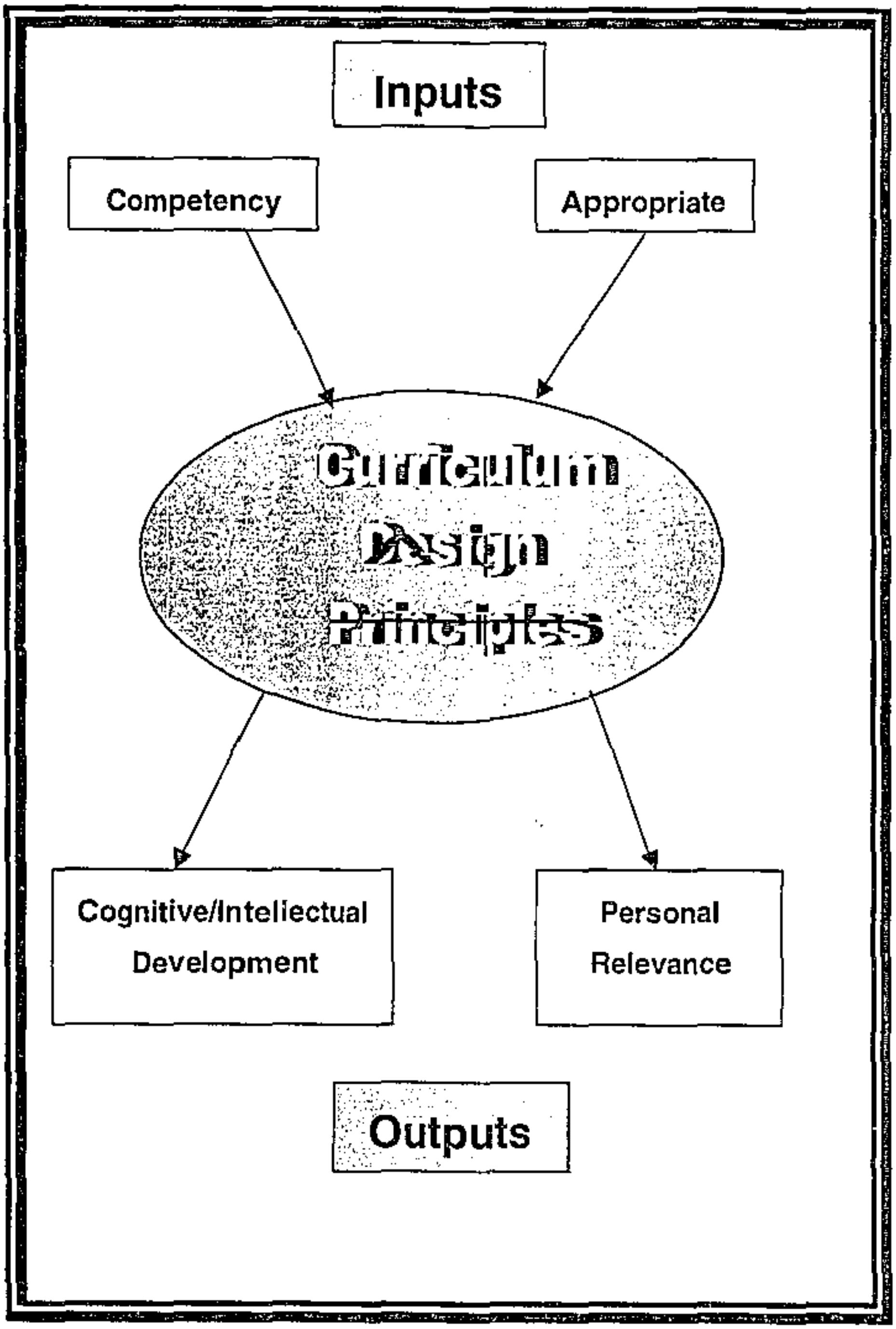

Figure One. The Conceptual Model

Chapter Three: METHODOLOGY

Introduction

This study used both qualitative and some quantitative approaches in collecting and analysing data. Data was collected from relevant literature, a comparison of the British and the Australian to the Botswana curriculum, and a survey of people with knowledge of technology education in Australia, Britain and Botswana. The sample for the study totalled twenty one (21) people in the three countries, both males and females. From this three-layered analysis was derived the principles of integration of technology in primary education in Botswana.

Context

Figure Two shows the context of the study from its broader perspective, that is, the Republic of Botswana, to its narrowest perspective, which is technology in primary education in Botswana. The Ministry of Education is responsible for the administration of the country's education. The Department of Curriculum Development and Evaluation produces the national curriculum, which comprises curriculum for all the subjects that are offered in primary, junior secondary and senior secondary schools. The primary and the junior secondary programs form the ten years of basic education. Design and Technology is offered in junior and senior schools but it has not yet been introduced in primary schools. The study focuses on developing principles for a Primary Technology program.

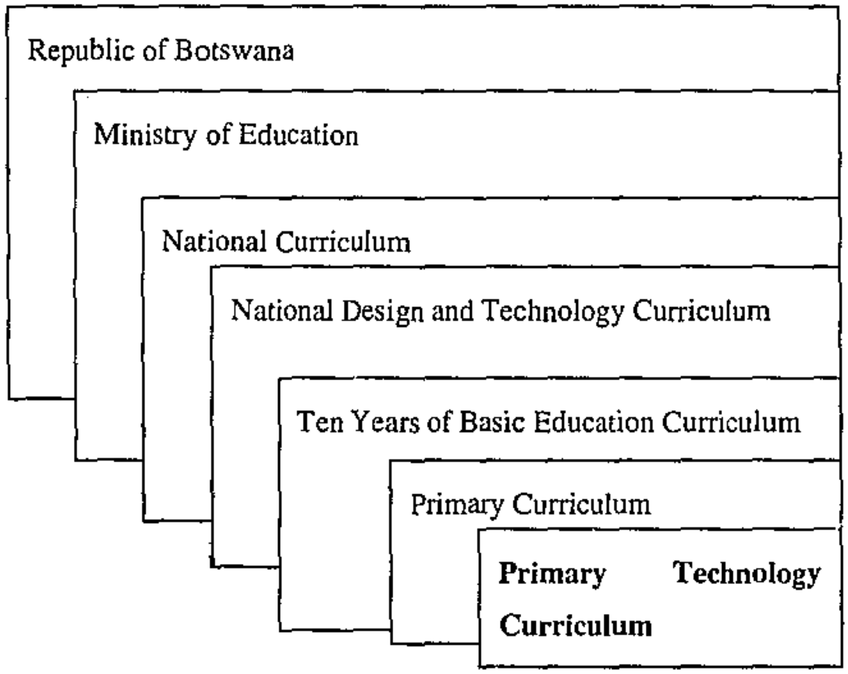

Figure Two. Context of the study

Data Collection

Data for this study was collected from the literature review and the survey. The literature review comprises philosophy of technology education which forms the basis of the significance of this study which is the importance of technology to the society, together with other rationales. Technology education in primary schools answers the questions, what, why, and how technology education is taught in countries like Britain and Australia. Principles of curriculum design, Australian, British and Botswana curriculum were reviewed in order to get a view of differences and similarities in terms of structure. Curriculum design literature provided different types of curriculum designs and their relevance to Technology Education and concepts of appropriate technology and how they can be integrated into the curriculum.

The survey based on curriculum design principles was designed and sent electronically to participants (21 participants) in all three countries. The survey had two versions, the word version and the web version (the word version is in appendix one). The purposive selection of the participants was based on their involvement in primary technology education curriculum designing. The questionnaire was designed to get information that was used for developing principles for curriculum design. An instrument designer was engaged to examine the questionnaire for face validity. The changes suggested by the instrument designer were made after discussions.

Variables and their Measurement

Introduction

The variables that were used in the survey followed Bynes' (2000:1) suggestions about principles of curriculum designing. He used Stenhouse's (1975:5) notion and suggested different principles for each of the three categories. These categories are planning, empirical study and principles in relation to justification. This study used one of the three categories: planning. Byrnes proposed that in planning there must be principles: selection of content, development of teaching strategies and making discussions to sequence what is going to be learnt. These principles are discussed in detail in the literature review chapter. Below is a discussion of the related variables and consequent questions used in the survey.

Number and country of residence. This variable was to identify where the responses were coming from and most importantly to be able to code the information according to the source and education background of the three countries if necessary.

Residence for the past five years. This was to establish exactly where the participants received their experience in technology education curriculum designing, if it was not from the three nominated countries. Since some other countries have programs totally different from those of Botswana, Britain and Australia, this question helped in coding the information.

Present Occupation. This variable informed the researcher whether the participants were still directly involved with technology education curriculum designing. The options provided to the respondents were; teacher, lecturer, technology education officer and other.

Experience of working with technology curriculum. The variable was set out to determine the experience the respondents in working with technology education curriculum. It enabled comparison of experience to find out similarities and differences.

Role (level and activity). The variable was a follow up on the previous variable, to locate participants' roles in the curriculum and at which level of schooling they took part in. With the level at which they were involved, the aim was to find out whether they were involved in primary, secondary tertiary or any other curriculum designing exercise. This assisted to validate other responses.

Principles guiding selection of content when planning primary technology curriculum. The variable was for the respondents to suggest the principles that should be taken into consideration when selecting content for the technology education curriculum. The question was not to suggest content for the curriculum but what leads to the content being selected.

Principles guiding the sequencing of content. This was a follow up to the previous variable that required the respondents to suggest ways in which the content of the curriculum is sequenced.

Considerations for selecting teaching strategies. The variable aimed at prompting the respondents to suggest methods that can best implement the technology education curriculum.

Should technology education be integrated with other subjects in primary schools? This question was meant to find out whether at primary level technology education should be introduced into the curriculum as an additional subject or should it be integrated with other related subjects such as science, art and mathematics. The response to this question was yes or no. This question aimed at getting the view of the respondents as professionals in the area because the literature reviewed suggested that at the primary level, technology education must be integrated with other subjects. In this case if it was introduced as an additional subject it would require specialised personnel of which in Botswana there are very few if none in primary schools.

Reasons for the response to the previous variable. This was a follow up to give the respondents a chance to say why technology education should be integrated with other subjects or why it should be introduced as an additional subject.

In Botswana primary teachers have not been trained for teaching technology education. Suggest three principles that could guide the implementation of technology curriculum in this situation. Implementation principles are very important because it would be pointless to design a curriculum without taking this into consideration. The respondents were to suggest ways which will benefit teachers in primary schools to teach the curriculum.

I would appreciate any other contribution you would like to make. The variable was for respondents to make any suggestion on other curriculum design aspects which could not be included elsewhere, as the respondents are experts in the field.

After the questionnaire was validated, it was sent to the twenty- one (21) participants to respond. A follow up e-mail was sent to check if all the participants have been able to access it. A week later fifteen (15) non-respondents were reminded.

Conducting the survey

Initially e-mails were sent to the participants informing them of the questionnaire through a consent form. The consent form had a reply email which was to be sent back whether the respondent agreed or did not agree to take part in the study. Initially there were twenty-six (26) people identified by the researcher with the help of the supervisor. Three (3) people were not contactable because they were away from their workstations. Two (2) declined from taking part in the survey. One (1) was retired and one (1) is not working in the field of technology education.

A trial copy of the questionnaire was sent out to a selected group of the participants (two from each country). Both versions were sent for trial. This was to determine whether there were problems like accessing the form from the e-mail, downloading, or problems of mailing it back. Respondents were also asked to check the validity. These computed questionnaires were examined to ensure valid comprehension of the items by the respondent. The respondents send back the trial copy of the survey and appropriate corrections were made. Below is the sequence followed in conducting the survey.

1. Introductory e-mail informing about the study and requesting them to participate with the consent form (Appendix. Three).

2. The trial copy of the survey was sent to a select group for access and validation.

3. Corrections made and the survey sent to all those who had agreed to take part in the study. They were given one week to respond.

4. After a week a follow up e-mail was sent to nine (9) non-respondent. Six (6) who had not responded to the consent form were also reminded (total: 15 people). The follow up emails are in appendix five.

5. Telephone calls were made to those who had not responded in two weeks. Six (6) telephone calls were directed to those who had agreed to take part in the survey. Two (2) responded. Two (2) were out of their workstations when telephone contacts were made. Two (2) were said to be too busy to respond. The final two (2) of the six (6) who did not respond after having send an e-mail agreeing that they would take part could not be traced.

Data Analysis

Data was analysed with the aim of formulating principles for curriculum design which will guide the integration of technology into primary education in Botswana. Both qualitative and quantitative methods were used for analysing data in this research. The data analysis of the survey followed the descriptive survey analysis of Burns (1994:365), "this consists of determining the frequencies for the major variables involved in the study." These were then summarised and reported.

The qualitative research approach used in the research was the "reductionist interpretative approach" of Miles and Huberman (1984). This approach reduces data to patterns and categories. One of its procedures is analytical description and structure. In this, the researcher clarified the summary of reviewed literature and data collected in order to identify themes, patterns, topics and roles (LeCompte, Millroy, and Preissle, 1992). This editing enabled the evaluation of the conceptual framework that identified categories relating to the information in the data. Punch (1998) explained that this process is facilitated by the use of labelling, indexing, editing and summarising.

Finally the conclusions drawn from the results were discussed to answer the following questions;

1. What is the rationale for introducing technology education in primary schools in Botswana?

2. How has technology education been integrated into Australian and British curriculum?

3. How can concepts of Appropriate Technology be incorporated into technology education at primary level in Botswana?

4. Upon what principles should the integration of technology education into primary education in Botswana be based?

Limitations

The study will be conducted under the following limitations

1. Focus was on curriculum frameworks of Britain, Australia (and its states) and Botswana only. This is to avoid a very wide scope and also the education system of Botswana is more inclined to Britain and Australia

2. The study did not include assessment because of time limitations. This can be done in future research.

3. Due to the limited number of people with technology curriculum design knowledge, the target group was very small.

4. Communication, access to the Internet and work commitments made it hard for some people to respond to the survey. Two of the respondents were sent the survey and could not respond because they were busy. Three people could not be traced as they were out of their workstations. Further telephone calls were made but could not reach them. Three non-respondents from Botswana did not respond to the survey.

Chapter Four: PRESENTATION AND ANALYSIS OF DATA

Introduction

Data for this study was collected through a review of literature and a survey of people with primary technology education curriculum designing experience in Australia, Botswana and Britain. This chapter presents and analyses the collected data to answer the following research questions:

1. What is the rationale for introducing technology education in primary schools in Botswana?

2. How has technology education been integrated into Australian and British curriculum?

3. How can concepts of Appropriate Technology be incorporated into technology education at primary level in Botswana?

4. Upon what principles should the integration of technology education into primary education in Botswana be based?

The literature and the survey provided both qualitative and quantitative data. The qualitative method is used for analysing data to answer questions one, two, three and part of question four. This followed the reductionist interpretive approach of Miles and Hobberman (1994). The reductionist approach reduces data to patterns and categories. Its analytical procedure enables the researcher to summarise the reviewed literature and collected data in order to identify themes, patterns, topics and roles. The quantitative method used in answering question four follows the descriptive survey analysis of Burns (1994). This consists of determining frequencies for the major variables involved in the study. The purpose of this chapter is to present and analyse information for answering each research question.

What is the rationale for introducing technology education in primary schools in Botswana?

Introduction

"Technology Education is an integrated, experience-based instructional program designed to prepare the students to be knowledgeable about technology- its evolution, systems, technologies, utilisation and cultural significance" (www.techedlab.com). Technology education relates to the process of applying knowledge and skills to satisfy human needs and wants. The rationale for teaching technology in schools is based on its economical, educational, motivational, cultural and environmental importance (Jones 1997). It has the capacity through its ability to develop the students' problem solving skills to develop their mental ability to cope with the changing world.

The rationale for teaching technology education in schools

Technology is seen as the key to economic development of any nation. Students should acquire technological skills so as to manage the manpower needs of society. The argument is further supported by the fact that technological innovations have meant that the industry requirements and the type of manufacturing processes employed have changed radically, and thus the need for skilled manpower to cope with the changes (Jones 1997).

The educational rationale for technology is that it is a unique mode of human operations and worthy of study on its own merits. The importance of the subject in schools is based on the growing awareness of the cognitive complexity inherent in combining knowledge with action. Technology education develops students' problem solving abilities and their personal qualities. It also provides a source of understanding which can contribute to better learning. Technology education enables students to work from their background knowledge and skills. This advancement motivates students and they in turn learn more in order to solve problems as an individual and in an innovative way. The schools then need to integrate knowledge and skills which will enable students to apply learning in real life situations. For example, knowledge and skills learnt through appropriate technology creates in students the necessary mechanism to solve their everyday technological problems.

Technological solutions that meet human needs and interests provide motivation since students can realise the applicability of technology into their real life situations. They see themselves as a valuable part of the community because they can contribute to some real situations. Apart from providing motivation, technology education helps students explore its impact in their environment. This encourages them to take responsibility for their environment. By recognising the impact of technology education on the environment students will be better equipped to handle changes caused by technological advancement.

Technologies have been developed by different cultures. Their cultural technologies are appropriate because they are bounded within the cultural context of the community. Technology education should have these other technologies as a starting point as they are technologies that are familiar to students. Technology education provides a learning environment which address as the needs of students and thus is likely to be appreciated. For example, most students in Botswana have had experience in building mud/earth houses which are traditional Tswana houses. This can be a starting point when teaching about structures as they are familiar with the concept.

Technology education must develop students' technological literacy and awareness. They should recognise their responsibilities in the technological society and be empowered to actively contribute to the technological changes. The students, through learning technology skills, should be able to take risks, make sound decisions, be innovative and develop strategies to deal with problems. Furthermore technology education inevitably confronts conflicting constraints such as importing other technologies which requires judgements to be made by choice. These are influenced by cultural values.

Conclusion

The importance of teaching technology education relies on several issues: the role it plays in a given society, the economic importance of technology education, the educational importance and the role it plays in culture and the environment (Jones 1997). The economic development that takes place has been due to technological innovations that have been created in the world. When we talk of economic development there is no way technology education can be left behind. The technological skills that students acquire can help them meet their individual and societal needs.

Williams (1996) shares the same idea that technology must transmit culture, improve the way of life and the social environment, and meet the needs of the individuals to clarify the reason why the learning area has to be introduced in schools.

The educational importance of technology education rests on the awareness of the cognitive complexity inherent in combining knowledge with action. The nature of technology education provides the context of integrating knowledge and skills across other learning areas. It provides an understanding which can contribute to better learning and enables students to use their background experience. For better technological outputs, the education system needs to apply processes that can be applied in real life situations.

The motivation that technology education provides enables learners to recognise themselves as part of the technological society. Therefore technology education is a vital learning area in the education system. Apart from the motivation it provides, technology education develops in students the ability to explore its impact to the environment. This makes students responsible to the environment in which they live. Activities such as those in appropriate technology are very good examples of the awareness of the negative effects technology can bring to the environment. Appropriate technology encourages the production and use of technology that is safe for the environment.

Technology has been around as long as mankind. Different cultures have come up with different technologies to suit them. Although students are aware of some specific innovations, they might not use the term 'technology'. For example, the traditional way of drawing water from the well using a crank is not known as a technology. Therefore, when teaching concepts like mechanisms, these technologies should be identified and juxtaposed with concepts students already know. The ability of technology to develop technological literacy makes it a good candidate for being part of the curriculum. Development cannot be achieved unless people are technologically literate.

How has technology education been integrated into Australian and British curriculum?

The curriculum of Britain and selected states of Australia together with related literature were reviewed. The Botswana curriculum was also reviewed in order to establish its

similarities with Australia and Britain and how technology education can be introduced in a competency based context in Botswana.

The National Statement on Technology Education for Australian schools was introduced in 1994. One of its goals was to develop in students the skills to analyse and solve problems, to create in students' minds an understanding of the roles of science and technology in society and to develop scientific and technological skills. To achieve this, four independent strands were set out. These were: Designing, Making and Appraising; Materials; Information and Systems. Together with the strands, four bands were formulated. They are such that bands A and B are covered in primary school and C and D in secondary. Students' achievements were measured using eight progressive levels.

Different Australian states have since developed their own outcome based technology education curriculum. In Western Australia, the curriculum has seven learning outcomes. These are: technology process (investigating, devising, producing and evaluating), materials, information, systems, enterprise, technology skills and technology in society. The Western Australian curriculum covers stages of child development, from early childhood to late adolescence. The two primary development stages are early and middle childhood. These are students attending kindergarten through to year seven.

During the early childhood stage, children display curiosity about aspects of life such as how things work. They develop understanding of technology in school and at home. The school stimulates conditions to help children connect their existing experiences with new ones. Technology process is learnt through thought and action, and trial and error. The role of the teacher is to guide students through the learning by pointing it out as a process. Information is gathered from a variety of sources. For example, through audio and text students develop skills of specifying, gathering, sorting and analysing information. During the late childhood stage children see themselves as members of the community. Emphasis is put on students working collaboratively as they start appreciating other people's work (Curriculum framework 1998: 301-305).

The New South Wales primary schools science and technology curriculum is offered in three stages. Stage one is covered in years one and two, stage two is covered in years three and four and stage three is covered in years five and six. The curriculum (primary) has content strands which are building environment, information and communications,

living things, physical phenomena, products and services and earth and its surroundings. To cover these content strands, technology processes were developed. These are investigation, designing and making, and using technology.

The Queensland technology curriculum uses organising ideas, level statements and associated learning outcomes. These are organised in strands, which are technology practice, investigation, ideation, production and evaluation, and information, materials and systems. To achieve these strands and desired outcomes, the curriculum has six levels. These levels indicate students' progression. The levels develop in sophistication.

The Victorian primary technology curriculum is spread over three levels. These are formulated to achieve three technology strands: information, materials and systems/movement. These are achieved through students investigating designing, producing and evaluating (technology process) their products. There are set outcomes and indicators for each of the six levels. For example, in level one, information strand, students are expected to investigate the nature of information. They are expected to design, produce and evaluate information products.

The South Australian curriculum, also used in the Northern Territory, is articulated through three strands which are covered in all the four curriculum bands. The primary school band is 'the primary years band.' Learning in this band pertains to the constructivist view of learning. The difference across the bands includes changes in the kinds of and range of purpose, contexts, concepts, processes and reflection on learning.

The South Australian primary schools technology strands are critique, designing and making. The curriculum has three standards that are used to evaluate students' progression. Standard one is measured at the end of year two, standard two is measured at the end of year four and standard three is measured at the end of year six.

The British curriculum is covered in four stages. Primary schools cover stages one and two. Students are taught to develop their Design and Technology capabilities through combination of their Designing and Making skills with Knowledge and Understanding so as to design and make products. The emphasis that is put on knowledge and understanding is on mechanisms, structures, products and applications, quality, health and safety and vocabulary. These are common in the stages but differ in complexity.

The Botswana curriculum is competency based. Its prime aim is to achieve the set objectives. The primary education curriculum is divided into two levels. The curriculum, through the recommendations of the 1996 Education Commission, has some subjects packaged to allow for the two levels. Technology education is packaged with other subjects like art, home economics, music and physical education.

Implementation Strategies

In both Australia and Britain, technology education in primary schools is generally taught by class teachers. The initial implementation of the subject was by cross-curricular approach. Subjects which seemed appropriate to integrating technology education with are science, maths, art, social studies and music (Lewis 1981, Javis 1993). For example, in social studies when teaching about shelters, students can be asked to design and model different houses they have seen. Students should be allowed to design structures with which they feel confident. Emphasis must be put on appropriateness of the shelter to different people in the community. This can be done in groups for easy management. When integrating technology education with other subject areas, consideration should be taken to integrate in a way that technology maintains its nature as a 'hands on' discipline.

In some primary schools it is recommended that certain teachers be nominated from schools and trained to serve as specialist teachers or coordinators in their respective schools. Nomination of these teachers may be based on knowledge, interest, participation in technology, out of class events and education. The implementation of the program is reinforced by various stakeholders such as the education department and tertiary personnel as well as parents who may assist the teachers with ideas for teaching in the learning area. These people organise and run workshops (in-service training) for teachers and they address specific problems that might be experienced in individual schools which might be difficult for the specialist teachers.

Conclusion

The similarities amongst the curriculum of the Britain and states of Australia are that primary education is divided into stages, though some Australian states differ in the number of stages. There is evidence of these stages in Botswana in that it has two stages, lower and upper primary. These stages describe the progression of students from

the early stages of their primary education to their later stages. For Britain and Australia the stages extend to secondary education. British and Australian curriculum are wholly outcome based except for the South Australian curriculum which, though outcome based, has some key competencies.

Content in the British and the Australian curricula is progressive in that the stages through which the children progress are systematically developed from simple to complex. Each stage is relevant to the capabilities and age of the students. The two curriculum are well written and explained. Teachers can easily understand what is expected of them. In contrast, the Botswana curriculum is not structured progressively.

In Australia and Britain, primary teachers' support materials are prepared so they can be accessed from the Internet. For example, the New South Wales curriculum website (http://www.bosnsw-k6.nsw.edu.au/scitech/k6_scitechsyll.pdf: 228) contains a list of resources from which teachers can access information. In other situations where there is no Internet access, the education department and the specialist teachers are responsible for developing the teacher support materials. In Botswana there are no teacher support materials, which would be important because teachers in the field have not gone through formal technology education training.

Furthermore, Lewis (1981) and Javis (1993) made suggestions that technology education in primary schools be integrated with science, maths, art, social studies and music, agriculture, business studies and home economics. The packaging of subjects in the Botswana curriculum is not consistent in the two levels. Also it does not take into consideration the subjects that are relevant to technology education. Packaging should be done with relevant subjects and the name should always include technology, as its aim is to give the students the basics of technology and not of design, art and craft.

In most cases in Australia and Britain, technology education is integrated with other subjects. These subjects are those which can accommodate technology education concepts. For example, systems can be taught in science classes. Integrating technology into other existing subjects makes it easier for introducing technology into the curriculum. This is because technology does not seem to be an additional subject for primary teachers who teach all the subjects to their classes and therefore making integration easier and more successful.

How can concepts of Appropriate Technology be incorporated into technology education at primary level in Botswana?

Principles of appropriate technology are very important as they can guide its concepts to be incorporated into the primary technology curriculum. The following are the principles of appropriate technology.

Appropriate technology encourages the use of renewable fuels. For example, the use of solar energy to provide power for rural houses and the use of wind to pump water. Such materials are environmentally friendly and cheap to maintain. Those sources of energy that are non renewable like oil, gas are generally expensive.

Locally available materials are generally cheap and it is more likely that the local people are knowledgeable about them. They do not require the expense of high technology equipment. In class such materials are recommended since students can start their projects on time. Because of the local knowledge about the materials it is less likely that materials which are not environmentally friendly are used.

Technology curriculum must take into consideration the cultural aspects of the local people. One of the principles of appropriate technology is that the culture of the local community be taken into account. Technology that is appropriate must suit the local peoples' needs and encourage self-reliance. The different local modes of transport must be investigated. This helps when some materials need some modern modes of transport which are expensive to run and maintain. Appropriate technology aims at improving the lives of local people. For example, in Botswana the Rural Industries Innovation Centre has developed a baking oven constructed from mud/earth. Local people have, therefore been assisted to make a living by baking bread using this inexpensive and locally produced innovation.

Appropriate Technology is technology that solves technological problems by providing solutions which are relevant to the local community. Appropriate Technology is concerned with using renewable sources of energy and recycling materials whenever possible to reduce pollution of the environment. It aims at improving the lives of people by providing employment to the local community and maximising use of local materials. (Dunn 1979).

For technology to be appropriate for the local people it must be cost effective, involve local skills, affordable, user friendly and flexible to develop for the future. The notion by appropriate technology writers that it must use locally available and renewable materials makes it ideal for students at primary school, as they will grow up with the knowledge of caring about the environment. Students will develop positive attitudes towards the environment (McCullagh 1977). The fuels that are not environmentally friendly are those which will have more negative impact on the environment. Such as coal and paraffin. Incorporating concepts of appropriate technology to the curriculum will reinforce the rationale for teaching technology education, that technology develops in the students the awareness of the impact of technologies to the environment.

Conclusion

Botswana is a developing country and society has developed over time ways of coping with life. For example, the building of the mud/earth house and the structure involved in roofing these houses is something that has been going on for a long time in Botswana and students are familiar with it. The products that students should be engaged in should be those which will be usable in their real life situations. The students must be aware of the fact that technology can have both a positive and negative impact and appropriate technology can be a good mechanism to impart this awareness. The principles of appropriate technology, that it should use renewable materials and that there must be recycling whenever possible, are proper principles which can enlighten the students about the effects of technology to the environment.

The projects that the students engage in must be those which are cost effective. The notion by appropriate technology that 'when you are poor start simple' serves as very good advice to technologists that there is no way one can jump into advanced technologies when no resources and manpower are available for that purpose. Primary schools also lack resources such as finance, so this type of technology can alleviate this problem because locally available materials are usually cheaper. If help is needed for such activities then local people can be called instead of waiting for some specialised personnel who might be unable to solve the problem.

Upon what principles should the integration of technology education into primary education in Botswana be based?

A survey was conducted and respondents were purposively selected from Australia, Botswana and United Kingdom. A total of 21 were sent the survey and 17 (80.95%) people responded.

Background Information

Country of Residence

Of the 17 respondents, six (35.29%) were from Australia, seven (41.17%)from Britain and four (23.53%) from Botswana. Table 1 shows the number of respondents and their percentage in the three different countries.

COUNTRY	NUMBER OF RESPONDENTS	PERCENTAGE
Australia	6	35.29
Britain	7	41.17
Botswana	4	23.53
TOTAL	**17**	**100**

Table 1: Number and country of residence

Previous Residence

The other background information that was asked of the participants was to find out where they had worked for the last five years. The results showed that fourteen (82.35%) respondents had spent the previous five years in their respective countries. Two (2) other respondents spent five years in one of the countries which the study is focusing on. Only one (1) person was in a country that is out of the study's parameters. Table 2 shows the results of where the respondents spent their last five years.

Residence for the past five years	Number	Percentage
Australia	6	35.29

Britain	5	29.41
Botswana	3	17.65
Other	3	17.65
TOTAL	**17**	**100**

Table 2: Residence for the past five years

Occupation

Of the 17 respondents, eleven (64.71%) are technology education lecturers, three (17.65%) are technology education teachers, two (11.76%) are technology education officers and one (5.88%) is retired. Table 3 shows the results of the respondents' occupation.

Country	Teacher	Lecturer	Technology Education Officer	Retired
Australia	2	4		
Britain		6		1
Botswana	1	1	2	
Sub Totals	**3**	**11**	**2**	**1**
%	**17.65**	**64.71**	**11.76**	**5.88**

Table 3: Occupation

Experience

All of the respondents who took part in this study have more than five years experience in the field. Six (35.29%) have more than 20 years experience, five (29.41%) have between 16 and 20 years experience, three (17.65%) have between 11 and 15 years and three (17.65%) have between 6 and 10 years experience. Table 4 illustrates the respondents' experience.

No. Of Years	No of respondents	%
1-5	0	0
6-10	3	17.65

11-15	3	17.65
16.20	5	29.41
Over 20	6	35.29
Total	17	100

Table 4: Experience

To collect information to answer question four a series of sub questions were incorporated in the survey. This analysis of the findings used the "reductionist interpretative approach" of Miles and Huberman (1984). This approach reduces data to patterns and categories. These patterns and categories have been discussed under the following sub headings.

Planning Primary Technology Education Curriculum

As regard the selection of content, the responses were grouped together and the following themes were derived: national principles, environment, student growth and development, appropriate technology and aims of technology education and learning needs.

National Principles

Thirteen (76.47%) participants made suggestions as regard national principles. Some of their contributions were based on the aims of education of a particular country. For example, one of the aims of education in Botswana is to build a self reliant nation. For the content selection to fit well into the national principles it must also fit well into the aims of education of the given country. An example of such an aim is developing the students to be future citizens. There was another suggestion that, for content to be relevant, the aims of the curriculum must be addressed, that is, the mission statement: what is it that the curriculum wants to achieve.

The four national Principles of Botswana are: Democracy; Self-reliance; Development and Unity. The curriculum must take into account these four national principles and the "Vision 2016" (1999: 2) which asserts one of the aims of the Ministry of Education as that, " by the year 2016, Botswana will have a system of quality education that is able to adapt to the changing needs of the country as the world around us changes."

Environment

Four (23.52%) participants suggested that content selection must take into consideration environmental issues. They suggested that students' home environment has an influence on selecting content. Students' immediate environment must be taken into consideration, that is, what they already know from their home background before coming to school, and the regional and geographical context of the home and school.

Students' Growth and Development

On the theme of students' growth and development nine (52.94%) respondents believed that curriculum content must focus on a plan of sequential development of the young minds. The selection must take into consideration the ages of its students. The content must aim at developing students mentally and psychologically. Respondents shared the same view as followed by Australian states and Britain for structuring their curriculum in progressive levels.

Appropriate Technology

Four (29.41%) respondents suggested that for content to be valid, it must meet the needs of the society taking into consideration locally available materials and the students' home experience. They share the same view as Dunn (1979), that appropriate technology is important because it aims at improving peoples' lives and maximising the use of local and renewable materials. The curriculum should include concepts of appropriate technology. For lower primary, students can use materials such as reeds and grass which are locally available and easy to work with (reeds bend easily without breaking). During the exercise students will learn to thread as a method of joining. Teachers should also talk about the advantages and the disadvantages of threading.

Aims of Technology Education and Learning Needs

Eleven (64.71%) of the respondents stated that technology education content must aim at developing students' knowledge, skills and attitudes. It must also develop technological literacy and awareness. Content must be selected on the basis of involving students in the process of designing. That content must encourage students' involvement in coming up with the solutions to problems. In addition students should be encouraged to identify needs that require some practical solution. For example, when teaching health and diseases in science, students can collect used tins to make bins to dispose needles to combat the spread of AIDS.

Sequencing Content of Technology Education Curriculum

All the respondents made contributions to the sequencing of technology education content. Their responses were themed under the following sub headings; consistency, relevance and progress.

Consistency

According to information gathered from sixteen (94.41%) of the respondents, sequencing of content must be consistent. There must be no gaps which will lead to difficulty in teaching the concepts that follow. That is, the next concept must build on the previous one and there must be logical flow from simple to complex. The consistency of the curriculum content can be maintained by levels of progression.

Relevance

Fourteen (83.32%) respondents suggested that content of the curriculum must be relevant to students' capabilities. That is, it must be sequenced such that there is a clear distinction of what is expected of students at different levels/standards. It must be sequenced such that it will develop the students and empower them to be innovative. The content strands can help keep the content relevant. The strands are broad areas on which the curriculum content is based. For example, Western Australian content strands are Technology process (investigation, devising, producing and evaluating), materials, information, systems, enterprise, technology skills and technology in society.

Progress

Three (17.64%) respondents replied that sequencing of content for primary technology education must be progressive, that is, for it to be relevant to the aims of the subject it must take students' developmental stages into consideration. These responses agree with Piaget (1977) who noted that, "educators must plan and develop a developmentally appropriate curriculum that enhances their students' logical and conceptual growth." The progression levels can maintain the progression of the curriculum content.

Teaching Technology

All the respondents contributed to the question on how to select teaching strategies. The responses have been themed and are discussed under the following sub-headings: resources, nature of the curriculum, learning environment and approach and type of students in class.

Resources

Teaching strategies are influenced by the availability of resources. Sixteen (94.41%) respondents mentioned the financial, physical and human resources. Some teaching strategies might require expensive equipment; if there are not enough funds it becomes difficult to employ such strategies. Teaching strategies must take into consideration the teachers' confidence. Furthermore there is a suggestion that teacher qualifications must be taken into account when selecting teaching strategies. Taking Botswana as an example, most of the teachers are technically unqualified as regards technology education; therefore strategies that are chosen for them must initially be clear and simple. Availability of materials for both teachers and students can influence the way concepts are taught. Therefore the more material, the wider the strategies' selection criteria can be.

If appropriate technology can be incorporated into technology curriculum, problems caused by resources can be reduced. The use of locally available materials which are cheap and known to the locals can solve the financial and human resources. Because available materials have already been used by local people, they can sometimes be asked to resource about the methods of working with such materials and the tools that can be used when working on the materials.

Nature of the Curriculum

The nature of what is supposed to be learnt can influence the selection of teaching strategies. Eleven (64.71%) respondents suggested that the desired goals have impact on how to teach. Some suggested outcomes, attainment targets and competency levels. The desired outcomes in the Western Australian curriculum have an influence on how to teach. For example, when teaching how to use a chisel, the methods applied will be different when teaching the technology process. Some responses focus on the 'hands on' nature of technology education, and how this influences the way the subject is taught. Technology education focuses on both processes and products, which are achieved through some specific strategies.

Learning Environment and Approach

Six (35.29%) respondents suggested environmental issues that are based on where the subject is taught. They suggested that classroom organisation has an influence on the type of strategies engaged. The size of the class/ number of students influence how to teach. Some respondents mentioned time allocation for a particular topic/concept as one

of the determining factors on the selection of teaching strategies. There is also a suggestion that an emphasis must be put on concepts and activities of interest to the students.

Type of Students

The data that were gathered from sixteen (94.41%) respondents stated that the type of students that are being taught at a particular moment influences the way teaching has to be carried out. Their background experiences and capabilities are contributory factors and their learning preferences also play a role in selecting teaching strategies. The same concept is taught differently to students depending on their level in school. For example, teaching the use of a tool like scissors to a year one student will be different from teaching the same concept to year two. In year one, students are taught how to handle and use the scissors safely where as in year two there is more emphasis on accurate cutting. Some students learn better when doing, some when listening and some when seeing. The teaching strategies that are selected to cater for the students are determined by how best students can achieve the desired outcomes.

Implementation Strategies

When asked whether technology education should be integrated with other subjects in primary schools or introduced as an additional subject, twelve (70.59%) respondents promoted the idea that technology education must be integrated with other related subjects in the curriculum in primary schools. Four (23.53%) were negative about the subject being integrated with other subjects. Table 5 shows a summary of their responses.

YES	13	76.47%
NO	4	23.53%

Table 5: Integration Responses

For those who responded affirmatively, technology education must be integrated with other subjects at primary level, their responses were discussed under the themes: activities and approaches, and resources. For those who were negative about integration of technology education, their responses were categorised under the theme: technology as a discipline.

Activities and approaches

The argument put forward by ten (58.82%) respondents who believe that technology education must be integrated into other subjects in primary schools is that integration encourages articulation and enunciation of technological capabilities and intelligence. Others add that technology education contributes knowledge, skills and attitudes to many other areas such as science, mathematics and art, which are closely related to technology education. Integration enhances development of abstract thinking and problem solving. The respondents note that, as technology is being used to guide today's lives, every subject should therefore infuse technology. They suggest that care must be taken on what to integrate with other subjects because not everything can be integrated and some aspects of technology education cannot be taught in any other subjects. For example, characteristics and behaviour of materials remains a concept that can best be taught in a technology subject context.

Resources

Three (17.65%) respondents who agreed with the integration suggested it should be encouraged because of limited resources in primary schools. At the moment, in Botswana, there are no special facilities to cater for technology education and if they are required, introducing the subject will be delayed. They suggested that the cross-curricular approach eases up teaching as students make artefacts which are related to the concepts learnt in other subjects. One of the respondents noted that, "integration can enhance planning activities that are real and relevant to students' everyday lives."

Technology Education as a Discipline

Four (23.52%) respondents were negative to the idea of integrating technology education with other related subjects. They suggested that technology is a discipline on its own and has the right of being taught on its own. They find the dangers with integrating being that technology might be ignored as a 'hands on' subject. They say it might be lost, devalued and not pure technology education.

Conclusion

A Technology Education curriculum must address the national principles of a given country. It must fit well into Botswana's four national principles which are Democracy, Self Reliance, Development and Unity. The curriculum must develop students as future citizens. The environment in which the students are situated influences the type of content included in the curriculum. The curriculum content has to take into

consideration students' home background. It has to be at the level of the students: their mental, physical and psychological state. Primary Technology curriculum must aim to develop students' knowledge, skills and attitudes, thus developing their technological literacy and awareness.

Sequencing the content of the curriculum must take into consideration the fact that primary school students are young and still developing. The processes they engage in must aim at developing their capabilities step by step. The curriculum must be sequenced such that there is a clear distinction of what is expected at different levels. The sequencing must be consistent without gaps between the concepts. A new concept must build on the previous one, beginning with simple and developing to complex material. The curriculum content must be sequenced so that it facilitates students' progress; it must be developmental.

Selection of teaching strategies is influenced by the availability of physical, human and financial resources. Teachers' qualifications and confidence also have an influence in selecting the teaching strategies. For those teachers with less experience, as in Botswana, the teaching strategies must be clear and simple. The environment in which learning is going to take place influences how to teach. This includes classroom set up, size of class and gender. Other aspects that influence the selection of teaching strategies include nature of the curriculum, that is, the desired end results. Examples of these would be the attainment targets. There is yet another suggestion that time allocated to different concepts is a pre-determining factor for selection of teaching strategies.

The idea of integrating Technology Education with other related subjects in primary schools is important. This is due to the fact that human, financial and physical resources in primary schools are limited. It is through integration that technological capabilities can be combined with students' intelligence. Though integration is important there is an augment by some technology educators that technology education is a discipline by itself and therefore it must be treated as a discipline. They ague that integration might make technology education lose its nature as a 'hands on' subject. Care must be taken on what and with what to integrate, teachers must be guided on how integration is to be effective.

Chapter Five: DISCUSSIONS AND CONCLUSIONS

Introduction

This chapter discusses the results presented in chapter four. These results outline the importance of integrating technology education into the primary curriculum of Botswana. Some countries like Australia and Britain have already integrated the learning area or are in the process of doing so. Since the education system of Botswana is more or less similar to these two countries, this research used their models to identify what is being taught and how it has been taught. Appropriate technology is a very important area and since Botswana is a developing country there is a need to look into how components of appropriate technology can be incorporated into primary technology education in Botswana. The last area discussed in this chapter is the principles upon which technology education can be integrated into primary curriculum in Botswana. The discussions and conclusions are presented in the form of responses to the research questions.

What is the rationale for introducing technology education in primary schools in Botswana?

Technology education is viewed as "an integrated, experience-based instructional program designed to prepare the students to be knowledgeable about technology- its evolution, systems, technologies, utilisation and cultural significance" (www.techedlab.com 2000). The importance of teaching technology in primary schools in Botswana is to enable students to become more innovative, knowledgeable, skilful and adaptable to the social, economic and environmental changes that are taking place throughout the country and the world. The problem solving skills that technology education develops in students enable them to cope with everyday life. Technology education teaches students to

- meet the demands of the changing world. Through its problem solving skills technology education provides opportunities for students to become actively involved in dealing with human needs.

- be able to devise ways of generating and applying ideas. This is achieved through the processes involved in the designing and making of products which

encourages students to develop some ideas which can solve particular problems or meet a particular need.

- understand the role technology plays in the society. The technological activities that students get involved in developing their awareness on the use of technology. The concepts of appropriate technology that this study proposes be incorporated into the technology learning area can serve as the basis for relaying the importance of technology to society.

- develop appropriate skills. The skills they learn through the concepts of appropriate technology develop the students' awareness of the negative and positive impact different technologies can have on the people and the environment. This develops the students' ability to judge, and to select the appropriate technologies.

- be enterprising. The enterprising skills of being resourceful, responsible and adaptable can be achieved through appropriate technology activities such ass marketing their products and selection of materials.

When introduced at lower level of education (primary level), students stand a better chance of being able to come to grips with what is going on in society. In Botswana, basic education which is the first ten years of formal education, "is a fundamental human right. It promotes the all-round development of the individual; fosters intellectual growth and creativity; enables every citizen to achieve his/her full potential; develops moral, ethical and social values, cultural identity, self-esteem and good citizenship; prepares citizens to participate actively to further develop our democracy and prepare citizens for life in the 21st Century" (Ten Years of Basic Education Curriculum Blueprint 1996c: 1). Technology education has the capacity to develop the students so that they can fit well in the society.

How has technology education been integrated into Australian and British curriculum?

Technology education in Australia and Britain is divided into stages which are developmental. That is, one stage leads to the next from primary through to secondary school. Most of the Australian states' curriculum are divided into bands and stages and

the British curriculum is divided into key stages. The primary key stages are key stages one and two. Both Australian and British curriculum are outcome based. One of the major characteristics of an outcome-based curriculum is that the curriculum content is included in the curriculum framework. Botswana curriculum has two levels in primary education. These are lower and upper primary. The curriculum is competency based and the curriculum content is in the form of the syllabus.

Apart from being divided into stages or levels the curriculum content of Australia and Britain has been divided into broad areas or strands. Below is a summery of the strands, the stages and levels which have been used in curriculum of Australia and Britain.

The Statement on technology for Australian schools outlines four learning strands. These are Designing, Making and Appraising, Materials, Information and Systems. These strands are similar in the four bands but differ in sophistication. Bands A and B are for primary education and Bands C and D for secondary. The students' achievements are measured using eight progression levels. Students are expected to have covered a certain number of levels at the end of each band.

The Western Australian Technology and Enterprise learning area covers four phases of development which are the same as bands in the national statement on technology education. These are early childhood stage (K-3) and middle childhood (4-7) for primary education, and early adolescence and late adolescence for secondary. The curriculum has seven learning outcomes which relate to technology process (investigation, devising, producing and evaluating), materials, information, systems, enterprise, technology skills and technology in society. These are the learning strands and are common in all the developmental stages.

The New South Wales Science and Technology in primary education is covered in three stages. Stage one is covered during years one and two. Stage two is covered during years three and four, and stage three is covered during years five and six. In the technology process students engage in investigating, designing and making and using technology. The objectives of the learning area are to develop students' knowledge and understanding of, and skills in, the following content strands: built environments, information and communication, living things, physical phenomena, product and services, and earth and surroundings. Science and Technology learning area also develops in students: the process of investigating that people use to develop reliable

understanding of the natural and man made environments, the process of designing and making that people use to satisfy their needs and wants and lastly the technologies people select and use, and how these technologies affect other people, the environment and the future.

The Queensland Science and Technology curriculum has organising ideas, level statements and associated learning outcomes that are organised in four strands; technology practice (investigation, ideation, production and evaluation), information, materials and systems. In order to achieve the outcomes there are six levels which indicate progression of increasing sophistication and complexity in the learning outcomes. For those students who demonstrate a level of understanding lower than level one, there is an additional level called foundation level. For a student to proceed onto the next level she/he must demonstrate a level of understanding of the set outcomes of the previous level.

Victoria Science and Technology curriculum has three strands: information, materials and movement/systems. The phases of the technology process are investigation, design, production and evaluation. Their primary technology curriculum is spread out over three levels. During level one, students learn how information is used in school and home. They are introduced to materials through play and structured activities. The problems that are posed to students are those which focus on the three strands and they solve them using the technology process. This is the same in the other two levels but differs in depth.

In South Australia and the Northern Territory the Design and Technology curriculum is articulated through three strands that are covered in four bands. The four curriculum bands are early years band (for kindergarten), primary band (for primary schooling), middle years band (for middle schools) and senior years band (for senior schools). The three strands which have some key ideas articulated to them are critiquing, designing and making.

Apart from the strands and bands the South Australian curriculum has five performance standards. These are meant to depict the developing students' capabilities and they also serve as a broad description of expected growth and capabilities of the students. These standards range from standard one through to five. The first three standards are measured during primary schooling. Standard one is measured at the end of year two,

standard two is measured at the end of year four and standard three is measured at the end of year six. To ensure that there is transition from schools to work, training and long life learning there are seven key competencies (KC) that are covered throughout the bands. These are discussed in details on page 69.

The British curriculum is articulated through four key stages. Their primary education is covered during key stages one and two. The curriculum is focused on the attainment targets (design and make) of skills, knowledge and understanding which students of different maturity and abilities are expected to have achieved at the end of each key stage. The Design and Technology learning area develop students' capabilities through designing and making skills with knowledge and understanding to enable them to make products. Emphasis on knowledge and understanding is put on mechanisms, structures, products and applications, quality, health and safety and vocabulary.

The Botswana curriculum is competency based, so its prime aim is to achieve the set competencies. Primary education is divided into two levels, lower and higher primary. The curriculum, through the recommendations of the 1996 Education Commission, has some subjects packaged to allow for the two levels. Technology education is to be packaged with other subjects like art, home economics, music and physical education. In Botswana the syllabus has the details of the content of the subject. The curriculum contains a list of aims and general objectives.

Common aspects of the Australian, British and Botswana curriculum are that primary education is levels/bands/key stages. The difference is that the Australian and British bands/key stages are from primary through to secondary schooling and Botswana's curriculum has no relationship in the technology curriculum. The link of primary to secondary is important because this creates a curriculum which is developmental.

Other common features between the Australian and the British curriculum which are not evident or the same as the Botswana curriculum include the strands. The curriculum of the Australian and British curriculum have strands, which serve as the parameters of the content. They are effective in the sense that they guide the selection and sequencing of the content. For example, the Western Australian content strands (technology process, materials, information, systems, enterprise, technology skills, and technology and society) are selected for the curriculum will be within the lines of these strands and the progression levels. Another feature of the Australian and British curriculum is that the

levels are progressive, and students do the same concepts from primary through to secondary. The difference is in the complexity of the concepts.

How can concepts of Appropriate Technology be incorporated into technology education at primary level in Botswana?

For concepts of appropriate technology to fit in the primary curriculum of Botswana this main question should be asked, "Is what I am asking my students to do appropriate?" Then one can make appropriate technology check points. These are in the form of questions.

- What type of energy does it require?
- Is it going to be made using local materials?
- Does it have positive or negative impact on the environment?
- Have aspects of local culture been taken into account?
- Is it cost effective?
- Does it suit the local peoples' needs and does it increase self-reliance?
- What ways can the artefact reach the market?
- Will it improve people's lives?

The above questions can be set as specifications for the desired product. The teacher can commence by asking students to identify their needs at home or community and come up with solutions for these needs and use the questions as specifications and evaluation questions.

Upon what principles should the integration of technology education into primary education in Botswana be based?

The principles for developing technology education curriculum in Botswana that this study has followed are based on Byrnes' (2000) suggestions of principles which were developed from Stenhouse's (1975) notion that "curriculum should provide a basis for planning a course." On planning the curriculum, there must be principles for selection

of content, principles for sequencing of the content and principles for selection of teaching strategies. Apart from these principles, this study developed principles of implementing the curriculum in Botswana in primary schools based on the current situation of teachers. The principles should guide the development of a curriculum that will fit in a competency context, the curriculum must be appropriate to Botswana's environment and be able to develop students' cognition. It must develop students' intellect and they must have personal relevance (refer to the conceptual model, p37-39).

In any education system the curriculum must address the country's national principles. The primary technology curriculum that this study is oriented to must address Botswana's four national principles: Democracy, Self Reliance, Unity and Development. For the curriculum to be relevant to Botswana, it must produce responsible future citizens who will readily adapt to the situation of their country. The selection of the curriculum content must take into consideration students' mental, physical and psychological level. Technology education curriculum must aim at developing students' knowledge, skills and attitudes, thus developing their technological literacy and awareness.

Curriculum content must be sequenced in such a way that there is a distinction of what is expected of students at different levels. There must be consistency between the concepts. Primary students are in the early stages of development and most of the concepts they are introduced to are new. The activities and processes they get involved in must be developmental, starting from what they know.

Teaching strategies are determined by the availability of human, financial and physical resources. In Botswana the problem is that resources are scarce since nothing has been put in place for starting technology education. For example, there is no teacher training program. When selecting the teaching strategies, this must be taken into consideration. The strategies must take into consideration the classroom set up, size of class (in Botswana the maximum number of students per class in forty five) and gender. The technology area that is being taught at a particular time also has a role to play on which teaching strategies to use. For example, when teaching a home economics concept, where students might need to do the practical outside class, maybe cooking using fire wood, the strategies employed must cater for such activities. The activities that are recommended for students must also be simple to understand and enjoyable (Western Australia curriculum, 1998).

So, limited resources in primary schools make it difficult for technology education to be introduced as an additional subject. When the learning area can be introduced as an additional subject it will require specialised personnel which can delay the integration (Lewis, 1981). The cross curricular approach to teaching technology education is the most recommended (Jarvis, 1993).

Principles

The principles of integration of technology education in Botswana are drawn from the previous discussions and conclusions. These principles can guide the selection and sequencing of content, with concepts of appropriate technology, the selection of teaching and implementation strategies.

Principle A

The goal of teaching technology in primary schools in Botswana is to make students more innovative, knowledgeable, skilful and adaptable to the social, economic and environmental changes that are taking place throughout the country and the world.

Technology learning area teaches students to devise ways of generating and applying ideas. This is achieved through the processes involved in the designing and making of products which encourages students to develop ideas which can solve particular problems or meet particular needs.

Students should understand the role technology plays in the society. The technological activities that students get involved in develop their awareness on how technology can be used to solve everyday problems.

Principle B

Primary technology education curriculum must be developmental.

The curriculum must have stages to make it easier to define what is expected of students at the end of each primary stage. For example, Botswana curriculum has two stages, lower primary and upper primary. This study recommends that these two stages be maintained. Apart from the stages, the primary technology curriculum must have developmental levels. These levels are important because they outline the

developmental progression of students throughout the primary education. They can also be used as progression checklists, that is, what the students have understood in the previous level before they proceed on to the next level. This study recommends that in Botswana primary technology be spread through four (4) progression levels. The levels should be such that levels one and two are covered during lower primary and levels three and four are covered during upper primary. The levels can also guide assessment of students' work. The study recommends that by the time students move on to upper primary, those who have not achieved the required degree of competencies should continue at their individual level of competency until they meet the requirements to progress to the next level.

Principle C

Primary technology education curriculum that is developed for Botswana must have strands.

Strands are important because they guide the selection and sequencing of the content. These strands should be covered in both lower and upper primary schooling and they should link to the junior secondary curriculum. This study recommends that the Western Australian strands be adopted (the technology process strand must be modified by including need identification to match with the Botswana secondary technology curriculum) because they cover all areas of technology education. These are technology process (needs identification, investigation, designing and making, and evaluating), tools and materials, information, systems, enterprise, technology skills and technology in the society

Principle D

Concepts and principles of appropriate technology should be incorporated into the primary technology curriculum in Botswana.

Appropriate technology is the technology that is used to solve technological problems by providing sustainable solutions that will benefit the local community and which are sensitive to the need to reduce pollution by using renewable energy and recycling whenever possible. Appropriate technology aims at improving the lives of the people and maximising the use of locally available materials.

This study proposes the concepts of appropriate technology could be covered under in all the strands. Students should be encouraged to identify the needs of the local community. Maybe through projects which the students work on in groups to identify their local community problems and provide solutions to them. By identifying the needs of the local community, students will have the opportunity to explore local materials, providing sustainable solutions which are environmentally friendly, device artefacts which will be used by the local people. This can encourage students to develop a sense of community.

Principle E

Selection of content for primary technology curriculum should be based on the national principles of Botswana.

Content selection should address the four national principles of Botswana (Democracy, Self-reliance, Development and Unity), taking into consideration the physical, psychological and mental level of the students. The four national principles are used to describe a Botswana citizen. Students should be taught in such a way that the teaching aligns with the four principles.

Technology education by its nature has the mechanism for relating to the four principles. By allowing students to identify the needs and come up with solutions, this teaches them to learn independently and to realise the importance of being free to express themselves. One of the aims of this study is to come up with principles that will guide curriculum development which will produce students with self-reliance. Appropriate technology that teaches students to generate solutions which will benefit the local community, can be used to foster the principle of self-reliance. By solving local community problems, students will in turn develop their own communities. The unity principle developed by the community projects that this study has suggested could foster unity amongst students, as they will learn to accept others' ideas.

Principle F

Curriculum content must be sequenced such that it is consistent, relevant and progressive.

Curriculum content must be sequenced in such a way that there is a distinction between what is expected of the students at different levels. There must be no gaps between the levels. An example of progression could be the structures which students make in different levels having the same concepts but differ at degree of complexity. There must be consistency between the concepts. Primary students are in the early stages of development and most of the concepts introduced to them are new. The activities and processes they get involved in must be developmental, starting from what they know.

Principle G

Selection of teaching strategies for primary technology studies in Botswana should be based on the availability of resources, nature of the curriculum and the learning environment.

Selection of teaching strategies is influenced by the availability of physical, human and financial resources. Teachers' qualifications and confidence also have an influence in selecting the teaching strategies. For those teachers with less experience, as in Botswana, the teaching strategies must be clear and simple.

The environment in which learning is going to take place influences how to teach. This includes classroom set up, size of class and gender. The study recommends that if classes are too large (exceeding the number stipulated for technology education classes), multiple activity teaching can be adopted. For example, if students are working on a systems project, some groups could do practical while others work on folios. These groups need to be swapped around to maintain balanced progress.

There is yet another suggestion that time allocated to different concepts is a pre-determining factor for selection of teaching strategies.

Principle H

Technology studies should be integrated with other subjects in primary schools.

Implementation of technology studies should be through a cross-curricular approach. This is because introducing the learning area as an additional subject will require specialised personnel and this can delay integration. One other problem that can be faced if technology education is introduced as a subject is that primary teachers in most

schools in Botswana teach all the subjects to their classes. Introducing technology education as an additional subject will raise concerns amongst them as to the load of teaching and this will not only fail technology education but it can also fail the whole primary education system. Subjects which seem appropriate to integrating with technology education are science, maths, art, social studies, agriculture, business studies, home economics and music. For example, in social studies when teaching shelter, students can be asked to design and model different houses they have seen. Students should be encouraged to select and design structures with which they are familiar. Teaching emphasis must be put on appropriateness of the shelter to different people in the community. Projects can be done in groups for easy management.

When integrating technology education with other existing subjects in Botswana's primary curriculum, care must be taken that the learning area does not lose its nature as a 'hands on' learning area. The nature of technology education is a combination of theory and practice. Most of the subjects which technology education can be integrated with are taught as theory subject in Botswana, therefore when technology is brought into the scene with those subjects it must be practical. For example, teaching shelter in social studies requires students to come up with some models of shelter. They are also expected to know why the shelter they have modelled is good. The teacher must teacher concepts like triangulation, structural failure and parts of a structure.

Other suggestions

Other suggestions which developed from this study.

- The technology learning area in primary schools should be called technology studies. The reason behind this is that if it is named design and technology, as in secondary schools, it loses its value as a learning area and becomes a subject. This will then make it difficult to integrate with other subjects.

- The initial step of introducing technology studies in primary schools in Botswana is to in-service teachers in the field. In-servicing can be done by first selecting teachers and training them to be specialist teachers in their schools. Workshops must be run to train these specialist teachers and other teachers in the field. In the meantime, a programme for primary teacher training colleges should be developed for those teachers who are still training, so that upon

completion of their course, they can assist those teachers who are already in the field.

- Problems which can arise may include storage of materials, equipment and students' projects, teachers' attitudes and confidence towards integration, parents' attitude towards helping in implementing the subject. However, using book stores and other available facilities can solve the problem of storage. Workshops and monitoring can help alleviate the problems of teachers' attitudes and confidence. The parents can be informed about the integration through parents teachers association meetings.

In conclusion it is hoped that the above principles and suggestions reinforcing the significance of technology education will guide curriculum designers in Botswana about what should be included in the curriculum and what should be taught at different levels. It is also hoped that the study will not only be a contribution to the development of technology education in primary schools in Botswana, but also to technology education as a whole.

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APPENDICES

Appendix One: Research Survey (Word Version)

TOPIC: Development of Principles for the Integration of Technology Education in the Primary Curriculum In Botswana

<u>Patrick T. Mmokele (Edith Cowan University, Perth, Western Australia)</u>

Thank you for agreeing to participate in this survey.

Please return this form to me as an email attachment, or print out and fax to me on 61 8 9370 6281

Instructions

- Type the letter X in the appropriate box.
- Where there is need for you to type more information please use the boxes provided. (Note that the boxes will increase in size as information increases).

1. In which country do you reside?

   Botswana ☐ Australia ☐ United Kingdom ☐

2. Where did you spend your last five years of work/study?

3. Present occupation. NOTE: If your response to this question is "Other," please specify by typing your occupation in the box.

Teacher ☐ **Lecturer** ☐ **Technology Education Officer** ☐ **Other. (Please specify)** ☐

4. Experience of working with technology curriculum

Under 5 years ☐ **5-10 years** ☐ **11-15 years** ☐ **16-20 years** ☐ **Over 20 years** ☐

5. Please describe your role (level and activity)

6. What should guide the selection of content when planning primary technology curriculum?

7. What principles should guide the sequencing of content?

8. What should be taken into consideration when selecting teaching strategies?

9. Should technology education be integrated with other subjects in primary schools?

Yes ☐ No ☐

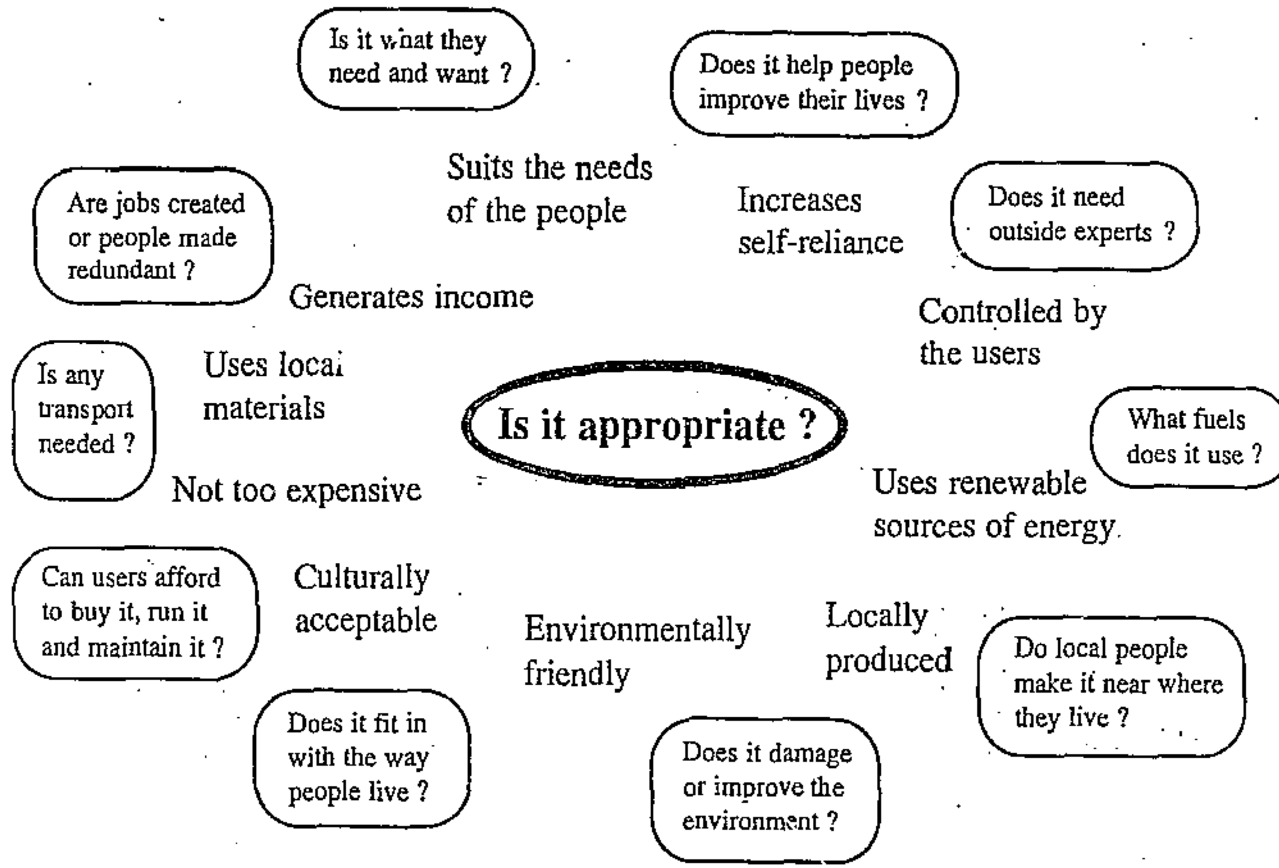
10. Give reasons for the answer to question 9.

11.In Botswana primary teachers have not been trained for teaching technology education. Suggest three principles which could guide the implementation of technology curriculum in this situation.

A
B
C

12.I would appreciate any other contribution you would like to make

Appendix Two: Appropriate Technology Investigation Model



Produced by: Intermediate Technology, Myson House, Railway Terrace, Rugby CV21 3HT Tel: 0788 560 631 Fax: 0788 540 270

Appendix Three: Consent Form

***Project Title*: Development of Principles for the integration of Technology Education into the Curriculum In Botswana.**

Dear Participant

My name is Patrick Mmokele, a student at Edith Cowan University in Western Australia. Under the supervision of Dr John Williams I am doing research for my Honours degree based on the above topic.

I am kindly requesting you to contribute to this research by responding to a survey. The intention of the survey, which I will forward to you within a week, is to find out from technology educators how technology can best be developed and implemented in primary education.

- All the information you give is strictly confidential and anonymous. All questions will be aggregated, summarised and reported; no person will be identified by name.

- The summarised findings of the study will be made available to the participants on request.

If you agree to participate, realising that you may withdraw at any time, and agree that the research data for this study may published provided you are not identifiable, then please send me the following email.

I ________________ (the participant) have read the information above and everything I have asked has been answered to my satisfaction.

I agree to participate in this activity, realising I may withdraw at any time, and agree that the research data for this study may be published provided I am not identifiable.

Appendix Four: Survey Letter

Thank you ladies and gentlemen for agreeing to take part in this survey. Please read the following instructions before you open the survey.

1. This survey works very well with Internet explorer and Netscape navigator V6.
2. Ten (10) people can access the survey in one day, so if by any chance it does not work on the first try wait until the next day to respond to it.
3. If you are using Netscape Navigator 4.7 or if the survey does not open or the submission message does not appear, a word version can be accessed. It is an attachment in this email. (This survey, for technical reasons does not work well with Netscape Navigator 4.7)
4. Please read the instructions on your chosen survey version before you respond to it.
5. When you open the web version, you will get the message: **Select the database to view**. Under this message this message there is a folder **Curriculum Development Survey.** Click on it and access the survey.

To get the survey, click on this URL: http://139.230.169.65:591

Thanks again for your time

Patrick Mmokele

Appendix Five: Follow up e-mail

Dear Colleagues

I haven't received any responses from you so far. I would be grateful if you could please acknowledge if you are willing to take part in my study so that I can send you the survey.

Thank you in anticipation

Regards Patrick Mmokele

Appendix Six: Useful Links

The following are links which were identified as useful in technology education in primary schools.

http://www.boardofstudies.nsw.edu.au/syllabus99/dance_syl.doc

D & T Online

UK National Curriculum for Design and Technology

VALIDATE: Values In Design and Technology Education

Design and Technology Teacher Centre

Design and Technology Activity Ideas

Design and Technology Documents Page - New South Wales or

http://www.bosnsw-k6.nsw.edu.au/scitech/k6_scitechsyll.pdf

http://www.curriculum.wa.edu.au

http://www.brunel.ac.uk/depts/des/dtrb/publish/paper1.htm

http://www.sofweb.vic.edu.au

http://www.qscc.qld.edu.au

Nuffield Foundation Primary Design and Technology

Schemes of Work: Primary Design and Technology

Science at Work

http://www.students.trinity.wa.edu.au/library/default.htm

http://www.techedlab.com

Appendix Seven: Western Australian Strands and Outcomes

Adopted from the Western Australia Curriculum Framework (1998: 292- 293).

The Technology Process is fundamental to this learning area and integral to the achievement of all Technology and Enterprise Outcomes. The statement of each outcome is accompanied by a more detailed description which includes selected examples showing how students may demonstrate achievement of the outcomes from kindergarten to year 12. Any activity in which students engage will give them the opportunity to work towards a range of Technology and Enterprise outcomes, as well as contributing to the achievement of various outcomes in other learning areas.

1. *Technology Process*

Students apply a technology process to create or modify products, processes, systems, services or environment to meet human needs and realise opportunities

2. *Materials*

Students select and use materials that are appropriate to achieving solutions to technology changes.

3. *Information*

Students design, adapt, use and present information that is appropriate to achieving solutions to technology challenges.

4. *Systems*

Students design, adapt and use systems that are appropriate to achieving solutions to technology challenges

5. *Enterprise*

students pursue and realise opportunities through the development of innovative strategies designed to meet human needs.

6. *Technology Skills6.*

Students apply organisational, operational and manipulative skills appropriate to using, developing and adapting technologies.

7. *Technology in Society*

Students understand how cultural beliefs, values, abilities and ethical positions are interconnected in the development and use of technology and enterprise.