ATTITUDES TO AND PERCEPTIONS OF DESIGN AND TECHNOLOGY STUDENTS TOWARDS THE SUBJECT: A CASE OF FIVE JUNIOR SECONDARY SCHOOLS IN BOTSWANA

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Presented in Partial Fulfilment of the Requirements for

the Degree of

Doctor of Philosophy

UNIVERSITY OF WALES INSTITUTE, CARDIFF
SCHOOL OF EDUCATION

March 2010

DECLARATION

DECLARATION

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ACKNOWLEDGEMENTS

First and foremost eternal thanks to the almighty God, without his mercy and grace this work would not have been achieved.

My profound and most sincere gratitude goes to my supervisor and director of research, Professor Janet Laugharne, for tirelessly providing valued mentorship, guidance and support through every step of the way.

Special thanks to: Dr Jim Newcomb and Dr Gary Beauchamp for their most valuable guidance and support; Dr Isabelle Durance for her most valuable mentorship, support, guidance and lectures; Dr Sian Rhiannon Williams and Jason Davies for taking time to read through my thesis and providing invaluable feedback throughout my study; My wife Mpho and my daughter Kgalaletso for their continued patience, support and encouragement throughout the duration of my study.

Last but not least I thank my colleague Dr Magdeline Mannathoko for providing me with a family environment in Cardiff in the absence of my family. I thank my mother; mother in law; brothers; sisters in law; nieces; nephews; cousins and friends for their continued reminders that I must finish my study and come back home.

Thank you all, and may God bless you!

EMMANUEL!!!

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GLOSSARY OF TERMS

Acceleration	A system of allowing exceptional students to skip a school grade.
Basic Education	The first ten years of schooling in Botswana considered as every child"s right.
Batswana	The plural form of the nationality of the people of Botswana.
Bursar	A professional financial administrator in a school.
Core	A status that a subject is given in relation to other subjects in the school curriculum in Botswana to indicate that such a subject is important and valuable such that all students should benefit from it, i.e. mandatory.
File	A rough surfaced blade tool with a handle. It is used to cut fine amounts of material from a workpiece.
Form	Secondary school grade in the education system of Botswana.
Junior Certificate	An award given to students after successful completion of junior secondary school.
Junior Secondary School	The first three years of secondary education in Botswana, prior to 2 years of senior secondary education.

Optional	A status that a subject is given in relation to other subjects in the school curriculum in Botswana to indicate that students can choose to study the subject or not.
Portfolio	A collection of drawings accompanied by reflective narrative developed by students as part of a design and make project to document progress towards or show evidence that a learning target has been achieved through the process of designing and making.
Pula	Botswana currency (Notes)
Repetition	A system of allowing failing students to repeat the same grade.
Scheme and Record of Work Book	Ministry of Education official document in which teachers are expected to write down their plan for covering the syllabus content for a term or year and also to record work done and students marks for monthly tests.
Standard	Primary school grade in the education system of Botswana.
Tender system	A government procurement system in which three quotations have to be provided before a requisition of purchase could be authorised.
Vote	Budget allocations to schools and other government organisations, for recurrent and maintenance costs.

ABSTRACT

The nature of design and technology in the school curriculum is shifting with the times, from a distinct subject associated with notions of craft and vocational preparation to an emerging technological literacy subject that supports education for democracy. This paradigm shift has resulted in diverse views about the place of design and technology in the curriculum internationally and in the context of the present study, Botswana. Here, where the subject declined in uptake over a period of 10 years by up to 6% per year, despite positive encouragement by the government, understanding student attitudes towards the subject is central to providing evidence-based options to policy makers. This study illustrates how quantitative approaches used in the social sciences and based on multivariate analysis (categorical Principal Components Analysis, Clustering Analysis and General Linear Modelling), can complement qualitative analysis to inform educational policy. The combination of quantitative and qualitative analysis can provide effective, evidence-based information and support policy development.

The study was conducted with design and technology students in their final year of junior secondary school (15 – 18 years old). An attitude survey of 233 students, focus group interviews involving 47 students, and semi- structured interviews involving 22 teachers and other staff were conducted in five junior secondary schools across Botswana.

Qualitative interviews indicated consistently that age, gender and school performance all affected attitudes of students towards design and technology and gave an in-depth understanding of the issue. Multivariate analysis provided information in ranking how different attitudes contributed to the overall perception of the subject (PCA-Factor analysis), in assessing the relative and interacting effects of external determinants like age or gender; and in classifying students into attitude groups. The findings show that design and technology enrolment could be improved by targeting children, girls in particular, who deemed the subject to be too difficult or unimportant, and by reinforcing perceptions of design and technology as an enjoyable life-skill.

CHAPTER 1: BACKGROUND

1.1 Introduction

Botswana introduced the implementation of the Revised National Policy on Education (RNPE) in 1996. One of the recommendations of RNPE was to make design and technology a [1]core subject in [2]Junior Secondary Schools in Botswana by the year 2000. The amended recommendation reads:

> With respect to the junior Certificate Curriculum, each student should take eight core subjects, namely, English, Setswana, Social Studies, Mathematics, Integrated Science, Agriculture, ***Design and Technology*** and Moral Education (Republic of Botswana, 1994, p. 63).

Prior to the RNPE, design and technology had been offered as an optional subject since its introduction in the curriculum in 1990.

Design and technology is a relatively new subject in Botswana, even though it has evolved from old craft courses (Moalosi, 2001). This is true of the subject also on a world scale (Owen-Jackson, 2002; Ginestiẽ, 2005; Barlex, 2007). Gawith et al (2007) wrote that technology education in New Zealand was both an old and a new subject. They further explained that technology education as an old subject was associated with notions of craft and vocational preparation and that, as a new subject, a greater emphasis was being placed on technology in a critical social context. This dual nature of technology education has resulted in diverse views about its place in the curriculum. Perceptions about the value, and the role,

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[1] Core is a status that a subject is given in relation to other subjects in the school curriculum in Botswana to indicate that such a subject is important and valuable such that all students should benefit from it, i.e. mandatory.

[2] The first three years of secondary education in Botswana, prior to 2 years of senior secondary education.

of technology education in the 21st century are also divided, as will be discussed in chapter three. The contention seems to be in the conflict of interest between technology education as an old subject (experience-based or handicraft education) and technology education as a new and emerging technological literacy subject that supports education for democracy (Steeg, 2008). As an old subject, technology education‟s emphasis is on competence, which only a few people need in order to do a job or make a living, and it carries with it a stigma, a history that may render it out of date in the 21st century curriculum. As an emerging technological literacy subject, technology education emphasis is on literacy, which everyone needs, and it strives to lose its roots, which makes it a distinct subject with a defined role in the school curriculum. As an emerging technological literacy subject, it is expected to shift, to be better placed to accommodate (embrace, even) the change that is brought about by a range of technological, legal and social developments in the ways that products are designed and made. Historical periods of the human society (de Vries, 1996) and the corresponding trends in development of technology in post-industrial society (Ivanov, 2000, 2006; Steeg, 2008) have led to many questions about the mutual co-existence and interaction of education and technology at the present time (Levin and Kojukhov, 2008; Steeg, 2008; Kumar, 2002).

The rate at which technological developments impact on the teaching and learning of design and technology has been reported as more regular and rapid than in other subjects (Barlex, 2007; Keirl, 2007; Kumar, 2002). Design and technology is constantly going through transformation, leaving the international and local subject communities with a burden to continually convince policy-makers that it is a unique and important subject to the lives of the students. This situation has significant implications for the subject and the subject community. Those responsible for technology education have to continually protect it against the more established subjects that have been in the school curriculum a long time and to justify its place in the post-industrial society school curriculum. Keirl wrote that:

> For many years the design and technology community has carried more of a curriculum development burden than most subjects – especially those born with their silver spoons (English, maths, science) who have historical precedent, unchallenged status, and assured resources on their side (Keirl, 2007, p. 70).

This is even more of a challenge in countries such as the one in which the context of this study is set, Botswana. While the development of the current design and technology education in Botswana was in line with the goal of the RNPE, which was to prepare [3]Batswana for the transition from a traditional agro-based economy to the industrial economy (Republic of Botswana, 1996), computerization and globalization have influenced nations, including Botswana, towards the post-industrial society. Attributes of this post-industrial society brought about conflicts as to the nature and the role of technology education in the post-industrial society‟s school curriculum. According to Levin and Kojukhov (2008) micro-technologies[4] are the basis of the post-industrial society, and so the traditional technology education (experience based or handicraft technology) faces significant difficulties in the case of studying micro-technologies. Steeg (2008) also argued that the current design and technology curriculum in England is irrelevant, because it develops in pupils, designing and making skills and knowledge that are derived from industrial design practice. According to him, ideas of designing for clients, designing for mass production, market awareness and protecting design ideas, which derives from industrial design practice, are irrelevant in this age. As such, despite the continuing popularity of design and technology, there are suggestions that things remain insecure (Keirl, 2007), and that many pupils find the subject unsatisfying (Steeg, 2008).

[3] Batswana is the nationality of the people of Botswana.
[4] Modern life technology or high-tech technology.

1.2 Rationale for the study

Research has been undertaken around the world in relation to various aspects of design and technology within the school curriculum, for example, in Wales (Hendley, Stables and Stables, 1996), in England (Stables and Kimbell, 2000; McCarthy and Moss, 1990), in Spain (Font-Agusti, 2000), and in Australia (Gardner, 1994; Gardner, 1995; Fritz, 1996). However, little research in the literature is available about design and technology research in Botswana, apart from three doctoral study research (Moalosi, 2007; Dingalo, 2002) and a handful journal publications (Molwane, 2000; Moalosi, 1999; Moalosi and Molwane, 2008; Dingalo and Moalosi, 2003; Molwane and Mwendapole, 2008; Gaotlhobogwe, 2004; Moalosi et al, 2007).

In speculation, the reason why there is so little research in the area of design and technology in Botswana could be due to the following. Firstly, Botswana is a small country with a population of around two million people and so there are relatively few academics available to be involved in research. Secondly, design and technology is a new area of study and thirdly, design and technology is not considered to be of significant value by many people in universities and, therefore, not perceived by many to be an area worthy of research. Dingalo and Moalosi (2003), for example, noted that design comes from the art and craft tradition in which research and professional dialogue has been, for the most part, absent.

My career experience spans over nine years of teaching design and technology at secondary school level in Botswana, two years of design and technology teacher training at a college of education in Botswana, and four years of design and technology teacher training at the

University of Botswana. This qualifies me as one of the few academics in the area of design and technology in Botswana. During my career, and now as part of my work, I spend time in schools with teachers and students of design and technology and all I sense is degrees of dissatisfaction. Resulting from these interactions with teachers and students and the apparent slump of interest and decline in the uptake of the subject by students, I became interested in their perceptions, particularly regarding the recommendation about making it a core subject. Understanding student attitudes and perceptions towards design and technology, their underlying drivers, and factors affecting its uptake is central to providing evidence-based options to policy makers on how to develop educational strategies. More than personal choice, the aggregate uptake of a curriculum subject can also have large effects on national economies and social development, and so is under particular scrutiny by educational stakeholders (Tabulawa, 2009). Technology education, in particular, has been reported to have the potential to contribute to economic development by giving people some control over the material world, to liberate humankind from excessive manual labour, hunger, poverty, inadequate housing and poor health (Van Rensburg et al, 1999, p. 139). Furthermore, I believe that through this study I will become an attuned professional with an enhanced personal knowledge base in technology education. The study will also benefit the profile of design and technology as a subject in the curriculum.

On a more general level this study could offer an opportunity for the government to evaluate the current philosophy upon the subject of design and technology, and address curriculum imbalances that currently exist between subjects and between schools. For example, according to the 1996 design and technology junior certificate examinations register report, in one junior secondary school, only 13 candidates were registered, while in another, 149 candidates were registered (Botswana Examinations Council, 2007). During sampling of case study schools for this research, out of the 212 junior secondary schools across Botswana, no school was found to meet the research design criteria set for group one schools, i.e. high enrolment and high performance in design and technology. Two hundred schools were found to meet the criteria set for group four schools, i.e. low enrolment and low performance in design and technology (see table 1.1). The skewed numbers of schools across the four categories created for sampling the junior secondary schools is a clear indication of the severity of the problem being investigated in this study.

Interestingly, the problem of declining enrolments in technology education is not particular to Botswana. Neale observed that in his study in Scotland, 70% of similar aged pupils (Key Stage three and four) did not want to continue any studies in technology and nearly 30% said that, if in retrospect they had been given the option, they would not have taken design and technology at key stage four (Neale, 2003, p. 25). In South Africa, pass rates and enrolments in related subjects of Science and Mathematics were reported to be declining (Van Rensburg et al, 1999). Mottier (1999) observed that the more technology is introduced in general education, the more students turn to other studies. Using this study as an example, I illustrated how multivariate analysis (Principal Components Analysis, Clustering Analysis and General Linear Modelling), used to investigate patterns in attitude surveys (Linting et al., 2007; Van Rensburg et al, 1999) and widely used in other science fields (Durance and Ormerod, 2007), coupled with qualitative analysis, can help to understand student attitudes to curriculum subjects.

1.3 The aims of the study

Since the introduction of design and technology and the elevation of its status (in principle) from option to core in junior secondary schools, no research has been undertaken in Botswana to look into the views of students about design and technology at the junior secondary school level. A similar study was conducted in 1997 but it investigated attitudes of students towards technology in senior secondary schools (Meide, 1997). Although the study of attitudes of students towards technology in senior secondary schools was conducted 13 years ago; it identified some of the issues of relevance in current developments in the subject, as will be discussed later. I considered the views of the junior secondary school students to be very important and hence, the aims of this study were to investigate attitudes and perceptions of design and technology students towards the subject in junior secondary school; to examine how the views of these students help to explain the problem of declining enrolments in the subject; to establish the factors leading to the decline in enrolments in design and technology in junior secondary schools in Botswana, and to make recommendations to address the problem in the future. In order to meet this aims, the following research questions were established:

1. What factors influence students" attitudes towards and perceptions of design and technology?
2. How does examining the views of form three design and technology students help explain the problem of declining enrolment in the subject?
3. How could the decrease in uptake in design and technology be tackled?

This research study was initially set to be conducted within junior secondary schools with varying levels of performance and enrolment in design and technology. The initial plan was to select one junior secondary school from each of the following categories:

1. High enrolment and high performance.
2. High enrolment and low performance.
3. Low enrolment and high performance.
4. Low enrolment and low performance.

The initial plan could not work out because, when getting to the field, in selecting case study junior secondary schools, as indicated in table 1.1 no school was found to meet the criteria set out for category one schools, i.e. high enrolment and high performance. Only four schools met the criteria set out for category two schools, i.e. high enrolment and low performance, so one school was selected from these four schools. Eight schools were found to meet the criteria set out for category three schools, i.e. low enrolment and high performance, and five of these schools were in Selibe Phikwe region, so two of these schools were selected from Selibe Phikwe. Two hundred schools were found to meet the criteria set out for category four schools, i.e. low enrolment and low performance, so two of these schools were selected from Gaborone. Convenience sampling was used in selecting all these case study schools.

Table 1.1: Number of schools per school category

School Category	**Number of schools in that category**
1. High Enrolment / High Performance	0
2. High Enrolment / Low Performance	4
3. Low Enrolment / High Performance	8
4. Low Enrolment / Low Performance	200

Note: Schools were categorised according to enrolment and performance of students in design and technology in the 2007 junior certificate examinations.

1.4 Overview of thesis structure

Chapter one and two provide the background and the context in which this study is discussed. Chapter one discusses the definitions of design and technology education, the rationale and aims of the study. Chapter two provides an overview of Botswana‟s education system, the structure of the junior secondary education as well as the content of design and technology curriculum in Botswana.

The review of literature, covered in chapter three provides a historical backdrop of the development of design and technology in junior secondary schools in Botswana. In this chapter the fundamental philosophies that support design and technology, and an overview of general perceptions about design and technology, are discussed. Chapter three attempts to locate the place of design and technology in the 21st century and in the school curriculum, by looking at the unique contribution that the subject claims to make in the lives of the students. The chapter discusses studies carried out around the area of technology education, particularly how students in different parts of the world perceive design and technology. According to literature reviewed, perceptions of and attitudes towards technology education are as varied as technology itself. Even experts in the field do not often agree on what technology is and what it is not (Spendlove, 2008; Dakers, 2006), allowing both policy-makers and the students to make their own, sometimes wrong, conclusions.

Well-established subjects and some developing, but more easily-defined, subjects seem to be winning the favour of policy-makers and students, leaving design and technology educators with a burden to convince students to choose their subject. There is evidence of attempts to subsume technology education under such fields as science and art and design, depending on how technology education is defined in a given country. A specific example is the provision of CAPA (Creative and Performing Arts) in primary schools in Botswana. CAPA is a subject that draws its content from about seven different subject areas, design and technology being one of them. Given the limited content of design and technology in comparison to other subject areas in the CAPA syllabus, lack of design and technology in primary teacher training institutions, limited knowledge and skills by primary school teachers in this subject area, design and technology appears to be of least importance in the seven subject areas. The recent developments of bringing aspects of subject content together within areas of learning in the primary school curriculum in England (Rose, 2009) has been viewed in the same way.

The choice of methods used to address the questions raised in this study is discussed in chapter four, where I have discussed how the study has evolved throughout the various stages. Chapter four also highlights the reasons for choosing methods and the strategies used in data collection and analysis, and how these were adapted to suit the context of this study. The methods and strategies used are also discussed in relation to similar studies and how other researchers have used them. Finally, in this chapter I discuss how the data was analysed.

In chapter five the procedures used to analyse the questionnaire and the results of the questionnaire analysis (quantitative) are discussed. A discussion of how these results answer the research questions is also discussed here.

Chapter six outlines the procedures used to analyse the interviews and the results of the interview analysis (qualitative) are discussed. A discussion of the meaning of these results and how they answered the research questions was also carried out in this chapter.

In chapter seven I present a general discussion of the qualitative and the quantitative results in line with the research questions and how the two complement each other. Finally, in chapter eight conclusions arising from the discussion are presented and recommendations for short term and long term interventions are made, together with suggestions for future research.

1.5 Design and technology as technology education

Variations of technology education on the international scene exist in terms of titles and curricular frameworks (Ginestiẽ, 2005) and this also offers considerable challenges in terms of defining the subject, as there is no common agreement as to what technology education actually is, or is supposed to be. Observing the same point, Compton and Jones (2004, p. 5) wrote that within education there is a diversity of concepts of technology, resulting in a range of curricula foci. De Vries (2007) noted that design and technology is often called just „technology" in some countries. For example, in the UK it is known as 'design and technology'; in Iceland it is known as 'design and craft'; and as 'technology and design' in Northern Ireland. While design and technology is an amalgam of specialist areas put together in one subject in Botswana, it is taught as a range of discrete subject areas, and modules in Scotland, where „technology education" as a title has been adopted. Rasinen (2003, p. 31) wrote that different countries use different terms to describe technology education, such as techniques, design and technology, technology education, and technological education. Kumar (2002,) indicated that, in spite of the fact that „design" does not appear in the title of the course „Technology" in the Netherlands, design constitutes a major component.

> Technology education refers to educating children to employ the hardware and software of technology. It includes educating theory and practice of a range of material processes for metal, wood, plastics materials and, more recently, textile, leather and food materials. All these areas have a component of learning theory but the greater and more important is that of gaining practical experience (Kumar, 2002, p. 125).

According to Ginestiẽ (2005, p. 8), the term technology education is increasingly being used throughout the world to define and describe curriculum organisations that, on the whole, can be assimilated to a subject in itself. Given this background, defining technology education is problematic because different models and perspectives have been adopted in different countries (Compton and Jones, 2004). UNESCO (Martin, 2003) defined it as the study of the utilization of tools, resources and systems to solve problems and to enhance control over the natural and the made environment in an endeavour to improve the human condition.

Hill (2003) justified the use of the term „technology education‟ rather than „design and technology‟ because the former is more commonly used internationally. Generally, and internationally, it is more appropriate to discuss design and technology under its precursor title, technology education, because technology education operates across boundaries and beyond different titles and curricular frameworks found around the world. Except in the specific discussions of the subject in Botswana and the United Kingdom, technology education will be used to embrace all forms of variations discussed above.

1.6 The nature of design and technology

Kimbell and Perry (2001, p. 121) observed that at the heart of design and technology education lies a distinctive model of teaching and learning. It is project-based and involves learners taking a task from inception to completion within constraints of time, cost and resources. According to Rutland (cited in Owen-Jackson, 2002) design and technology is about the realisation of appropriate solutions to human problems, with value judgements being made throughout the designing and making process.

The meaning of design and technology is better articulated in the following citation quoted in

Barlex (2007):

> Our understanding is that whereas most, but not all, design activities will generally include technology and most technology activities will include design, there is not always total correspondence. Our use of design and technology as a unitary concept, to be spoken in one breath as it were, does not therefore embody redundancy. It is intended to emphasize the intimate connection between the two activities as well as imply a concept which is broader than either design or technology individually and the whole of which we believe is educationally important (Barlex, 2007, p. 11).

The fundamental nature of design and technology is that it is not a subject rooted in the academic tradition, which values particularly the acquisition of knowledge for its own sake, but rather, as a subject in which knowledge is viewed as a resource to be used, as a means to an end (Barlex, 2007). What is important in design and technology is that knowledge is not possessed only in propositional form (which can be expressed in words), but that it becomes actively integrated in the processes which constitute design and technology activity. According to Kumar (2002, p. 125) these processes refer to hardware and software aspects of materials, processing, measurement, manufacturing, information technology, computer-aided tasks and testing. De Vries (2007) indentified four perspectives that characterize the nature of design and technology. These are:

- Technology as artefacts, which are viewed in terms of both their physical and functional nature;
- Technology as knowledge, where knowledge is viewed in terms of normative judgements (how things should be) and collective acceptance (agreement, not discovery);
- Technology as processes, in terms of designing, making and using things; and
- Technology as a property of humans, to reflect on in terms of ethics and aesthetic convictions.

Mainly because of its history of having evolved from craft-based subjects, which were aimed at academically weak students, design and technology is often, wrongly or rightly, perceived as being a vocationally-based subject (Dakers, 2006, 2007, Dingalo and Moalosi, 2003). Black (1994) (cited in Compton and Jones, 2004) identified five variations of technology education that may be found both within and between countries. Hence it differs from one country to another and it changes from time to time. As a result, politicians and many people in decision-making positions have a very limited understanding of what this subject is. Many perceive it in terms of technological artefacts; computers, cars, television, mobile phones and so on. Often they do not see design and technology in terms of the knowledge and processes involved in creating and using these technological artefacts, nor as knowledge and processes involved in evaluating the various implications for society, resulting from these technological artefacts and processes. The representation of design and technology as vocational has resulted in ill-informed attitudes towards design and technology, both from governments and their societies.

Hill (2003) concluded that what the student chooses to do with their study of technology become the actual deciding factor as to whether their study of technology is vocational, craft or academic. Dakers (2007) observed that we might conclude that design and technology exists primarily for the student rather than for the world of work. However, the unprecedented growth of technology has created a situation where technological knowledge and processes continually shape the world in which we live. The impact of existing and emerging technologies upon cultural development, the consequences these technologies have upon the environment and society is why governments engage strongly with the development of technology education, despite the uncertainty of its definition.

Literature reveals that in most parts of the world, for example, the United Kingdom, the Netherlands, Chile, Greece, Canada, New Zealand and Israel, technology education is provided as a mandatory subject at least up to lower levels of secondary school (Ginestiẽ, 2005; Volman and ten Dam, 2007). An interesting observation is that although technology education is said to be mandatory within the curriculum, this seems not to be enforced in some countries. For example, in Botswana, junior secondary schools still offer it as an option, although it is officially mandatory up to the end of junior secondary school. Dakers (2000) reported that in the England, where technology education was mandatory up to key stage 4 (Upper secondary) until 2003 (Benson, 2005), not all schools offered the choice of design and technology and, where non-compliance was observed, it was not reported.

CHAPTER 2: CONTEXT OF THE STUDY

2.1 Botswana in brief

Botswana occupies 581,730 square kilometres of southern Africa (see figure 2.1) and is about the size of France in comparison with a European country. More than 80% of the country‟s population (circa 1.9 million) lives in the eastern part around three large urban centres (Gaborone, Francistown and Maun). Botswana is a middle income, developing country whose economy is one of the most successful in Africa (World bank online, 2009) and more than 80% of the adult population is literate, placing Botswana above India; for example, in the Human Development Index assessment (UNDP, United Nations Development Programme online, 2009).

Figure 2.1: Botswana within the southern tip of the African continent (Source: WorldAtlas.com online).

Botswana is reported to have the highest percentage of female-headed households worldwide (Republic of Botswana, 2008). According to this report, these female-headed households were also poorer than their male-headed counterparts, with thirty four percent reported to be living below the poverty line, compared to only twenty seven percent of male-headed households. Students attitudes to and perceptions of technology have been attributed to availability of technological toys and gadgets in households (Bame et al, 1989), and poverty levels determine the availability of such.

2.2 Botswana's education system

The education system in Botswana is made of 10 years basic education[5], which is a right for all school age children, comprising seven years of primary and three years of junior secondary education. Primary School Leaving Examinations (PSLE) are taken at the end of the first seven years of basic education but are not used for selection into junior secondary school. In 2005 gross and net primary school enrolment rates were 106.7% and 84% respectively (SACMEQ 1995- 2009, online). According to an online country report (EFA 2000, 2009), a significant number of children enrolled in primary schools were either younger or older than the primary school age, hence the gross enrolment rate exceeded 100%. This comes as a result of scholastic delays caused by repetition or starting school late, since education in Botswana is not compulsory at any level. All students are guaranteed ten years basic education leading to a junior certificate qualification at the end of the three years of junior (lower) secondary education. Students sit for a Junior Certificate Examination (JCE) used to determine progression into senior (upper) secondary school. All schools at all levels of education are co-educational.

[5] The first ten years of schooling in Botswana considered to be every child"s right.

Approximately half the students from junior secondary education proceed to senior secondary education leading to the award of the Botswana General Certificate of Secondary Education (BGCSE). After two decades of free, state education, in 2006 Botswana announced the reintroduction of school fees. Figure 2.2 illustrates the education structure in terms of levels, grades and age range between each level.

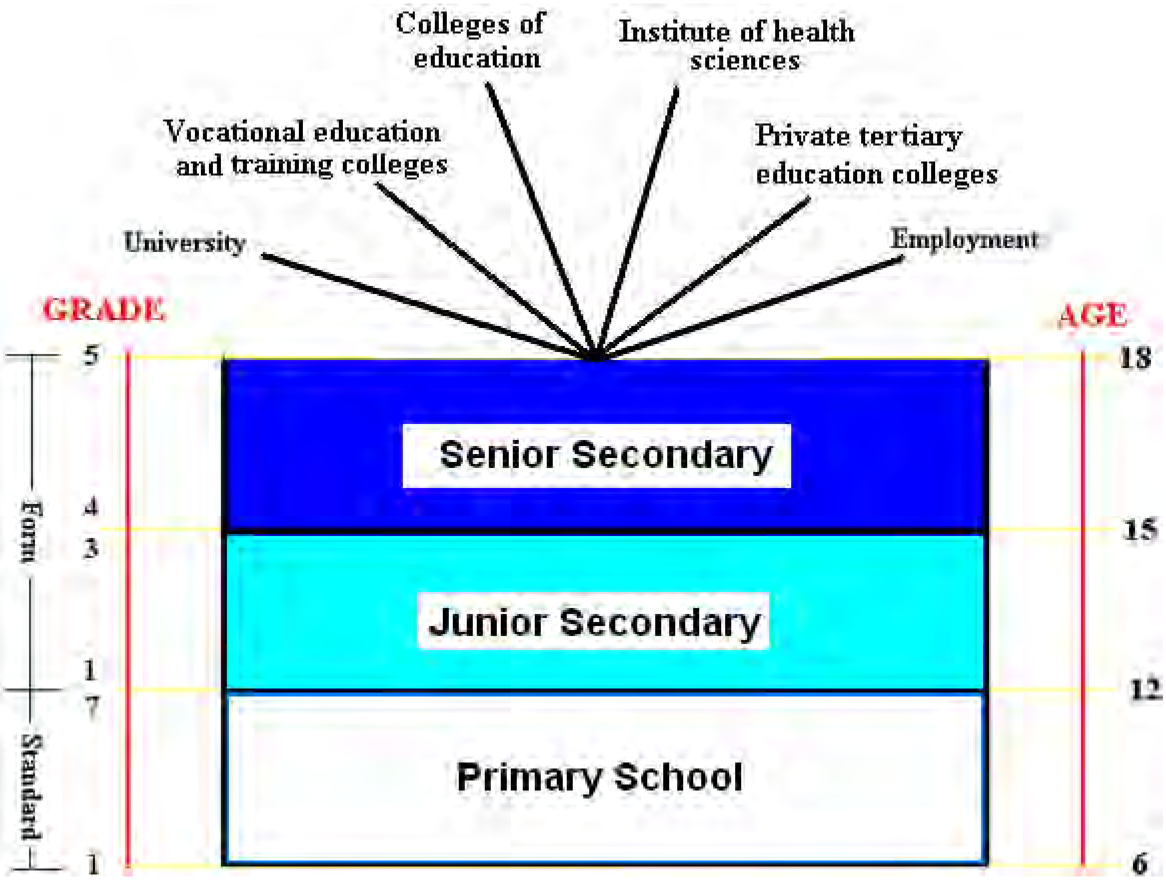


Figure 2.2: Botswana‟s education structure showing grade levels and age ranges (Source: designed by the author).

Primary school education begins at the age of 6 years in standard[6] one and proceeds for seven years to standard seven. Junior secondary school education begins at the age of 13 years in

[6] Primary school grade in the education system of Botswana.

form[7] one and proceeds for 3 years to form three. Senior secondary school education begins at the age of 16 years in form four and proceeds for two years. However, as indicated by the online country report (EFA 2000, 2009), a significant number of children enrolled at each level of schooling are either younger or older than the recommended age for that level. This is caused by repetitions[8], accelerations[9] and sometimes corrupt practices.

Figure 2.2 also shows options open to students after secondary school. The majority of students, who proceed, go to university, colleges of education, vocational education and training colleges, Institutions of health sciences, and numerous private tertiary education colleges in and outside the country, are government sponsored.

2.3 Junior secondary schools

At the time of conducting this study there were 212 junior secondary schools in Botswana. Within the junior secondary school system, schools are classified as either group two junior secondary schools or group three junior secondary schools. Group two junior secondary schools are schools with between six to nine streams and group three junior secondary are those with between twelve to twenty four streams. Table 2.1 gives an illustration of how these schools are grouped within the junior secondary school system.

[7] Secondary school grade in the education system of Botswana.
[8] A system of allowing failing students to repeat the same grade.
[9] A system of allowing exceptional students to skip a school grade.

Table 2.1: Classification of junior secondary schools (Source: Republic of Botswana, 2006).

School Group	No of streams / classes
3	6
3	9
2	12
2	15
2	18
2	24

Number of streams indicate the number of classes per each grade in a school, e.g. a six stream school is one with two form one classes, two form two classes, and two form three classes.

In addition to this classification, four of these junior secondary schools were piloting double shift, a new initiative intended to increase enrolments in schools. In a double shift school there is a morning shift and an afternoon shift. Both shifts share the same facilities in an alternating manner. For example, morning shift may start at 0600hrs and finish at 1200hrs. Afternoon shift would then start at 1200hrs and finish at 1800hrs.

Within the present research study, all the case study junior secondary schools, except school one, were group two schools with 18 streams. Only school one was a group two school with 24 streams. School two was one of those piloting double shift. Specific details in terms of performance and enrolment in design and technology in these junior secondary schools, and how they might have affected students‟ attitudes towards and perceptions of design and technology are discussed in chapter four.

2.4 Structure of junior secondary education

The structure of the junior secondary curriculum in terms of the distribution of subjects for students" selection is given in the table 2.2 below. The programme offers eight core and seven optional subjects. Core means that every student must study the subject to meet the requirements of the examinations. Optional means that students are allowed to choose whether or not to study the subject. Design and technology, as has already been highlighted appears under the core subject column of table 2.2, but it is offered as an optional subject in all schools.

The optional subjects are divided into two groups of practical studies and general studies. Each student takes the eight core subjects shown in column one of table 2.2, and two or three optional subjects (one from each of the two groups of practical studies and general studies), plus one from either. The programme allows for students to take a minimum of ten and a maximum of eleven subjects. Although guidance and counselling is not included in table 2.2, it is allocated timetable space of 2% and it is not examinable. Environmental Education, Population/Family Life Education, HIV/AIDS Education, pre-vocational skills, computer awareness and similar areas are to be integrated and infused into the core and optional subjects (Republic of Botswana, 1995). These areas or themes are not given any time in the timetable and the decision as to how and when they should be covered is left to the discretion of the schools.

Table 2.2: Distribution of subjects for student selection at junior secondary school (Source: Republic of Botswana, 1995).

CORE SUBJECTS	OPTIONAL SUBJECTS			
	PRACTICAL STUDIES		GENERAL STUDIES	
	A	B	A	B
English	Business Studies	Home Economics	Art	Religious Education
Setswana			Music	Third Language
Mathematics			Physical Education	
Integrated Science				
Social Studies				
Agriculture				
Moral Education				
Design and Technology.				

Table 2.3 shows the distribution of time among subjects. Schools have an option to use either a 40 period week of 40 minutes per period or a 45 period week of 35 minutes per period. Although not stipulated in the programme, the number of periods per week allocated to a subject indicates the importance attached to that subject by the programme.

Table 2.3: Number of Periods per Subject per Week (Source: Ministry of Education, 1995).

	NUMBER OF PERIODS PER WEEK	
SUBJECT	**40 X 40**	**45 X 35**
Core Subjects		
Moral Education	2	2
English	5	5
Social Studies	4	4
Mathematics	5	5
Integrated Science	5	5
Design and Technology	4	5
Agriculture	4	5
Setswana	4	4
Practical Subjects	2	3
General Subjects	2	3
Third Option	2	3
Guidance & Counselling	1	1
TOTAL	**40**	**45**

Each subject (shown in column one) is allocated the number of periods per week as shown in column two and column three for a 40 min x 40 periods per week system and for a 35 min x 45 periods per week system, respectively.

Each practical study subject is allocated two periods per week as shown in column two for a 40 min x 40 periods per week system and three periods per week as shown in column three for a 45 min x 35 periods per week system. Since students are allowed to choose only one subject between business studies and home economics, two periods are shown for practical subjects in column two or three periods in column three. The same pattern occurs for general studies subjects.

The third option is for a student who chooses to study a maximum of 11 subjects. This eleventh subject is either from the practical studies group or from the general studies groups and the number of periods is two for a 40 x 40 system and three for a 45 x 35. The last is guidance and counselling, which is allocated one period per week in both the 40×40 and the 45×35 systems.

Also, as a way of developing foundation skills, government recommended that „each student should take at least one co-curricular [*extra-curricular*] activity in the form of a sporting club activity, a club or a hobby" (Republic of Botswana, 1993b, p. 158). Teachers and students were required to stay at school up to six o"clock for practical projects, afternoon study and activities (including sport and clubs). Failure by students and teachers to stay at school late resulted in uncompleted practical projects and poor examination results. In other words, it was almost impossible to be successful in design and technology by only utilizing the official time-table. The work demanded that teachers and students put in extra time to complete projects and portfolios, which were part of the examinations procedure.

2.5 Design and technology in Botswana

The ideal design and technology student is prepared to be open-minded and accept criticism in order to improve on their products. Such a student develops the skills of being tolerant and being able to accommodate failures; he or she is adventurous and acts upon their own initiative. Recognising the need for these qualities in society, the Government of Botswana decided that design and technology, like other subjects, must take responsibility for preparing students for life after school. The Botswana government newspaper, *Daily News* (7 October 2002) reported the former president Mogae saying that ...[A] diversified and expanded curriculum that includes subjects such as business studies, art [and design], design and technology and computer studies would enhance the development of entrepreneurial and employment skills among school leavers (Lauglo, 2004, p .8). Moalosi and Molwane (2008) observed that design and technology in Botswana is offered as a pre-vocational programme relating to the world of work. The pre-vocational nature of design and technology in Botswana and the proliferation of globalization and computerization in society bring about a debate about the role of design and technology in the school curriculum. The question that lingers is; where is the place of design and technology in the school curriculum? Or, as Steeg (2008) puts it, what is the purpose of a design and technology curriculum?

2.6 Junior secondary design and technology curriculum content

Moalosi (2001) observed that, after independence, Botswana adopted an education system which was basically a three-tier one: primary, secondary and higher academic education. Due to this „academic" focused type of education system, Botswana lagged behind in the technical field. At that time Botswana relied on expatriates for her much needed technical expertise. The lack of technical expertise ultimately led the government to introduce technical subjects into the secondary school curriculum, which was often criticized for being too academic. The technical subjects then were considered to have the potential to offer something more than just the intellectual skills associated with academic subjects. These technical subjects included woodwork, technical drawing, metalwork, and electronics; the latter was introduced in the curriculum much later than the other three.

As trends in technology education were changing worldwide, and to bring Botswana in line with international thinking in the field of technology education, the Ministry of Education instituted a consultancy to review the traditional technical subjects" curriculum. A report from this review, popularly known in Botswana as the Fox report (Fox, 1988) recommended the introduction of design and technology and the phasing out of woodwork, metalwork, technical drawing and electronics. Following this recommendation, in 1990, design and technology was gradually introduced in schools, phasing out the old traditional craft-based technical subjects. Technical subjects were generally relegated to a position of least choice, to be taken by students who were not performing well academically. Moalosi (1999) observed that, before 1990, it was a common misconception that if a student was academically weak they might perform well in practical subjects. Technical subjects tended to be studied by boys only and they were dominated by teacher-centred methods of teaching, which did not offer opportunities for critical thinking, ingenuity and creativity. Critical thinking, ingenuity and creativity are some of the intellectually challenging key aspects of a well-developed design and technology provision and are considered important life skills.

Developments in technology education on a world scale have seen a shift in focus, from what has been a practical subject area for less academic students, to a mandatory subject area most valued for its potential to enable students to creatively intervene in the „made world". However, even though the basic education (from primary to lower secondary school) policy in Botswana stipulated that design and technology was a mandatory subject, in practice this has not been possible to implement, and schools still offered it essentially as an optional subject.

These developments in technology education, together with its problem-solving approach resulted in an „image boost" for design and technology (Ndaba, 1994). It was no longer viewed by governments as just a practical subject for less academic students, but a subject that developed both practical skills as well as intellectual skills. Neither was it viewed as a subject for boys, but one with a potential to increase the participation and performance of girls in technology. However, design and technology essentially remained resistant materials dominated. Food and textiles remained as part of home economics and computer studies remained as part of the whole school computer awareness programme.

In the early stages of its introduction, during the early 1990s, design and technology started to enjoy the privilege of being studied by some of the most academically gifted students in schools. Ndaba (1994) noted that it was a subject favoured by teachers, students and the government. The subject‟s examination performance competed comparatively well with other academic subjects. There was an increase of girls studying design and technology, even though the majority of them continued with home economics. All this sudden change of perception, however, was short-lived. Currently, design and technology departments are struggling to convince students, particularly girls, to take the subject, and this study was carried out to investigate the problem of falling enrolments in the subject. No study has been done to find out why there had been a sudden change of attitudes towards and perception of design and technology by students. The current study was the first one to investigate this problem.

The rationale for lower secondary design and technology, as stipulated in the syllabus (Republic of Botswana, 1996a), claims that the subject lays a firm foundation of generic skills, knowledge, values and attitudes useful to students continuing with formal education or entering formal or informal sector employment. The rationale acknowledges that design and technology has the potential to empower young Batswana to become resourceful, self-reliant and economic participants in their communities. To achieve these goals the programme seeks to:

- develop sound knowledge, skills, values and attitudes, as students manufacture useful artefacts;
- stimulate creativity and imagination in students as they solve real-life problems in their communities;
- provide flexibility to allow for varied interpretation of the syllabus according to local context of each community;
- equip students with entrepreneurial skills to enable them to market their products effectively;
- enable students to communicate through a variety of media while solving real-life problems;
- enable students to apply scientific and technological knowledge and principles, knowledge from other subjects and other relevant sources, in problem-solving activities related to their communities;
- make students aware of the economic potential in their communities;

- develop in students, an appreciation of their environment and to enable them to perceive problems in their communities as a challenge and a potential source of income;
- enable students to incorporate indigenous materials and technologies into their Design and Technology activities;
- give students satisfaction and a sense of pride, as they to see their products being useful to their communities; and
- enable students to contribute to the economic, social and environmental development of their immediate communities and their country when they leave school.((Republic of Botswana, 1996a, p. i)

The syllabus is organized into foci with each of the three years having a different focus as indicated in table 2.4. It is further developed into units, topics, general and specific objectives. The units and topics covered in each year are illustrated in the table and the rest of the syllabus is attached as appendix 11. Although the focus for each year is different, the units and topics, except safety and first aid in year one and screen printing in year two, are the same through all the three years. About three quarters of the content in each year made up of Materials, and Tools and Processes and only about one quarter is made up of Safety and First Aid, Communications and Technologies.

Table 2.4: Junior secondary school design and technology syllabus content.

YEAR 1: Skills and Knowledge Orientation.

UNIT	TOPIC
SAFETY AND FIRST AID	Safety Precautions
	First Aid
MATERIALS	Timber
	Manufactured Boards
	Metals
	Plastics
	Additional Materials
	Adhesives
	Abrasives
	Fixings
	Fittings
	Finishes and Finishing
COMMUNICATION	Graphics
	Marketing
	Design Process
TECHNOLOGIES	Structures
	Mechanisms
	Energy
	Electricity and Electronics
TOOLS AND PROCESSES	Measuring and Marking out tools
	Saws and Sawing
	Planes and Planing
	Files and Filing
	Drills, Drilling and Boring tools
	Chisels and Chiseling
	Shearing and Shearing
	Holding and Cramping tools
	Driving / Impelling / Percussion tools
	Forming Plastics
	Deforming
	Joining and Fabrication

YEAR 2 : Design tasks and Project Orientation .

UNIT	TOPIC
MATERIALS	Timber
	Manufactured Boards
	Metals
	Plastics
	Additional Materials
	Adhesives
	Abrasives
	Fixings
	Fittings
	Finishes and Finishing
COMMUNICATION	Graphics
	Marketing
	Design Process
TECHNOLOGIES	Structures
	Mechanisms
	Energy
	Electricity and Electronics
TOOLS AND PROCESSES	Measuring and Marking out tools
	Saws and Sawing
	Planes and Planing
	Files and Filing
	Drills, Drilling and Boring tools
	Chisels and Chiseling
	Shearing and Shearing
	Holding and Cramping tools
	Driving / Impelling / Percussion tools
	Forming Plastics
	Deforming
	Joining and Fabrication
	Screen printing

YEAR 3: Skills, Product Design and Manufacturing

UNIT	TOPIC
COMMUNICATION	Graphics
	Marketing
	Design Process
TECHNOLOGIES	Mechanisms
	Energy
	Electricity and Electronics
TOOLS AND PROCESSES	Measuring and Marking out tools
	Saws and Sawing
	Planes and Planing
	Files and Filing
	Drills, Drilling and Boring tools
	Chisels and Chiseling
	Shearing and Shearing
	Holding and Cramping tools
	Driving / Impelling / Percussion tools
	Forming Plastics
	Deforming
	Joining and Fabrication

It must be noted that even though the syllabus is organised into foci with each of the three years having a different focus, students coming to start year one do not come into schools until after about twelve weeks into the school year. Before they settle for their choice optional subjects, they have an orientation period, usually of two or so weeks, in which they are introduced to the whole school system and to the different subjects available for them to choose from. As a result, a significant part of year one is lost and teachers are not able to cover year one syllabus content in year one, so most of it overlaps into year two.

The objectives of the syllabus range from simple knowledge and understanding, through application, to more complex analysis and evaluation skills. Considering the rationale of the syllabus and the competing demands on time by the 15 subjects in the junior secondary school programme, this appears to be a heavily congested programme. More so that a significant part of year one is lost due to the fact that students start their syllabus about twelve weeks into the year and have up to two weeks of orientation. Kimbell et al (1995) and Gibson (2005) in their respective studies identified the problem of too much work in „Design and Technology" in England and „Technology and Design" in Northern Ireland, respectively. Gibson (2005) observed that it was important that thought was given to the volume and nature of work required within the curriculum time available for the subject. It was not the intention of this study to review the curriculum, but the nature of the curriculum subject, in terms of quantity of work has been found to affect attitudes of pupils towards the subject (Gibson, 2005; Neale, 2003; Kimbell et al, 1995; Welch et al, 2005).

2.6.1 Assessment in design and technology

Assessment in design and technology in Botswana involves the use of „pen and paper" tests, as well as projects and portfolios (design and make coursework). Following the Revised National Policy on Education (1994), continuous assessment was identified to be an important aspect in the students" final grading system. As a result, a dilemma exists between continuous assessment as a priority for formative assessment (assessment for learning), or a focus on the assessment procedures outlined by Examinations Research Testing and Development (ERTD), which are summative in nature (assessment of learning).

In general, there is great pressure placed on teachers and administrators to devote more and more time to prepare students to do well in examinations. As a result, narrowly focused assessments that emphasize recall and many portfolio pages of „cut and paste" have led to a similar narrowing of the curriculum and emphasis on rote memorisation of facts, with little opportunity to practise the higher-order, design-related knowledge and thinking skills purported in the subject rationale. Molwane (2000, p. 124) made an observation that teachers in lower secondary schools concentrate on generic design process skills to the detriment of other content areas of the programme, e.g. mechanisms, electricity and other technologies.

Projects and portfolio assessment take the main part of assessment in design and technology in the Botswana junior secondary school system and they are judged against a generic assessment criteria provided by ERTD. A portfolio is a purposeful collection of students‟ work that exhibits the student mind-map, effort, progress, and achievement in the development of their project. A portfolio gives a quick clear reference of what the student has been doing all along and provides the opportunity to observe the non-verbal responses (although written or oral form is integral). In the literature (Barak, 2007; Welch et al, 2005) it is suggested that the use of generic assessment criteria for judging students‟ design skills is not only counterproductive but also stifles students‟ creativity. This is discussed in more detail in chapter three.

It is a general practice in junior secondary schools in Botswana that students have monthly tests and end of term examinations. However, according to Molwane (2000), the practice varies in detail from one school to the other. Some schools assess students‟ projects and portfolios as part of coursework. Most schools use monthly tests and examinations, in addition to the Junior Certificate Examinations (Molwane, 2000). Molwane observed that these monthly tests and end of term examinations serve the purposes of summative assessment and not formative assessment. He observed that the grades are logged in the scheme and record of work books [10]for „assumed‟ teacher use: „assumed‟ in the sense that teachers are expected (as part of their teaching practice) to reflect on students‟ performances

[10] Ministry of Education official document in which teachers are expected to write down their plan for covering the syllabus content for a term or year and also to record work done and students marks for monthly tests.

and make meaning out of the assessment information obtained (Molwane, 2000, p. 124) but they do not do this.

Progress reports in the scheme and record of work books forces teachers to give tests and assessment tasks one after another to enter the marks in the columns provided for each calendar month in the scheme and record of work books. Failure to do so is regarded as negligence of the teacher‟s responsibilities (Molwane, 2000). As a result teachers resort to tests and tasks which are easy to mark, compute and grade, e.g. multiple choice and short answer objective questions.

The final grade of each student at the end of the third year in design and technology is obtained from three pieces of assessments: Paper 1 (multiple-choice questions); Paper 2 (Short answer questions and graphic skills); and Paper 3 (Practical project and portfolio work).

Paper 3 comprises design and make coursework in which a significant amount of a student‟s marks are allocated. Research reported in *The Times* (Frean, 2006) observed that in the United Kingdom teachers were concerned with the burden of marking coursework and the extra work it generated for students who have to meet project deadlines for a large number of different subjects all at the same time. This concern is not only felt in the United Kingdom. In Botswana, teachers and students have the same problem, resulting in rushed work to meet the deadlines.

2.6.2 Status of design and technology in Botswana

Since its introduction in 1990 the government has been very enthusiastic about design and technology and large sums of money have gone into building school workshops equipped with some state of the art facilities. From the point of view of the government, it is not surprising that a recommendation to make design and technology a core subject at junior secondary school could be accepted because of perceived economic benefits, even though there are huge financial implications. Design and technology, as a practically-oriented discipline, has considerably high unit costs due to facilities, equipment, materials, consumables, less optimal utilization of available teaching loads and smaller classes. In principle, as a result of government policy, design and technology was supposed to be a core subject at junior secondary school level from the year 2000, but at the time this study was undertaken all junior secondary schools offered design and technology as an option. It is reported (Moalosi and Molwane, 2008) that at some point a number of schools implemented this initiative but, due to lack of physical infrastructure and other resources, the attempt failed in subsequent years and the schools reverted to the previous practice of offering the subject as an option. This is discussed further in the study in chapter three.

Despite the initiative to offer design and technology as a mandatory subject, there seems to be a widespread negative attitude towards it, particularly among students. This negative attitude may be a result of disappointment and unfulfilled anticipated expectations of the economic relevance and personal development goals of design and technology, which had been promised through the subject rationale. Klenowski was quoted in Welch et al (2005) as having observed that there was a possibility that too much would be promised and in practice a lot less would be accomplished worldwide. Also, due to the expensive nature of the subject, Botswana seems to have failed to maintain her enthusiasm in proving the much needed resources for design and technology. According to Moalosi and Molwane (2008), the Government of Botswana decided to redirect funds to fight the HIV/AIDS epidemic and this stalled other developments, including the elevation of design and technology from option to core status.

Considering the way design and technology was regarded by many and conducted in Botswana junior secondary schools, one was left with no choice but to contend that design and technology in Botswana was „practical", „vocational", „second class" and more often associated with „less able /body" than with „more able /mind". This is reflected in the way in which design and technology students have to work in their ill-equipped design and technology laboratories (workshops) for most part of their time in school, i.e. during study time, weekend and school holidays in order to fulfil what Compton and Jones (2004) called the materialist artefactual focus of the curriculum. In other words, the curriculum focus was on production or making of artefacts.

Already it has been 14 years since the recommendation to make design and technology a core (mandatory) subject was made, but it has not been implemented. Instead, the enrolment numbers in design and technology have been declining over the years. Table 2.5 gives an indication of how the enrolment has declined since 1999. The mandatory status policy for design and technology was never enforced, because of the obvious impractical logistics of insufficient staffing, facilities and curriculum congestion. According to table 2.5, this subject has declined in uptake over ten years by up to 6% per year despite its elevation to a core subject. Throughout this period, male enrolment has consistently been around three times higher than female enrolment, implying a gender bias in choice or uptake. A senior design and technology official observed that the enrolment has dropped to about 35% (Nyerenda, 2007).

Table 2.5: Enrolment numbers in design and technology for Junior Certificate Education between 1999 and 2007 (Source: designed by author through personal communication with Botswana Examinations Council 2008).

Year	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Female	3743	3573	3204	2932	2705	2625	3091	2645	2528
Male	13474	13837	13973	12895	12423	8988	8580	7611	7096
Total	17217	17410	17177	15827	15128	11613	11671	10256	9624

This decline poses concerns and questions about future levels of technological literacy and expertise in Botswana. It was on the basis of this background that the present research investigated factors that influence perceptions of Junior Secondary School students towards design and technology in Botswana.

2.7 Resource Constraints

Botswana is a relatively resource rich country, exporting diamond, copper, nickel, soda ash, beef and textiles, yet resource constraints in schools still exist and design and technology has suffered as a result. With foreign exchange reserves at 60.9 billion Pula[11] (Republic of Botswana, 2010) as at the end of November, 2009, Botswana is financially much better endowed and has backed the implementation of design and technology and other relatively new subjects such as business studies, music and computer awarenss with substantial resources (Lauglo, 2004). Indeed, the government is obliged to provide resources to schools to enable equal access and quality education for all learners. More often than not, however, there are varied constraints on achieving this goal due to poor management of available resources, and inadequacies and inconsistencies in resource supplies and other support agents which schools may not have any influence over. Inadequacies and inconsistencies in resource supplies may be human (professional and support staff) or physical (learning materials and other relevant resources). According to a school summary of inspection findings (Republic of Botswana, 2003c), a resource is something that lies ready for use or that can be drawn upon to take care of a need; for example, money, materials, tools, equipment, facilities and staff. The inspection report identified resource management as one of the challenges facing schools in Botswana. This issue was also found to be important in the present study.

Poor management of available resources is mainly a result of some or all of the following factors: inadequate training; misplacement of persons; negative attitudes and difficult social and physical environment. Regarding inadequate training, delivery of design and technology

[11] Botswana currency: 1Pula = 0.09275 Sterling pound.

is sometimes hampered by under-utilisation of equipment in schools because of the lack of the teacher"s knowledge in using such equipment. In some cases machines and other equipment are not as efficient as they ought to be, or are not working at all, because of lack of maintenance. The system in junior secondary schools in Botswana is such that a senior teacher oversees a group of subjects put together under one category; for example, practical subjects, which comprise design and technology, agriculture, business studies, music, and art. As a result of this arrangement the senior teacher for this group of subjects could come from any of these subjects and, in some isolated cases, from outside these subjects. This means that, if the senior teacher"s background is not in design and technology, he may lack knowledge of the subject to sufficiently coordinate and manage its resources. Furthermore, inconsistencies exist in design and technology as, in some schools, the subject is coordinated by senior teachers who may not have any interest in the subject. Another related problem, reported in Weeks (2002), is the alternative arrangements in schools of how many subjects are grouped under one category. Weeks reported that it was common to find ten subjects under one senior teacher in one school, while another had only two subjects under their supervision in another school. These alternative arrangements create difficulties with votes[12], communication and potential integration across subjects.

Botswana has problems staffing design and technology. There is severe lack of locally trained teachers in areas such as electricity and electronics, computer graphics and other computer applications. In-service support has been especially important and utilized, even though there is inadequate in-service personnel in the subject. Design and Technology, for example, is under the responsibility/supervision of three Principal Education Officers (PEOs), one

[12] Budget allocations to schools and other government organisations, for recurrent and maintenance costs.

Curriculum Development Officer and one Examinations Officer overseeing the subject in over 230 junior and senior secondary schools scattered across the country. According to Lauglo (2004) technological subjects require strong headquarters staff, curriculum development personnel, and education officers for in-service, supervision and inspection. Because there is shortage of skilled human resources, these areas are insufficiently provided.

Junior secondary schools have problems in replacing, servicing and maintenance of equipment because of the government tendering system[13]. The Botswana government operates a comprehensive tendering and evaluation process for all government purchases whether for the purchase of commodity items, computer equipment, consultancy services, building and infrastructure, vehicles or other items and services (Republic of Botswana, 2007b). This tendering process sometimes causes delays in the supply of resources, due to internal deficiencies in the bureaucracy involved in the system. Design and technology requires high levels of managerial skills to deal with: complicated timetables; a mixture of teachers with different background and specialist areas; specialist rooms and extensive problems of ordering, supply, control and maintenance of expensive equipment and machinery. A design and technology inventory report (Republic of Botswana, 2000) indicated glaring inconsistencies in the manner in which inventories were managed in junior secondary schools in Botswana. One school had lost/damaged tools and equipment to the value amounting to a few hundred Pula, while the other school had lost/damaged tools and equipment to the value amounting to several thousands of Pula. Although junior secondary schools have a supplies officer each, whose responsibilities include supplies and procurement, many of these officers are not familiar with special tools, materials and machinery used in

[13] A government procurement system in which three quotations have to be provided before a requisition of purchase could be authorised.

design and technology. As a result design and technology teachers find themselves not only responsible for control and monitoring of tools and equipment but also for maintenance and procurement of these tools and equipment, which is not part of their training. The school summary of inspection findings (Republic of Botswana, 2003c) established that inventories in schools were poorly maintained and recommended that a thorough survey was needed to establish the magnitude of the problem with a view to improving the situation before it got out of control.

2.8 Design and technology teacher training in Botswana

Teachers, as agents of curriculum implementation, are central to the education system and can make or break it (Squire, 2000). They are crucial in any strategy aimed at achieving a more effective and responsive education system (Masenge, 2003). The importance of teachers in any study of education cannot be overemphasised, as Squire (2000) and Masenge (2003) observed. This section discusses the training of design and technology teachers in Botswana. This training could affect general perceptions of the subject in many different ways. In particular to this study, perceptions may be affected by insufficient output of trained teachers, which results in understaffed schools and overworked teachers. Perceptions may also be affected by the quality of training, which is an important determinant of the level of learning achievement. Training may have a bearing as well, on enjoyment of teaching the subject, which was observed in Barmby (2006) as one of the reasons given by teachers for wanting to teach.

If all junior secondary schools in Botswana offered design and technology as core, as national policy stipulates, a shortage of design and technology teachers would be a serious problem. Even in 1994 Ndaba observed that the shortage of design and technology teachers would worsen when design and technology finally became a core curriculum subject.

Several innovations have taken place to provide more teachers of design and technology in Botswana. During the late 1980s expatriate craft teachers were recruited from Southern African countries and given in-service training in design and technology. These countries did not offer design and technology and, therefore, the only teachers that Botswana could get were those trained to teach craft subjects. Another innovation was through the Teachers of Britain Recruitment Scheme (TBRS) which was administered by British Council. The TBRS recruited graduates in design and technology. These teachers did not require as much in-service training in design and technology as their counterparts recruited from Southern African countries. However, in the longer term, the government of Botswana could not bear the cost of these two arrangements, and the cost to the taxpayer was dear (Ndaba, 1994).

In a bid to localise and be cost-effective, the government of Botswana started to train local teachers of design and technology at two institutions, namely, Molepolole College of Education (MCE) for junior secondary school design and technology teachers, and the then Botswana Polytechnic for senior secondary school design and technology teachers. Ndaba (1994) noted that a significant output of 25 teachers each year from MCE increased the number of local teachers, thus reducing dependence on expatriate teachers. Between 1987 and 1991 Botswana Polytechnic had a small intermittent enrolment in the design and technology programme and 14 students were transferred to the United Kingdom to complete their B. Ed (Design and Technology) course. Until 2005, the only route for upgrading of teachers from Diploma to Bachelors degree and to prepare them to teach design and technology rather than craft was to train them abroad (U.K and Australia). On returning from abroad, most of these teachers would be moved to teach at senior secondary schools, since they were then degree holders. Many of the teachers trained at MCE since its inception in 1984 have since upgraded and moved to teach at senior secondary schools.

In 1993, the Botswana Polytechnic was merged with the University of Botswana as a faculty of Engineering and Technology (FET). Since 1993, pre-service teacher training of design and technology teachers in Botswana takes place at two levels. Molepolole College of Education (MCE) runs a three-year diploma course in design and technology for junior secondary school teachers. The University of Botswana runs a five-year B. Ed programme for senior secondary school teachers. In 2005, the first cohort of diploma holding teachers was enrolled at the University of Botswana to upgrade to B. Ed. Diploma holders are enrolled at the third year of the programme at the University of Botswana.

Although Bachelors degree holders are trained to teach at senior secondary school, there are a few at junior secondary school. Thus the teachers interviewed in this study included teachers of different profiles as described above. The profile of teachers may have a bearing on their perceptions about the subject, as well as on their relationship with others.

2.8.1 Training of junior secondary school teachers

Training of teachers of design and technology for junior secondary school at MCE follows a three year diploma programme in which teacher trainees study a major and a minor subject plus subjects of Foundations of Education, Special Education awareness course and communication and study skills. The minimum entry requirement for a Diploma in Secondary Education at MCE is a Botswana General Certificate of Secondary Education (BGCSE) or equivalent with at least two credits. Candidates between 25 – 35 years of age may be considered on the basis of: relevant experience since they left school and passes in at least two courses at Cambridge Overseas School Certificate (COSC), or at least three subjects at BGCSE.

The structure of the design and technology programme is designed such that the course will develop students‟ knowledge and skills in two basic areas of design and technology and education. In the area of design and technology there are courses on resistant materials, technology, graphical communications and other topics. These courses develop candidates‟ basic knowledge and skills in design and technology. In the area of education there are courses on curriculum and instruction, teaching methods and assessment, which are meant to develop candidates‟ knowledge and skills of teaching. During the three years of training students undertake two periods of 10 weeks teaching practice across junior secondary schools in the Southern region of Botswana. On this teaching practice they teach both their major and minor subjects. College lecturers and school staff at which the students are posted for teaching practice supervise the teaching practice.

2.8.2 Training of senior secondary school teachers

Some teachers trained to teach at senior secondary school teach at junior secondary school due to circumstances best known to the teacher deployment department in the Ministry of Education in Botswana. It is important for this study to review training arrangements at this level because these teachers were among the sample interviewed in this study.

Training of teachers of design and technology for senior secondary school takes place at the University of Botswana in the Faculty of Engineering and Technology. The Department of Technology and Educational Studies (DTES) in the Faculty of Engineering and Technology at the University of Botswana is the only place in Africa, which has been offering a programme of study leading to a Bachelors Degree of Education (B. Ed) (Design and Technology) since 1993 (Tanna and Kumar, 2002).

With effect from the year 2002 the University of Botswana semesterised all academic programmes. A semester is defined as one of the two annual 14-weeks period of teaching (Tanna and Kumar, 2002). Semesterisation resulted in several new features incorporated into the design and technology programme, including making it more science-based while updating the curriculum into a Bachelors Degree of Design and Technology) (B. Des (Design and Technology Education).

In the B. Des (Design and Technology Education) programme students attend courses of the Bachelors of Science (BSc) programme offered by the Faculty of Science in the first year. This is meant to provide a strong scientific basis, which was lacking in the previous B. Ed (Design and Technology) programme. In the second year students attend basic engineering and technology foundation courses offered to all degree students in FET. The last three years of the programme is dedicated to the professional and associated courses in the area of design and technology offered by the DTES and in the area of education offered by the Department of Educational Foundations. During the five years of training students undertake a period of 6 weeks teaching practice across senior secondary schools in Botswana. University of Botswana lecturers and school staff at which the students are posted for teaching practice supervise the teaching practice.

Training determines the ability of the teachers to sufficiently handle the content of the syllabus. This in turn influences the number of students who study design and technology at junior secondary school and beyond. In Gibson‟s (2005) study on teachers‟ perceptions of „Technology and Design‟ within the Northern Ireland curriculum, teachers questioned if it was possible to teach all of the content of the programme of study within the time available, citing, in particular, the nature of project work. This is the same question asked by design and technology teachers in junior schools in Botswana. The training they get does not cover every aspect of the content they are going to be teaching, since the junior school programme itself is so all embracing. Clearly if it is not possible to cover every aspect of the content adequately, then the subject suffers. Perhaps this shortcoming could be addressed by considering the strength of individual teachers, so that teachers with different strength in different aspects of design and technology are deployed to different schools and are used in in-service training of others. This lack of strategic deployment of teachers has resulted in some cases with teachers who are strong in one area of design and technology placed in the same school.

The issues surrounding the context of the study, as discussed above, have implications for design and technology education in junior secondary schools in Botswana. The literature review in the next chapter is discussed in the light of these issues and how they impact upon attitudes and perceptions of design and technology students towards the subject.

CHAPTER 3: LITERATURE REVIEW

3.1 Introduction

Central to the junior secondary school curriculum in Botswana is the concept of pre-vocational preparation to develop readiness for work and trainability (Republic of Botswana, 1993b). Pre-vocational preparation is closely related to, and often confused with, vocational preparation. Moorad et al (1993) defined pre-vocational preparation as a concept concerned with orientating students to various practical skills with a view to preparing them for further training. Such programmes are broad based and not intended to qualify trainees for direct employment (Moorad et al, 1993).

The concept of pre-vocationalization has many facets that have to be clarified to avoid the confusion that seems apparent in educational policy in Botswana. This confusion is reported by Moorad et al (1993), who observed that there is lack of clarity as to whether the provision of vocational education in school should be pre-vocational and preparatory or whether it should provide complete training for the world of work. Owen-Jackson (2002) reported the same debates in the United Kingdom on the balance between design and technology‟s vocational purposes and general education purposes. Quoting Lauglo and Lillis, Chan (1990) wrote that there is no clear distinction between pre-vocational education and vocational education. Both required further on the job training, and neither can meaningfully be equated with general education.

The government of Botswana developed five approaches to achieve the goals of pre-vocational preparation. These approaches were called components of pre-vocational preparation (Republic of Botswana, 1993b) and were listed as:

1. The vocational orientation of academic subjects;
2. Practical subjects;
3. Foundation skills;
4. Familiarization with the nature of work; and
5. Careers guidance.

These components are some of the many approaches through which countries tried to achieve the objectives of pre-vocational preparation in education. Policy documents on each of these components as regards policy and practice in the context of Botswana is discussed to clarify the situation and determine their contribution to the development of the subject of design and technology in the curriculum.

Vocational orientation of academic subjects

This component involves teaching of academic subjects in such a way that they are related to the world of work. Lauglo (2004) viewed it as a more practical and applied way of teaching general education subjects, in an attempt to improve the relevance of education for work. Whenever appropriate, teachers are expected to demonstrate to students the practical application of concepts, knowledge and processes to various jobs available to students once they completed the basic education programme. Competition for time between academic subjects and other subjects, coupled with examinations pressure, made vocational orientation of all subjects problematic.

Practical subjects

Practical subjects require students to use motor skills, to apply cognitive skills in real, everyday situations. The teaching and learning involve a demonstration of practical skills to help students develop an understanding and appreciation of technology, manipulative skills and familiarity with tools, equipment and materials. Assessment is practically based, although it may also have a theory component to it. For example, design and technology capability cannot be appropriately assessed using „pen and paper" assessment tools, particularly the creative aspects. These „pen and paper" assessment tools need to be supplemented with projects and portfolios.

Earlier reviews (Lauglo, 2004; Moorad el al, 1993) pointed to the following constraints on the implementation of practical subjects in developing countries such as Botswana:

- Practical subjects tended to have complex staffing, servicing/logistics requirements, setting up and maintenance of facilities, equipment and tools, supply of materials and consumables and implementation of appropriate assessment procedures;
- Inadequate pedagogy;
- Considerably high unit costs;
- Unclear government commitment and haphazard planning;
- Taking time and other scarce resources away from other subjects;

- Practical subjects contributed to curriculum overcrowding which led to insufficient quality in learning outcomes, across the curriculum;
- Sometimes practical subjects were not attractive to pupils, parents and teachers;
- Curriculum design often had flaws, e.g., excessive overlap among different subjects, insufficiently logical and systematic progression on taught contents; and
- Practical subjects would not receive enough time and attention to give credible skills given that they were only allocated portions of the total timetable.

Design and technology in Botswana, and elsewhere, has not escaped these constraints. It has often been under particular scrutiny by educational stakeholders (Tabulawa, 2009), for being disproportionately expensive and expected to contribute to nation‟s prosperity (Matheson, 2006; Liyanage and Poon, 2003; Roth and Lee, 2004).

Mudariki and Weeks (1993) saw the introduction of practical subjects into schools in Botswana as a „light dosage of vocationalization‟. They observed that;

> At a minimum, vocationalization is the introduction of practical subjects into schools, for example, agriculture, commerce, design and technology, and home management – a move away from purely traditional, academic subjects. Vocationalization can go beyond this to include integration between practical and academic subjects, learning from self-reliance activities, and learning through clubs and societies. In some cases the whole school is looked at as a productive enterprise, offering a variety of experiences from administration through to technical production (Republic of Botswana, 1993(a) p. A12-2).

The general position taken by the literature considered here, views practical subjects in terms of motor skills development. This position on design and technology is unfortunate, because design and technology extended beyond the simple motor skills development. It includes aspects of decision making, problem-solving, and design skills, which are more generic and cut across the vocational/academic divide.

Foundation skills

Foundation skills are skills deemed to be important and applicable to work situations. They are not subject specific and all subjects are expected to infuse such skills in their teaching and learning processes, as can be seen in the following statement:

> A variety of foundation skills applicable to work situations, such as decision-making and problem-solving, self-presentation, team-work and computing are to be developed through the use of cross-curricular approaches to teaching and learning which stress process skills as well as subject content (Republic of Botswana, 1995, p. 3).

Most of these foundation skills, for example, problem-solving, are key skills in design and technology. If such skills are considered to be cross-curricular and not unique to design and technology then the position of design and technology in the curriculum becomes ambiguous. The subject of design and technology in junior secondary schools in Botswana is lost in the system, as it is in many other places, somewhere between vocational and academic. Spendlove (2008) views it as a hybrid and calls it „vocademic" and this is not helping the subject. The vocademic nature of the subject implies that it neither here nor there and as a result there are diverse views as to what the subject really is.

Some of the arguments raised for the place of design and technology in the mainstream curriculum include the following; that it draws its content from a range of subjects and applies cross-curricular skills to real-life situations; that it is at the heart of the school curriculum. In some way this position has not helped design and technology to gain a real sense of identity, but instead the subject was seen as applied science or applied engineering and, sometimes, as creative art.

The implementation of foundation skills led to the introduction of individual projects and research exercises across subjects. Weeks (2002) reported a general lack of understanding of the new independent study/portfolio approach to continuous assessment. This approach meant that a student‟s workload across all subjects, but mostly in practical subjects, increased. In the context of Botswana the rate of failure increased, due lack of understanding and insufficient training of teachers on these new methods.

Familiarization with the nature of work

This component is similar to the foundation skills component because it is meant to develop the foundation skills, and its implementation faces the same problems as foundation skills. Structured visits to companies, work simulations, community projects, hands-on experiences and the involvement of people from industry and the community are strategies mentioned in policy documents as most likely to develop work-related values and attitudes. According to Weeks‟ (2002) report, these were minimal. She observed that the usual contacts outside the schools were through educational excursions to a mine, industry, museum or some focal point, rather than long-time work placements.

Careers guidance

The Report of the National Commission on Education states that careers guidance should be systematically related to other elements of pre-vocational preparation programme across the school (Republic of Botswana, 1993b, p. 159). The policy guidelines on the implementation of guidance and counselling in Botswana noted that unemployment, lack of appropriate skills required by employers and the limited opportunities for further training, were some of the numerous challenges and realities that the school leaver faced (Republic of Botswana, 1996b, p. 7).

Students" occupational development needs and other aspects of preparation for life are catered for through careers guidance and counselling. Although not examinable, careers guidance and counselling was included in the school time-table at the recommendation of the Revised National Policy on Education of 1994. The ten year basic education programme curriculum blueprint stated that:

> Students need to understand the range of occupations available and to identify their own potential areas of interest and aptitude. They should know the educational and training requirements of particular occupations. Careers guidance will therefore be offered with the aim of equipping students with the necessary skills and knowledge that will enable them to make informed decisions about their occupational development and other aspects of preparation for life (Republic of Botswana, 1995, p. 4)

Although careers guidance and counselling had teachers whose specific responsibility was to coordinate the programme as part of their job description, this programme faced challenges.

Other teachers and students themselves did not give guidance and counselling much attention, because it was not examinable. In addition the demand upon the timetable from other subjects meant that careers guidance and counselling was given less priority than other subjects.

In 1997, UNICEF (Republic of Botswana, 2005a) proposed an initiative that was meant to expose students to a wide range of careers in Botswana called Job Shadowing. The objectives of job shadowing were given as;

1. To expose students to the realities of the work place;
2. To increase the employability and trainability of students;
3. To expose students to a wide range of occupational choices; and
4. To equip students with job seeking skills.

The job shadowing programme was said to have been pilot tested in schools in Gaborone (see section 4.4) and was now part of the on-going career guidance programme run in secondary schools alongside career fairs. The report of the project mentioned that job shadowing strengthened career guidance in schools, but it did not give much detail about its achievements or failures. Needless to say, job shadowing is a valuable initiative if well developed. In the USA, job shadowing is a legislated school-to-work programme, which links students up with employers.

3.2 Pre-vocationalisation & design and technology

The link between vocational education and design and technology education is a highly complex and much-debated one the world over. In clarifying the distinction between design and technology and vocational education, Dakers (2007) cautioned that design and technology was not specific job training in the traditional apprenticeship sense and that design and technology existed primarily for the student, rather than for the world of work (Barlex, 2007; Hill, 2003).

Design and technology could be directly linked to the whole pre-vocational preparation drive in the curriculum in Botswana because of the following reasons. Having evolved from traditional craft subjects, which were introduced to address technical expertise needs, design and technology was often assumed to be synonymous with vocational education. It was one of the subjects labelled „practical‟, even though this label implies only simple motor skills development. A well delivered design and technology programme should also develop decision-making, problem-solving, design, creative and innovative skills, which are well above simple motor skills. Spendlove (2008) observed that design and technology was „vocademic‟ in nature, meaning that it is neither vocational nor academic. This is the view expressed by Gawith et al (2007) when they observed that technology education is both an old and a new subject. As an old subject it has its roots in the vocational craft skills and as a new subject it encompasses general high-order intellectual skills. As a result of this nature of technology education it is difficult to spell out what design and technology is or is not without necessarily invoking other subject areas.

Design and technology is linked to the whole pre-vocational preparation attempts in Botswana also because of its „vocademic" nature, key skills and its link with the familiarization with the nature of work, all of which are goals of pre-vocational preparation. Internationally, as Compton and Jones (2004) observed, until recently many of the sociological theorists often explored the concept of technology in a narrow way of taking a materialistic artefactual focus, as opposed to a broad re-conceptualisation of technology as situated human activity, reliant on and reflective of social, cultural, political and environmental location (Compton and Jones, 2004, p. 5). Spendlove (2008, p. 7) also observed that, as a gross generalization, the subject has often been taken by pupils who are not very good at the sciences, mathematics, english or the humanities.

Black cited in Compton and Jones (2004) discussed the diversity both between and within countries, regarding technology education and its educational purpose. He identified five variations of technology education, which may be found both within and between countries.

1. Technology education as craft skills

The focus of technology education here is primarily linked to the use of tools and materials to make products. This approach is purely practical. The educational purpose would seem vocationally oriented. According to Spendlove (2008), this comes as a result of a myth that children needed to take home something that they have made in the subject. An example of this is evident in the junior secondary design and technology content in Botswana, which is predominantly resistant materials, as discussed earlier in chapter two.

2. Technology education as design and make

In this case elements of design are incorporated as distinct from making from a template as is the case above. This is an expanded version of the first one and again its educational purpose would seem vocationally oriented. An example of this is also evident in the junior secondary school design and technology content in Botswana. As discussed in chapter two, even though the focus of the junior secondary school content is skills and knowledge of resistant materials, tools and processes, and product manufacturing, there is limited amount of design content.

3. Technology education and Science

Technology education is essentially applied science in this case. Links are made to general education for future citizenship in a technological society. An example of this is the subject „Science and Technology" in Israel. Although, design and technology is distinct from science in many curricula, there is clearly aspects in common between the two that, if linked, could provide more opportunities for students to intervene in the made world. The vocational / academic divide is so entrenched in the education system in Botswana that bringing design and technology and science together would be a challenge. It must be noted though that the idea of viewing technology as applied science has also been challenged as a limited view of the technology (de Vries, 2008, William, 2008).

4. Technology education as „design and make" in the context of the application of scientific principles

While the focus of technology education in this case is on the process of design and manufacture, questions of „purpose and value" are explored in the context of solving problems using scientific or mathematical principles. The educational purpose here would seem to be to develop people as future citizens. Many technology education programmes in Europe and the United States of America are operating within this context, and, as a result, the value of design and technology seems to be overshadowed by the scientific perspective.

5. Technology education as practical capability

The focus of technology education here is centred on a complex process involving co-operation, defining of needs, designing, implementing and evaluating solutions. The educational purpose here is for "citizenship, broad vocational fitness, and personal development by way of the development of the synthesis of the powers of analysis, decision, manual and aesthetic skill, evaluation and collaboration" (Compton and Jones, 2004, p. 5). This is the ideal technology education that nations are striving to achieve.

A review of the implementation of design and technology under pre-vocational preparation in Botswana indicates an array of problems that junior secondary schools face in their attempt to pre-vocationalize the curriculum. Implementation problems concerning pre-vocationalization affect the development of design and technology as a mandatory subject in junior secondary schools in Botswana. First, because it was itself used as one of the approaches to achieve pre-vocational preparation. Second, because where there are curriculum implementation problems, the environment or the atmosphere does not support any new initiatives, such as those found in an ever transforming subject like design and technology. Implementers, in this case teachers and students, may not be willing to engage in any reform because they are frustrated by current problems. I view this as a potential impediment to increased enrolment in junior secondary school design and technology in Botswana. Making it a mandatory subject may well have exacerbated problems of curriculum overcrowding, inadequate pedagogy, and lack of attractiveness, as highlighted earlier. In this case, practitioners would rather have it as it has always been: an optional (practical/vocational) subject.

The implementation of design and technology as a mandatory subject may well have been stalled by the fact that design and technology was directly linked to the concept of pre-vocationalization, which is, in many people‟s opinions, not a core curriculum concept. According to Dakers (2007) and Spendlove (2008), design and technology education is often perceived to be for those who are less intellectually capable of following the academic curriculum. The academic curriculum is the core of schooling and is widely perceived as being different from design and technology education, which is seen as vocational. To implement the subject of design and technology mandatory required breaking the barriers of a well-established post-colonial cultural system, which has long valued academic qualifications as being superior to vocational ones. As Van Rensburg et al (1999, p. 149) reported that many of South Africa‟s people view technological jobs as blue collar jobs and academic education and white collar jobs as of high status. The same view is held by many in Botswana.

As can be see, vocational and/or pre-vocational provision in secondary school has many variants on the world scene, depending on the functions it is purported to serve. In some countries it is perceived as a „widening of general education‟, also known as diversification (Botswana, Kenya and Ghana are examples). In others, it is perceived as broad familiarization and preparation for further training, as in the case where it is provided as a parallel system (bi-partite model) alongside general education (UK, USA, Hong Kong and many Latin American countries are examples). In other countries it is perceived as preparation for work, where vocational education is institutionalized and offered in vocational education schools (Greece and the Netherlands). Paleocrassas et al (2002) developed a scheme shown in figure 3.1 to illustrate the different provisions (curriculum options) of vocationalization across the world. At one extreme of the continuum is the academic option in which there is no vocational component.

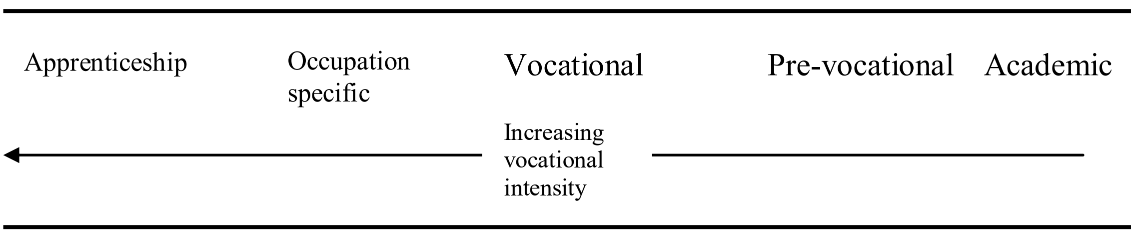


Figure 3.1: Curriculum options by vocational intensity (Source: Paleocrassas et al, 2002).

In many of these contexts vocationalization within the secondary school has been strongly criticized. Firstly, it has been criticized for having an inferior or lower status in contrast to general education. Secondly, it has been criticized for being related to a stage of economic development of stagnation, which Pscharopoulos and Patrinos (1993) called locking people into „dead-end‟ jobs. Thirdly, it is regarded as being costly since such qualifications do not make school leavers more employable than school leavers of general education.

Design and technology education, in general, develops skills that are more generic and could be developed equally across the academic/vocational, mind/body divide (Dakers, 2007). For this reason, design and technology is offered in many countries as a core (mandatory) subject at least up to lower secondary school, with some advocating that it should be in the mainstream curriculum, as a discipline in its own right. The problem is that educators in other fields, for example, science, mathematics, history and geography claim exactly the same thing: that they develop these generic skills. However, in the next four sections, I aim to show how design and technology is unique and able to develop knowledge and skills in a way that other subjects in the school curriculum could not.

3.3 Uniqueness of design and technology

The key function of education, according to Adeyinka and Major (2006), is to enable the individual to cultivate good habits and develop the right attitude to life and work. The aim of education must be to prepare individuals for life. Thus, one of the central goals of the curriculum is adequate preparation for the world of work (Republic of Botswana, 1994). A relevant and realistic curriculum should prepare students for the realities of their post-school life (Republic of Botswana, 1996a). These observations clearly show that one important purpose of education is to prepare people for life outside the educational system. Thus the value of any curriculum subject should be judged not on the basis of „knowledge acquisition‟ but on „knowledge application‟. Design and technology integrates skills, knowledge, experience, resources and creativity in an active, thought-provoking manner to promote knowledge application.

Unemployment of junior secondary school leavers in Botswana is reported to be on the increase (Republic of Botswana, 1996a). These youths expect to find jobs in the formal sector [14]and do not seem to consider other sources of income generation in their communities. On the other hand many reports, (Mooketsi, 1993; Monkge, 2001), suggest that employers in Botswana generally have negative attitudes towards school leavers. Education is seen by employers as in the sort of way described by Hills (2004), who observed that education in the United Kingdom was a world of the printed word, of memorising information, all of it second-hand, in preparation for formal examinations.

The negative attitudes of employers towards school leavers in Botswana come as a result of the seemingly educational imbalance in favour of people who „understand" rather than people who have to „act". Put another way, the education system has been blamed for producing people who are simply „not capable". Education is to develop and transmit knowledge for a range of purposes, including the preparation of young people for the „world of work". There is need for improved information transfer and articulation between education and employment. Important issues arise regarding the nature and source of technological knowledge relevant to society. Furthermore, questions of knowledge arise which are related to a well-documented framework (Nuttgens, 1980; Hills, 2004, 2005; Burgess, 1985) of „Education for capability". According to Dakers et al (2007) technological knowledge is variously known as „Technological Literacy", or „Technological Capability".

[14] Formal sector employment is one in which an employee is paid a salary at specific times by the employer. This is different from informal sector employment in which there is no employer, e.g. personal business or farming.

3.3.1 Technological literacy

The role of technology education could be said to be to prepare students to become technologically literate. Because of the nature of technological literacy, which is broad and encompassing, technology educators do not agree as to what constitute „technological literacy". In its narrow sense technological literacy may be taken to mean technological capability (Dakers et al, 2007), but in its broader sense technological literacy means a lot more than just capability. It includes the ability to use, understand, manage and evaluate technology (Havice, 2006). As a result, technological literacy is spans two paradigms as explained by Gawith et al (2007) in figure 3.2 below, which is somewhat similar to the different provisions (curriculum options) of vocationalization across the world illustrated by Paleocrassas et al (2002) in figure 3.1. According to Gawith et al (2007), teachers in New Zealand, and I believe in many other countries, are concerned that the pendulum has swung and seemed stuck too far away from the roots of technology education towards an increasingly academic technological social studies approach.

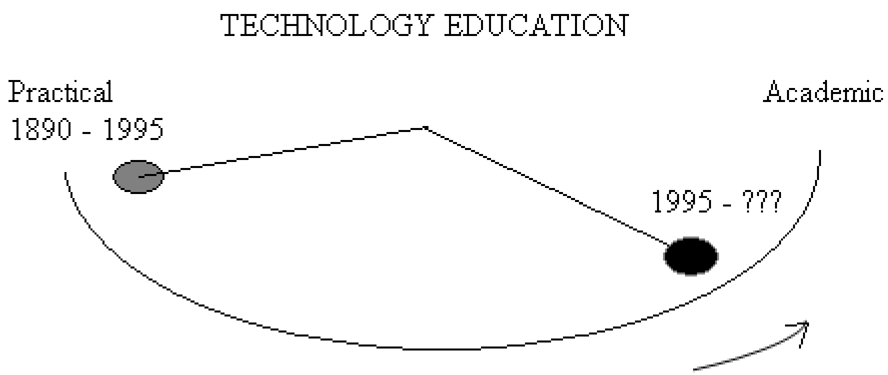


Figure 3.2: Technology Education: Practical vs. Academic (Source: Gawith et al, 2007).

The issue at hand is that for it to survive in the mainstream curriculum, technology education has to have a defined role in the wider agenda of general education, in which there is so much competition from other mainstream curriculum subjects. While some technology educators (Barak, 2008; Wakes, 2008) argue that the role of technology education is to develop students‟ general higher-order intellectual skills (academic), some (Barlex, 2008; De Vries, 2008) consider that this is a weak justification and does not bring out the uniqueness of technology education. According to Compton and Jones (2004) focusing on the more generic underpinnings of technology is becoming inevitable to ensure such things as fitness for purpose and assessment of risks, and as traditional boundaries are crossed in the establishment of new technological outcomes.

De Vries (2008) warned that it is risky to justify the position of technology education in the curriculum on the basis of general concepts and skills, because technology, as a domain of knowledge and skills, has characteristics that differ from those in other fields. According to Williams (2008), technology education develops students‟ general higher-order intellectual skills in a particular context which concurrently develops a knowledge and understanding of the technological system. Garmire and Person in Van Keulen (2008) identified three dimensions in the characteristics of a technologically literate person as: knowledge, critical thinking and decision-making, and capabilities.

A sound understanding of technology as a process that involves human decisions rather than natural necessities, and the ability to use and critically assess technology, is a crucial element of technology education, intended to develop an informed, literate citizenship that can make sensible and considered decisions about technological things in a technological world.

There is a growing body of literature that argues that technological knowledge exist as distinct from, and fundamentally different to, other knowledge domains, particularly science, which is often confused with technology. According to Baird, cited in Compton and Jones (2004), the epistemic criteria for judging technological knowledge should be referenced to the „made" rather than to the „natural" or „imagined" world, as is the case of science, and art and music respectively. Baird argues that technology is a situated and purposeful activity embedded in the made world and impacted on by social, cultural, environmental, political, and economic perspectives and contexts at both local and global levels (Compton and Jones, 2004, p. 6). According to de Vries (2007), while scientific knowledge focuses on how things actually are, through discovery, technological knowledge focuses on how things ought to be, through collective negotiation and acceptance on the part of technological stakeholders. Technology education, therefore, seeks to provide an appropriate style of learning needed to engage in a rapidly-changing, knowledge economy. The ever-increasing environmental and economic challenges and opportunities, and diverse lifestyles brought an increasing demand to commit to an education that fostered new knowledge, capabilities and dispositions, an education that challenges traditional boundaries, such as culture or subject disciplines. Design and technology provides an education for an increasingly global and culturally diverse community, where ideas, innovation and enterprise are central to the design and development of sustainable, socially responsible, preferred futures (Spry, 2009, p. 155). Considering the content of the design and technology syllabus (Appendix 11), this does not seem to be the goal of technology education in Botswana.

The advancement of technology has pushed the parameters of technological literacy across the traditional boundaries (Compton and Jones, 2004) between curriculum subjects and, as such, more and more subjects that were traditionally not technical in nature are now technical. Skills and capabilities that were traditionally technical are becoming more and more generic and so technological education is becoming entwined with the sciences, mathematics, and the arts. Nonetheless, design and technology remain better placed than most subject to develop the much needed technological literacy.

3.3.2 Technological capability

Capability is defined as the ability to act effectively in the face of new circumstances (Hills, 2004). Action is an important aspect of capability and it implies effective application of knowledge.

> A well-balanced education should, of course, embrace analysis and acquisition of knowledge. But it must also include the exercise of creative skills, the competence to undertake and complete tasks and the ability to cope with everyday life; and also doing all these things in co-operation with others (Hills, 2004, p. 22).

The concept of Education for Capability (Hills, 2004) emphasise the need for education for competence and capability rather than knowledge and higher-order intellectual skills for their own sake. Knowledge and higher-order intellectual skills are valuable, but insufficient without the competence to apply them in real working situations.

To articulate the way in which knowledge can be developed to foster capability over and above ability, a framework, which identifies forms of knowledge, is discussed next. It is particularly relevant to this study and applicable to design and technology education. A discussion of forms of knowledge, not only help us to understand the role of knowledge in technological capability and technological literacy but brings out the value and uniqueness of design and technology education.

3.4 Forms of knowledge framework

A framework discussing forms of knowledge is considered in this study as a way of expressing the value and uniqueness of design and technology as a distinct area of learning in the school curriculum. This framework is consistent with other frameworks articulating the role of design and technology in the school curriculum. For example, the South Australian Curriculum Standards and Accountability (SACSA) Framework in design and technology (Spry, 2009), discussed later in the chapter, illustrates how the head, the hands, and the heart are important attributes for providing a quality design and technology education.

MacFarlane, cited in Hills (2005) identified two forms of knowledge categorised into: Mode-one (factual, intellectual knowledge, based on hypothesis and theories) and Mode-two (thinking concerned with the application of academic knowledge to useful purposes). Mode-one and Mode-two knowledge are discussed in this study as conceptual knowledge and procedural knowledge (McCormick, 1997, 2002). The third form of knowledge, not identified in the MacFarlane model, known as conditional knowledge is also discussed as an important component of design and technology. The appropriateness of knowledge should be considered within particular contexts. For example, in the context of design and technology in Botswana, craft knowledge may not be a status symbol, but it is still valuable, perhaps more valuable than intellectual knowledge. As a developing country, the value of craft knowledge in Botswana is indispensable and people‟s attitudes need to be changed to appreciate this aspect.

Conceptual knowledge

McCormick (1997) refers to Mode-one form of knowledge as conceptual knowledge, a form of „know -what" knowledge, which allows situations to be explained in terms of „know-why". De Vries (2007) refers to this kind of knowledge as propositional knowledge. It is also sometimes referred to as „knowledge-what" or more commonly „knowing that" (Gibson, 2005). Proponents of technology education argue that the didactic procedures of Mode-one knowledge should give way to the more conversational styles of Mode-two thinking, so that students would be valued less for their ability and more for their capability (see section 3.5). Gibson (2005) warned that although concepts are potentially very powerful in apparently allowing abstract ideas to be explained in a universal manner, such concepts are limited to context and are domain specific, and therefore lack transferability. Many researchers including, McCormick, 1997, 2002 and 2004) disagree with this view. McCormick (1997) argues that one of the premises of teachers is that they teach academic or theoretical knowledge, because it is applicable in all situations. However, this assumption that theoretical knowledge or conceptual knowledge can be de-contextualised and used in practical situations outside schools may not be as easy as it appears. Furthermore, McCormick (2004) observed that the context within which the knowledge is situated needs to be seen as part of that knowledge. The issue of context is important in technological capability, because knowledge can became stagnant and of no use when it is considered out of context. In design and technology conceptual knowledge is important, but not dominant, and it is interdependent with other forms of knowledge.

Procedural knowledge

Mode-two knowledge, referred to as procedural knowledge by McCormick (1997), is concerned with skills and competence, with implicit knowledge and with experiential knowledge. Procedural knowledge is, according to Hills (2005), close to capability; to know-how (de Vries, 2007); to technology; to design; and to many other generic skills, the knowledge content for which is incidental. Such a form of knowledge can be described as a form of know-how, which cannot be expressed in sentences, and is characterised by a range of skills that must also be informed by conceptual knowledge (Gibson, 2005). While conceptual knowledge can take place independent of procedural knowledge, the opposite is not possible.

Hills (2005) made an important observation about procedural knowledge, that it cannot be taught and examined as part of assessment grading (assessment of learning).

> It does not belong to the academic world of the graded intellect but to the useful world of intelligence – the ability to do and to be. It cannot be overemphasised that the purpose of education is not to grade the young by their ability to leap over hurdles of intellectual attainment but rather by their own way, in their own time, a sequence of gently rising steps, each the result of a succession of the virtuous cycles of learning (Hills, 2005, p. 21).

The structure of classroom learning in Botswana, together with the pressures of examinations or assessment, makes it very difficult for teachers to establish an appropriate balance between conceptual and procedural knowledge. For capability to be fostered and cherished there is need for this balance as will be shown in section 3.5 which discusses ability and capability.

Procedural knowledge in technology education, however, has been blamed for teaching young people to be proficient users of technology, rather than becoming proficient in understanding the underlying conceptual issues resulting from the use of technology (Dow and Dakers, 2009). This kind of technological knowledge is more related to how to use technology to achieve some required end, rather than the development of knowledge about technology, which might consider the ethics and consequences for human beings of such technology. McCormick (1997) observed that procedural knowledge was sometimes taken to include know-how-to-do-it knowledge, a form of practical knowledge, which required another form of knowledge, known as conditional knowledge.

Conditional knowledge

Conditional knowledge is the third form of knowledge, not identified in the MacFarlane model referred to earlier. As McCormick (1997) observed, some writers indicated that conditional knowledge subsumed procedural knowledge. Some indicated that procedural knowledge subsumed conditional knowledge. Conditional knowledge is the knowledge of when and where the other two forms of knowledge, the conceptual and the procedural, could or should be applied. Gibson (2005) referred to this form of knowledge as strategic knowledge. McCormick (2004) described this as the „know-how-to-decide-what-to-do-and-when-knowledge‟. This is the knowledge of processes that were consciously invoked to facilitate the acquisition and utilisation of other forms of knowledge. According to Welch and Barlex (2004, p. 2), intelligent thought involves self-monitoring and awareness about when and how to use skills, and expertise develops as a principled and coherent way of thinking and representing problems, not just as an accumulation of knowledge. Tacit and implicit knowledge may be an important part of conditional knowledge. According to Gibson

(2005) this kind of knowledge cannot easily be expressed, either in written or oral form. Tacit knowledge largely results from the individual practice and experience. Oral or written forms of communication, such as descriptions, diagrams and pictures may help to explain what is taking place, but that knowledge is personal, subjective, immediate and of special form. It can be referred to as the „tricks of the trade" that experienced workers learn (Gibson, 2005).

An educational system that is biased towards explicit knowledge may be found guilty of „short-changing" students in as far as conditional knowledge is concerned. The value of explicit knowledge lies not in its ownership but in its application (Hills, 2004). Hills also raises another important point, which further renders explicit knowledge less valuable in today"s world than implicit knowledge. According to him:

> The arrival of the computer and the internet has transformed the way education can be delivered and helped to make the case for more training-based education. The PC is not only the knowledge harvester, it is also the knowledge manager. It can edit, organise, retrieve and stimulate every conceivable thought in real and virtual time. Nobody now needs to remember information but only where to find it. If the value of information was once a measure of its scarcity, then knowledge as information is now free and valueless (Hills, 2005, p. 24).

Furthermore he argued that;

> Because rote learning is then an unnecessary chore, time and energy is released for more rewarding activities, aimed at enriching the experience of students and enlarging their implicit knowledge (ibid).

While this may not be true in developing nations such as Botswana, where computer facilities and the internet are not readily available to the majority of the population, the advent of the computer and information communication technologies still impact upon the lives of the people. Conceptual knowledge is more readily available now than ever before, but procedural and conditional knowledge remain a personal possession that cannot be freely shared and technology education should capitalise on this strength of tacit knowledge.

A quality design and technology education necessary for the 21^{st} century citizen weaves the three types of knowledge into a dynamic and holistic learning experience for all students. Unfortunately as Gawith et al (2007) put it (figure 3.2), the pendulum seem to be swinging between the practical, which is inclined to procedural knowledge and the academic, which is inclined to conceptual knowledge. Conditional knowledge does not feature much in the school curriculum because of its tacit, subjective and implicit nature, as a result students" experience of design and technology is limited to conceptual and procedural knowledge. This may also affect their view of the subject.

3.5 Ability and capability in design and technology

There are some fundamental concepts that facilitate the teaching and learning of design and technology. According to Doherty et al (2002) concepts can be defined as organised but ever-changing groupings of thoughts or notions used to understand, classify and manage knowledge, skills and values. Conceptual development in design and technology concerns the relationship between knowledge, skills, and values and attitudes, as illustrated in figure 3.3 below (Doherty et al, 2002).

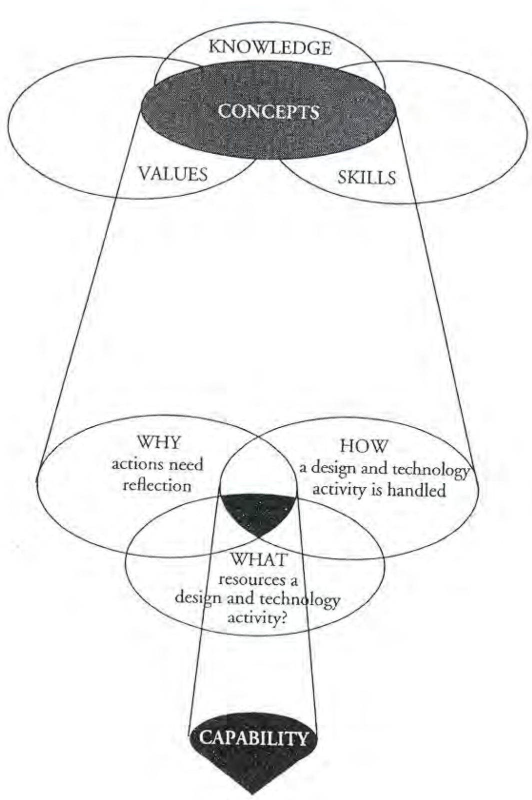


Figure 3.3: Inter-relating the concept groupings in design and technology capability (Source: Doherty el al (2002).

Teaching and learning design and technology, involves the „what" „how" and „why" of these concepts. According to Doherty et al (2002), it is only when an inter-relationship is established between the knowledge, values and skills of design and technology that capability is achieved. When the concepts of why, how and what are developed in isolation, the result is ability, which could reach very high standards. When the concepts are developed in an inter-related way, the result is capability. It is only when the concepts are managed to enable inter-relationships to be made between all three that design and technology capability is being developed as illustrated in figure 3.3. These interconnected concepts are recognizable in the SACSA Framework in design and technology (figure 3.4) which illustrates the interconnected strands of critiquing, designing and making.

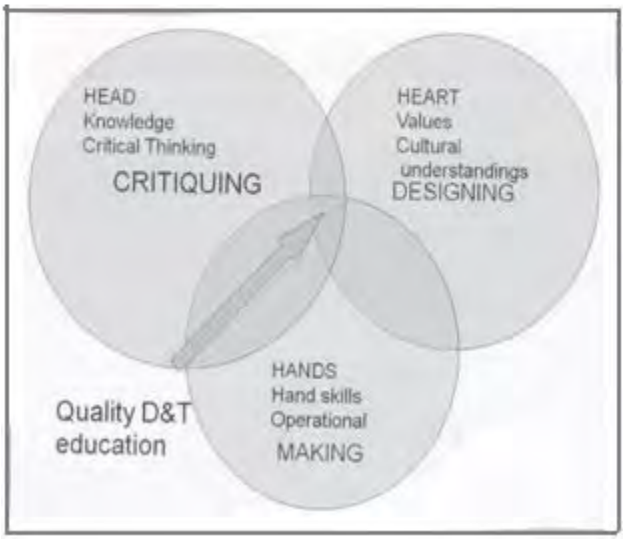


Figure 3.4: SACSA, design and technology interconnected strands (Source: Spry, 2009)

Black and Harrison in McCormick (2002) developed similar models that recognised the combination of process and content in capability. They also recognised the link between thinking and action. It is the ability to act that is the predominant idea of capability (McCormick, 2002).

The focus on processes within capability brings us to problem-solving and design, which are often highlighted in relation to technology. Frequently the two terms are considered to be similar and there is a tendency for them to be used interchangeably (Gibson, 2005). However, according to McCormick (1997) and Hennessy and Murphy (1999), the two processes are different. These processes are discussed in the next section to establish how they relate to knowledge and capability.

3.6 Problem-solving, design, and creativity in design and technology

Problem-solving, design and creativity are concepts that often stress the role of technology education in fostering students" general intellectual skills or higher order thinking skills, such as creative thinking, critical thinking and teamwork. Problem-solving and design are two different concepts (McCormick, 1997; Hennessy and Murphy, 1999; Barak, 2007), although many consider them equivalent. Barak (2007) observed that unlike the concept of design, technological problem-solving does not always end with the development of a new product. For example, a small functional change in an existing product can solve a problem for which the product was not made or designed. Creativity is usually confused with, or used interchangeably with, such concepts as innovation. Creativity is an aspect of design and problem-solving in design and technology.

For the purpose of this study, problem-solving, design, and creativity are discussed from the point of view that they all represent procedural and conditional knowledge in design and technology. When teaching problem-solving methods, the processes involved in solving the problem are the focus, and understanding of concepts (conceptual knowledge) is usually of secondary importance (Hennessy and McCormick, 1994). Discussing problem-solving, design and creativity in design and technology within the framework of procedural and conditional knowledge does not in any way undervalue conceptual knowledge. No level of procedural or conditional knowledge could be of benefit, if the conceptual knowledge base was weak (McCormick et al, 1994). Knowledge is one of the three major factors influencing creativity, and we cannot talk of problem-solving, design and creativity without talking about the role of knowledge in these concepts.

McCormick and Davison (1996) suggested three perspectives as to how problem-solving and design relate to one another. First is where design is considered to be a form of problem-solving, second is where design is considered to be a repertoire of intellectual skills involved in problem-solving and third is where design is viewed as a process of planning in problem-solving. The parameters of design are provided by the concept of problem-solving within which it is embedded. Hence many consider them equivalent.

Problem-solving

One of the pinnacles of technology education is problem-solving. Problem-solving, however, is an inter-disciplinary and cross-curricular concept and as such, makes design and technology to be viewed as an inter-disciplinary and cross-curricular subject. While at the centre stage of emphasizing the role of technology education in fostering students" general intellectual skills or higher order thinking skills, problem-solving is a difficult concept to define (Newcomb, 2002; Hannessy and McCormick, 2002; Barak, 2007). According to Hannessy and McCormick (2002), there is a basic confusion between problem-based learning and teaching problem-solving methods:

> Most areas of the curriculum give pupils problems to solve as one approach to learning, where the main purpose is to help pupils understand certain concepts or ideas in the subject. The actual process of solving the problem may be unimportant (Hannessy and McCormick, 2002, p. 109).
>
> When teaching problem-solving methods on the other hand, the processes involved in solving the problem are the focus, and understanding of concepts is usually of secondary importance (Hannessy and McCormick, 2002, p. 109).

There are two different views of literature on problem-solving that appears contradictory and for which attention is needed. There is literature that characterises problem-solving as an idealized process involving sub-processes of problem identification, generating and implementing a solution and evaluating the solution. According to this approach, there is a general problem-solving process that can be used in a variety of contexts. In my view, this approach mixes up problem-solving with design process. When attempts are made to treat problem-solving as a series of steps the whole process can be ritualised. In this way, the thinking involved becomes divorced from the process used. The focus of the activity becomes the steps and not the thinking.

Some literature characterised problem-solving as context dependent or domain specific and therefore that it cannot be applied in a universal manner (Gibson, 2005). According this approach, individuals may „problem-solve" in one situation and not necessarily have the required knowledge and understanding to enable them to „problem-solve" in other areas. Researchers holding this view argue that in problem-solving, rather than applying some specialist procedure specifying how to solve a problem, people use a variety of methods that change appropriately, according to the circumstances.

The difficulty in defining problem-solving is further complicated by the broad spectrum of views held about it. The following paragraph by Doherty et al illustrates this difficulty:

> In design and technology, problem-solving can range from *ad hoc* ingenuity in making to strategic project planning and the consideration for significant alternatives in designing. Particular ways in which pupils can develop their problem-solving skills in this subject include the sorting, comparing and analysing of data or information; researching; understanding patterns or seeing connections; preventing hazards; recognizing issues; sequencing; recognizing different factors; explaining the workings of a system or design features; formulating and testing ideas; suggesting approaches; selecting options; predicting or making judgements and decisions and justifying their reasons and arguments; applying their ideas in a creative way, both in innovative designing and in ingenious making; developing criteria for product success, and refining ideas and evaluating their products (Doherty et al, 2002, p. 226).

The way problem-solving is approached in a design and technology classroom has implications on students‟ understanding and their future use of this strategy. If it is treated as a series of steps to be adhered to, in solving problems (procedural knowledge), then problem-solving in our classrooms becomes an artificially constructed process that has no relevance to life outside the school classroom. The teaching and learning of problem-solving is also hampered by current assessment procedures. There is a widespread tendency for what should have been a creative experience to be diluted by attempts to satisfy assessment criteria, resulting in a situation where students appear to have used a process (and hence have apparently learned it) but, in fact, may not have used it.

> Although this process can be a useful structure it is often does not reflect pupils‟ thinking about the design-process or their problem-solving (whether they are seen as the same or different). It is treated as a ritual to go through (Hannessy and McCormick, 2002, p. 115).

Drawing from the works of renowned educational philosophers, John Dewey and George Polya, Barak (2007, p. 156) concluded that there is no one all-purpose, problem-solving method but there are some problem-solving approaches or representations that can be useful over several disciplines; and other methods that are unique to each subject separately.

What separates problem-solving in technology education from problem-solving in other fields (who claim the same role of fostering students‟ general intellectual skills, or higher order thinking skills) is: the type of problems presented to students; the solutions they are expected to arrive at; and the solving process involved (Barak, 2007). Havice (2006) clarifies this point by the following exemplar comparison between technology education and science, which informs problem-solving in the two disciplines. Technology education includes the study of the human made world, created by people through invention and innovation and asks the question "why?" On the other hand science is the study of the natural world, discovered by people through observation and description and asks the question "why?"

Design

Design is an aspect of technology education that separates design and technology from its predecessors, which is subsumed in problem-solving. As mentioned earlier there is a tendency to view design and problem-solving as one and the same thing. Design is an aspect of design and technology education that develops thinking and decision-making capabilities in students, Kimbell and Perry (2001) described it as „thought in action‟. While problem-solving is concerned with real problems and solutions, design is a planning process, providing students with a systematic sequence of activities that enables them to think through the inception of a product (as an idea) to the actual production of the product. Design does not necessarily have to start with a problem.

The systematic sequence of design activities in design and technology is known as „the design process‟ and it has been criticised for being too mechanistic and rigid to represent what really goes on in the mind when designing. The literature (Chidgey, 1994; Barak, 2007; Banks, 2004; Eggleston, 1996) suggests different models of „the design process", including linear, cyclic and iterative models, but many researchers in the field have advised that there is no such a thing as „the design process", since the design experience is not always fixed, but involves complex interaction between elements of the design activities.

The dilemma facing teachers and their students is that the assessment procedures are formulated around the stages of a particular „design process" and marks allocated accordingly. As a result teachers enforce rigid procedures for satisfying assessment criteria, which is counter-productive and denies students the enjoyment of flexibility in designing. During my teaching career I have experienced cases where a design and technology product was realised and finished before quick notes and sketches were prepared in a manner acceptable for examination assessment. Molwane (2000) reported on how much teachers in Botswana junior secondary schools concentrated on portfolio and artefact (design and realisation) to the detriment of theory and other skills coverage in the quest for excellence. An over-emphasis on the design processes can lead to a „veneer of accomplishment", where students appear to use a process (and hence have apparently learned it) but, in fact, may not have used it.

Designing and problem-solving are creative activities and attempts to treat them as explicit steps as in „the design process" can actually inhibit creativity (Barlex, 2007; Welch et al, 2005). It is likely that the creativity that is talked about in design and technology is actually inhibited by many pages of the design portfolio, which is artificial and assessment-driven. Barak (2007, p.159) warned that, terms such as „thinking outside the box", „free flow of thoughts", „associative thinking" or „brainstorming" used in design and technology have become somewhat of a barrier for teaching problem-solving methods in school. Welch (2007) quoted Churchman describing real-world problems as ill-defined or „wicked", unlike the well-structured problems tackled in mathematics and science through convergent thinking. Design and technology education is not limited either to ill-defined or „wicked" problems or to structured problems, therefore, there is a place both for „disordered thinking" and for „convergent thinking" depending on the type of problem (Barak, 2007).

Creativity

Creativity, like problem-solving and design, is one of the major aspects of design and technology education that are often considered to make it distinct from other areas of the school curriculum. Creativity, as an important feature of technological literacy, manifests itself through designing and we cannot discuss one without mentioning the other (Barlex, 2007). In the state of Victoria in Australia, the importance of creativity is even reflected in the title of one of the subject domains of the curriculum, namely, Design, Creativity and Technology (VCAA, 2008 online). Spendlove (2008) observed that one of the great features of design and technology is that it is considered to be a creative subject and that it is the only subject in the current U.K curriculum where creativity is mentioned twice in the national curriculum statement of importance.

Creativity is essential in design but defining and quantifying or measuring creativity is difficult. Creativity as an educational concept is subjective and implicit in nature and as a result, as observed by Spendlove (2008), and McLellan and Nicholl (2008) teachers avoid it in preference for safer, explicit and measurable forms of performance. As discussed in chapter two, the focus of the design content in forms two and three in the junior secondary school curriculum in Botswana is examination focused. According to Spendlove (2008), a good indicator that students‟ creativity is encouraged is when there are opportunities for something to go wrong in a project. In an examination-focused project no teacher would risk having something go wrong in students‟ projects, meaning that essentially there would be no opportunity to develop creativity. Regardless of this, many teachers still insist that they are encouraging creativity. However, there are many definitions of creativity and therefore different interpretations of what is creative and what is not. Chakrabarti (2007) identified the following as occurring in the majority of the various definitions of creativity he analysed, that:

- Creativity occurred through a process;
- In the process of creativity an agent used its ability;
- In creativity, ideas, products or solutions are generated;
- Socially novel ideas, products or solutions are generated in the process of creativity; and
- Socially valuable ideas, products or solutions are generated in the process of creativity.

And from these he derived two definitions.

> Creativity is a process through which an agent uses its ability to generate something that is novel and valuable, where „something‟ refers to problem, solution, product, idea, or evaluation (Chakrabarti, 2007, p. 8).
>
> Creativity in design occurs through a process by which an agent uses its ability to generate ideas, products or solutions that are novel and useful (Chakrabarti, 2007, p. 8).

According to these definitions, a creative idea is one that is novel and useful. Richard Mayer quoted in Rutland and Spendlove (2007) observed that there appears to be a consensus that the two defining characteristics of creativity are originality (novelty) and usefulness. Novelty is a condition of being recent, original and different from other existing ideas and the higher the difference and the originality the better the creativity. Usefulness is a condition of the idea having a higher usage than other existing ideas. An idea is useful if it is important to people, if used often and if it is used for longer, or with longer effects. Developing an idea with a completely new function would constitute very high novelty. For example, the idea of the first flying machine is a very high novel idea, which has had a dramatic impact on humanity. Developing an idea with the same function as an existing idea, but with a new structure would constitute some novelty, for example, a new model of a car. In a case where the idea is similar to existing ideas in function and structure, then there is no sign of novelty. Most ideas coming out of our schools‟ design and technology fall within this last category.

In order to foster the courage to be different, and therefore be able to generate original thought, Morris (2007) observed that the need to allow children to take risks and make mistakes must outweigh the importance of them to fully understand concepts. The teaching should contain both the need to take risks and make mistakes and to fully understand concepts, but the focus should be on the former. The nature of examination-focused design and technology education is such that more attention is given to understanding concepts at the expense of creativity. It is for this reason that Rutland and Spendlove (2007) wrote that many teachers may think that it is much more important for the pupils to get the best marks they could by following examination boards‟ guidance, rather than trying to be creative. According to Spendlove (2005), little „c‟ creativity, which is often used as an indicator of ability to deal with incremental change, problem-solving and the ability to adapt to change, is more likely to be what educators would see from students on a daily basis; whereas big „C‟ creativity, which is used as an indicator of ability to generate something that is novel and valuable remained far more elusive. The Nuffield Design and Technology Project and the QCA (Qualifications and Curriculum Authority), in 1999 identified four features essential for creativity to take place in design and technology as discussed by Barlex (2007). The context in which the activity is presented has to be one which students can relate to. The activity must be supported by a significant stimulus. Knowledge, skills and understanding are also necessary features essential for creativity, and, lastly, an attitude of continuous reflection is required. Barlex (2007) observed that these four features alone cannot ensure creativity, since it arises out of the way in which these features are managed. Risk taking and risk management (Barlex, 2007; Morris, 2007; Spendlove, 2008) determined the achievement of big „C" creativity.

Although creativity is an essential aspect of design and technology, which is used in many cases to justify the place of the subject in the school curriculum, research indicates that there is little creativity taking place in technology education around the world (Spendlove, 2005, 2008; Morris, 2007; Rutland and Spendlove, 2007; Barlex, 2007).

The Young Foresight, a design and technology initiative in England is reported in Barlex (2007) as having been able to meet the conditions of creativity by having students design but not make products and services. Students designing and not making products removed the limitation of their personal skills, tools, material and equipment available in the school. This is also reported to enable students to consider applications of new and emerging technologies that are not accessible to schools. In a case where designed ideas have to be made, and be made by students for purposes of grading, students" ability, the tools, materials and equipment available in school have to be taken into consideration, and therefore limit creativity.

> The most common „risk" in the conventional designing and making approach to design and technology is in students conceiving a design that takes too long, or is too difficult to make. The risk is removed from Young Foresight as the design does not have to be made. The risks are intellectual risks in terms of the validity of the idea (Barlex, 2007, p. 105).

Design and technology, through creativity, has the potential to explore new territory by the exploration of ideas, materials, and technical processes and thereby offer students something different that could not be achieved with any other subject in the school curriculum. Students can find conventional education boring and routine, but with the application of knowledge and skills in some innovative ways to achieve valued goals (creativity), education becomes a fulfilling experience. Students" attitudes towards school, or towards any particular subject in the school curriculum, is a direct response reflecting their experience with that curriculum subject. In the case of this study, the declining enrolment is a direct response of students" attitudes towards the curriculum subject of design and technology.

3.7 Technology education in post industrial society

The way in which technology has transformed human society through stages of development – pre-industrial, industrial and post-industrial (Levin and Kojukhov, 2008), seems to have reduced the value of conceptual and procedural knowledge. According to research (Steeg, 2008) computerization and globalization have transformed society from capital-centred to information-centred, and the information infrastructure dominates the economic infrastructure. The conflict between the „rich" and „the poor" has been replaced with a new dominating conflict between the „informed" and „the non-informed" or the „technologically literate" and the „technologically illiterate". According to Ivanov (2006), the information society is giving way to a „Virtual society" in which computerisation is a secondary phenomenon, the primary being the phenomenon of virtualization. In the present virtual society, computerization has lost its technological aspect and has become a social factor. The realization of the social factor of computerization means that we have to re-consider the present education and the present technology in society, related to its transition towards the post-industrial society. Levin and Kojukhov (2008) observed that there is a corresponding relationship between society stages of development and types of technology (de Vries, 1996), and that one of the typical features of transition from one type of technology to another is changing ration between the formal and the informal (creative) components of the contemporary education. Levin and Kojukhov (2008) forecast that the main trend for development of education in the post-industrial society is in the increasing role of the informal component and consequently, transition to new pedagogical paradigms.

This study is set within the context of a society that is transforming from pre-industrial social stage and at the same time, is caught between industrial and post-industrial social stages. Some features of pre-industrial society are still prevalent in Botswana, for example limited production. Evidence of industrialization (modern) is also prevalent, for example mass production, social institutions (market, monetary system, schools, university) and universal and abstract standards that regulate human life. As a global player, Botswana also finds herself entangled in the post-industrial (post-modern) social stage; Mass privatization and a diffusion of national and global capital are on the increase. The society gradually "de-reificates", thus becoming a virtual society.

In the virtual society, computer simulations replace real events and human actions. Levin and Kojukhov (2008) observed that commonly accepted and respectful institutions of society are transforming into their virtual form and are de-materializing. They cited examples of virtual communities, virtual corporations, virtual entertainment, and virtual crime (Levin and Kojukhov (2008, p. 255). Social reality is rapidly being replaced with its computer simulations, rendering the social aspect of the developing technologies more important than the technological aspect of it. Examples of other social phenomena, which are simulations of institutional norms/roles performance are discussed in Levin and Kojukhov (2008). This has implications for such components of social life as technology education, because in a virtual reality one deals not with real objects, but with simulations. Steeg (2008) observed how technological developments such as, for example; fabbing, the internet of things, Web 2.0, nanotechnology and genetic engineering have implications for design and technology education.

De Vries (1998) identified three types of technologies that corresponded to different types of education. The experience-based, or handicraft technology corresponds to a type of education in which the "art of teaching" is very important. Teachers transfer their knowledge and skills in a non-formal, intuitive, creativity based manner. Secondly, macro-technology corresponds to a type of education in which the main content is formalized and symbolically described. Here the non-formal, intuitive, and creative part of the curriculum is not important to teachers. Lastly is the micro-technology, which is dominant in the post-industrial society.

Teaching and learning micro-technologies requires innovative and sometimes non-formal approaches, as traditional methods meet significant difficulties. School technology developments in Botswana and many other nations are facing this difficulty because micro-technologies in the post-industrial era are turning societies into virtual societies, but teaching and learning approaches remain unchanged. Technology education is dominated by organized, formalized, describable and understandable linear models, for example, „The design process‟, which suggest that the world is the objective reality and assumes that the majority of problems are solvable by applying these models (Dagan and Mioduser, 2002). Steeg (2008, p. 7) indicated that current technological developments locate design and technology with Art & Design, Citizenship, Information Communications Technology (or even better Computer Science) or the social sciences, and not within STEM (Science, Technology, Engineering and Maths), as current education politics suggests. In the virtual society (high-tech technology society) formalization loses its central role as a main educational activity. As a result, post-industrial education changes to become an informal, creative-oriented education (Levin and Kojukhov, 2008 p. 258).

> It seems that the industrial society and the corresponding macro-technology era (that are extremely pragmatic and formal methods-oriented), step aside to give a place to a new post-industrial society, which has a trend to become informal, non-pragmatic and, consequently, more "human-oriented" (Levin and Kojukhov, 2008, p. 259).

Based on the concept of virtualization and taking into account global computerization, Levin and Kojukhov (2008) proposed an innovative and completely person-oriented educational environment for the development of creativity of individuals. According to them, the virtual environment is a powerful computerized simulation tool that should be allowed to emancipate individual students from the troubles and shames, which are inevitable in a conventional classroom learning environment.

The way in which technology is leading the post-industrial society has implications for technology education, in particular, in Botswana. While education in Botswana in general is benchmarked favourably against such nations as the United Kingdom (Moalosi and Molwane, 2008) and other industrialized nations, the technological advancement gap is wide. Resources are scarce, and as a result it is generally lamented that technology cannot make a meaningful impact. However, Kumar (2002) noted that shortage of computers, which is being viewed as a handicap may actually be *a blessing in disguise* in the sense that it encourages group learning and collaborative learning, which are superior to individual learning. While Kumar is optimistic about the short supply of computers, group learning is still possible via computers, and the teachers may not hold the same view, because the situation on the ground may not allow for much group and collaborative learning.

While the virtual environment and global computerization is viewed as an inevitable tool for developing creativity of individual students (Levin and Kojukhov, 2008), and that it should be embraced and be celebrated as an opportunity to allow students in Botswana and the rest of the developing world to engage with the rest of the world (Kumar, 2002), there are conflicting views. Keirl (2003) indicated that this stance is problematic in the sense that markets and communications remain a long way from the reach of much of the world population; and that there is more to the picture than economics and communications. A point of contention that Keirl (2003, p. 57) raises is the fact that in this globalised society, with intensified world-wide social relations which link distant localities in such a way that local happenings are shaped by events occurring many miles away and vice versa, the majority of the world population does not have control over events. This is a lack of power rather than empowerment and could be the opposite of creative problem-solving.

Virtualization and global computerization are important and should be embraced but they cannot replace the value of experience based craft education, which has helped transform developed nations from pre-industrial, through industrial to post-industrial. The fact that hand-made products are valued more in society than computer-aided manufactured products, is a sign that craft skills cannot be easily replaced with computer skills.

3.8 Pupils' attitudes towards technology education

As the impact of technology on society is increasing, pupils" attitude towards technology education is increasingly becoming an important area of research. In the words of Mottier (1999), the more we live in increasingly technological environments, the more the younger generation do not see it as technical anymore and ironically, the more technology education is introduce in general education, the more students turn to other studies (Mottier, 1999, p. 5). Similar views have been expressed from most parts of the world (Neale, 2003; Gaotlhobogwe, 2008; Van Rensburg et al, 1999). As mentioned earlier, the advancement of technology has pushed the parameters of technological literacy across the traditional boundaries between curriculum subjects and, as such, more and more subjects that were traditionally not technical in nature now are. As discussed earlier, skills and capabilities that were traditionally technical have become more and more generic and so technical education is entwined with the sciences, the arts, mathematics and economics, and students prefer soft or easier options than technology. However, the role of technology education continues to impact on the 21st century society and so remains a national priority for most governments.

Research to determine pupils" attitudes towards, and concept of, technology has been conducted around the world since 1984 (Netherlands, 1984; USA, 1988; Botswana, 1997; Hong-Kong, 1999; South Africa, 1999, 2001; Thailand, 2002). „Attitudes" in the context of this study is viewed in the light of the following definitions:

> An attitude is a mental and neural state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual"s response to all objects and situations with which it is related (Allport, 1935: in Ankiewicz et al, 2001, p. 98).

> An attitude is a relatively enduring organization of beliefs around an object or situation predisposing one to respond in some preferential manner (Rokeach, 1970: in Ankiewicz et al, 2001, p. 98).

Ankiewicz et al (2001) indicated that there are three dimensions of attitudes, namely; the cognitive, the affective and the behavioural dimensions. The cognitive dimension is about the person‟s ideas or statements that express the relationship between situational and attitudinal objects (Gagné, 1977: in Ankiewicz et al, 2001). According to Corsini & Ozaki in Ankiewicz et al (2001) the cognitive dimension is the opinion that reflects an individual‟s perception of, and information on, the attitudinal object. The affective dimension refers to an individual‟s feeling or emotion concerning an attitudinal object (Van Rensburg and Ankiewicz, 1999, p. 142). The behavioural dimension is about an individual‟s pre-dispositions or readiness for action, as well as his or her actions towards the attitudinal object (Ankiewicz et al, 2001). White in Ankiewicz et al (2001) clearly shows the interplay of these three dimensions of attitude:

> An attitude to a concept such as science is the person‟s collection of beliefs about it, and episodes that are associated with it, that are linked with emotional reactions. The stimulation of these reactions affects decisions to engage in behaviour, such as choosing to take a science course, to read scientific matters, or to adopt a scientific-related hobby (Ankiewicz et al, 2001, p. 98).

The pupils‟ attitudes towards technology (PATT) questionnaire developed in the Netherlands by de Vries (1988) concentrated on the cognitive and the affective dimensions. The questionnaire was validated by de Vries, Dugger and Bame (1993) and used in the USA and has since been used in many other countries around the world including Botswana, Kenya, India, South Africa, Nigeria and Mexico according to de Klerk Wolters (1986, in Van Rensburg et al, 1999). However, Van Rensburg et al (1999) concluded that the PATT instrument did not yield valid and reliable results from the South African learners because of differences in language, terminology and contexts between developed first-world countries and Southern Africa.

Ankiewicz et al (2001) developed a similar instrument to the PATT instrument, suitable for the South African context and called it the Attitudinal Technology Profile (ATP). Anderson and Myburgh in Van Rensburg et al (1999) pointed out that, concepts and terminology, the frame of reference, the culture and how a question is formulated, all influence empirical research. The ATP instrument had fewer items (24) than the PATT instrument (100). Also the ATP instrument avoided formulating items using prescriptive/evaluative prepositions, which according to Ankiewicz et al (2001) demanded high level language proficiency in order for the learners to understand and interpret complicated technology related.

> It is assumed that descriptive propositions would not only enable one to include aspects in the items which learners in a developing context, such as South Africa, will understand, but also with which they are familiar in their living world. Items based on descriptive prepositions will also replace much of their earlier criticism towards the nature of the items included in the PATT questionnaire (Ankiewicz et al, 2001, p. 99).

Although the PATT instrument had both the cognitive and the affective components of attitudes, the majority of the items were of the affective. The ATP instrument also focused on the affective component of attitudes.

This literature was instrumental in shaping the design of the questionnaire for assessing factors influencing attitudes and perceptions of junior secondary school students towards design and technology in Botswana and is discussed in more detail in the next chapter.

3.8.1 Findings on students‟ attitude towards and perception of design and technology from international studies

South Africa

Two quantitative studies have been conducted in South Africa to investigate pupils‟ attitudes towards technology, Van Rensburg et al (1999) and Ankiewicz et al (2001). The two studies used two different instruments. The 1999 study used the PATT questionnaire as validated for the USA (de Vries, Dugger and Bame, 1993) and was administered on learners not exposed to any kind of technology education and on learners exposed to some technology education. Although this study yielded some interesting results, Van Rensburg et al (1999) reported that the results of the study were unreliable at a Cronbach alpha reliability coefficient of 0.66 and a low explained variance of 24.4. The 2001 study used the ATP questionnaire, which is reported (Ankiewicz et al, 2001) to have provided more reliable and valid results than PATT questionnaire. The ATP questionnaire was administered on learners who had been exposed to some technology education before and on learners without any exposure to technology education.

The 1999 study identified six factors from the analysis of pupils‟ attitudes towards technology, while the 2001 study identified four factors from the analysis of the pupils‟ attitudinal technology profile. The main differences between the results obtained from the two studies are summarised in table 3.1 below. The results from the two studies show a correspondence between the first factor identified (Disposition towards technology) by both questionnaires. According to Ankiewicz et al (2001, p. 102) this factor is about learners‟ persistence, creativity, imagination, entrepreneurship, use of materials, resources and information which can be associated with active participation in technological activities.

Table 3.1: Differences between the results obtained with the PATT and the ATP questionnaires (Source: Ankiewicz et al, 2001).

Aspect	PATT	ATP
Factor 1	Disposition towards technology [a] boys < girls	Disposition towards the technological process
Factor 2	Contributions of technology	Proximal technology [a] boys < girls
Factor 3	Dislike of technology [a] boys > girls	Distant technology
Factor 4	Gender discrimination [b] boys < girls	Innovation [b] boys > girls
Factor 5	Personality prerequisites	
Factor 6	Technology for all	
Reliability (Cronbach Alpha)	0.66	0.78
Explained variance (%)	24.4	35.5

[a] $p < 0.01$; [b] $p < 0.05$

Both studies investigated differences regarding gender and exposure to technology education. The 1999 study indicated that the vectors of averages for six factors, namely attitudes towards technology differed significantly between boys and girls (Van Rensburg et al, 1999, p. 146. Significant differences were found between boys and girls regarding: „dispositions towards technology", the disposition toward technology for girls was stronger than for boys; „dislike of technology", boys had a stronger view on the dislike of technology than girls; and „gender discrimination", girls had a stronger gender discrimination view of technology than boys. The 2001 study indicated significant differences between boys and girls regarding: „proximal technology", the attitudes of girls towards technology in their immediate environment was more positive than those of boys; and „innovation", the attitudes of boys towards innovation, and the risks and anxieties associated with it were more positive than those of girls.

Although the two studies yielded different results regarding boys‟ and girls‟ dispositions towards technology, the strong disposition of girls towards technology could have been accommodated in the second factor of the ATP questionnaire indicating that the attitudes of boys towards proximal technology were less positive than those of girls. The items that scored highly on the disposition towards the technological process factor could well be in the proximal technology factor, for example, „*do you persist solving a technological problem in your environment?"* or „*are you creative when you solve a technological in your environment?*

These results help to explain some of the problems associated with the decline of enrolments in design and technology in Botswana. For example, if the attitudes of boys towards innovation were more positive than those of girls, it would be expected that boys would have more endurance than girls to study the subject in an atmosphere in which there is insufficient resources. In such an environment students tend to scramble for the limited resources and usually the strongest, most of which are boys would survive. Similarly, due to girls‟ stronger gender discrimination view of technology than boys, it would be expected that in such an environment, as described by the interviewees in the current study, girls would find the study of technology unsuitable for them.

Botswana

A quantitative study to investigate students‟ attitudes towards technology was conducted in Botswana in 1993 (Meide, 1997). Unlike the current study, Meide‟s study involved form 5 students from eight senior secondary schools across the country. Four of these schools were located in rural settlements and four were located in urban settlements. The study used a modified version (89 item: 58 affective/behaviour attitude and 31 cognitive attitude) of the PATT – USA (Bame and Dugger, 1989) questionnaire. Meide (1997, p. 213) claimed that the results of this study added to the knowledge base for educators who wish to gain an understanding of the attitudes and concepts of technology among the form 5 students of 1993 and that the study was useful to those who may have wished to replicate it. It is to be noted that Van Rensburg et al (1999, p. 147) observed the PATT – USA questionnaire was not suitable to produce valid and reliable results in Southern Africa as in mono – lingual, developed First World countries functioning in a technological society. However, the results from the 1993 study provided a valuable basis for the current study.

The study used a method of replication of previous PATT research studies conducted elsewhere, the design of which was facilitated by a single instrument to collect data. The study also aimed to determine whether:

- Boys‟ and girls‟ views about technology were similar or different (variable: GENDER);
- Technology education had an impact on students‟ views about technology (variable: EDUCATION); and

- Background (urban or rural) had an impact on students view about technology (variable: LOCALE).

Factorial analysis of variance (ANOVA) and Principal Component Analysis (PCA) were used to analyse the data relative to the research questions. Out of the 58 individual affective/behaviour attitude scale items, the PCA identified four factors, accounting for 30% of the total variance, as follows:

- General interest in technology;
- Technology as an activity for both boys and girls;
- Consequences of technology; and
- Technology being something difficult.

The study identified significant differences between boys and girls in the way in which each group responded to the affective/behaviour attitudes subscale and the cognitive subscale. Boys scored higher than girls on all the attitude subscales, indicating that girls‟ attitudes towards technology were generally less positive than those of boys. For example, boys were found to know more about technology and its relationship with society, science, and skills. In many case the significance levels were reported to be above 0.05 on all subscales. Students who studied technology in school scored higher than those did not study technology on all the attitude subscales, indicating that students studying technology displayed positive behavioural attitudes towards technology and possessed a greater understanding of the concepts related to it.

No significant differences were found on the affective/behaviour subscale „*Technology being something difficult"* between boys and girls or between technologically educated students and the non-technologically educated students. The study reported that the feeling among students about this view of technology was that it is neither difficult nor easy, as the typical response was on this item was neutral (Meide, 1997, p. 209). Locational differences proved less significance on the whole. However, Meide reported that preliminary cross-comparison between urban and rural students, revealed significant differences stemming from the question items designed to indicate levels of technological exposure (Meide, 1997, p. 209).

A combination of variables (GENDER and LOCALE) produced significant findings across the affective/behaviour attitudes subscale and particularly the cognitive subscale test scores. The following interesting findings were noted:

- Girls" scores were characterised by much wider distributions than the scores observed for boys when variances among boys and girls were compared across rural and urban locations.
- Boys from urban locations seemed to possess a greater concept of technology than boys from rural locations.

A high correlation was shown to be present between students" concept of the interdependent relationship of technology and society and the students" general interest towards technology. This is an indication that perceiving technology to be an important aspect in society is necessary to generate interest towards technology. Although, the Meide study was carried out over a decade ago, under a slightly different context, its findings were important in understanding and interpreting some of the results of this current study.

USA

Several quantitative research studies on pupils attitudes towards technology have been conducted in the USA, for example, Bame et al (1989) and Boser et al (1998). The PATT-USA questionnaire was the same one that was modified and used in other countries including Botswana and South Africa. The PATT-USA questionnaire had four parts to it, the first part required students to write a short description of what they thought technology was. The second part consisted of eleven questions to gather the demographic data about respondents. The third part consisted of 58 five-part Likert scale statements to which students were required to indicate their level of agreement or disagreement to the statements investigating their affective/behaviour attitudes towards technology. The fourth part consisted of 31 three-part Likert scale statements to which students indicated if they agreed, disagreed or did not know. These statements investigated the cognitive aspects of students" attitudes towards technology.

The first PATT- USA study was conducted in seven states of: Virginia, New Jersey, Florida, Oklahoma, Ohio, Utah and Wisconsin (Bame et al, 1989). A total of 10, 349 students across the seven states completed the questionnaire, of those who identified their gender, 61% were boys and 39% were girls. Eighty students did not identify whether they were males or females. The instrument was administered to middle school (13 – 15 years old) technology and non-technology education students. Technology education at the time was predominantly industrial arts.

Principal component factor analysis with varimax rotation was used to validate the affective/behaviour attitude sub-scale (58 items) and the cognitive attitude sub-scale (31 items). Out of the 58 individual affective/behaviour attitude scale items, the PCA identified five factors, as follows:

- General interest in technology;
- Attitude towards technology;
- Technology as an activity for both boys and girls;
- Consequences of technology; and
- Technology is difficult.

Out of the 31 individual cognitive attitude subscale items, the PCA identified one factor pertaining to general knowledge of technology.

Analysis of variance (ANOVA) and independent t-tests were used to determine if the demographic characteristics had any effect on the affective/behavioural and the cognitive attitudes towards technology.

Gender was found to have a significant impact on all attitude subscales. Boys were found to be more interested in technology than girls. Boys rated technology as having a more positive consequence than girls. Boys perceived technology as being more difficult than girls did. Girls perceived technology as being an activity for boys and girls, to a greater extent than boys did. Although boys perceived technology as being more difficult than girls did, they appeared to be more knowledgeable about technology.

The general interest of students from high school on technology was significantly higher than that of those students in the lower grades. The results also revealed that the extent that a student‟s parent or parents were reported to have a job or jobs dealing with technology was significantly related to the student‟s general interest in technology, attitude towards technology, technology as an activity for boys and girls, and consequences of technology. The presence of technical toys in the home was found to have significant positive impact on all attitude scales.

Students whose career prospects were in line with technological jobs were significantly more likely to be positive on all attitude scales. To think of a technological profession, students have to have exposure to opportunities available after school. Taking or having taken technology education made a significant difference on the affective/behavioural and cognitive attitude subscales.

Another study was carried out in the USA to examine changes in students‟ attitude towards technology among four teaching approaches typically used to deliver technology education in the middle schools (Boser et al, 1998). Four instructional approaches believed to represent the spectrum of instruction that is typically labelled as technology education were investigated to determine:

- If student‟s attitudes change as a result of participation in technology education programmes;
- If there are differences in the attitudes of boys and girls as per previous PATT-USA research findings, as a result of participation in technology education programmes; and

- If the instructional approach used to deliver technology education affect students" attitude towards technology.

Instructional approaches investigated in this research were the; Industrial Arts Approach, Integrated Approach, Modular Approach, and the Problem Solving Approach (see Boser et al, 1998 for a description of each of these approaches). Students who participated were between the ages of 12 – 14.

The study used the PATT-USA questionnaire, which was administered to students enrolled in the four identified approaches using a pre-test and post-test design. The total number of students in the pre-test sample was 155 (86 boys, 68 girls, and one unidentified gender). The total number of students in the post-test sample was 127 (66 boys, 59 girls, and two unidentified gender). The same statistical analysis procedures used in the previous PATT-USA studies (Bame et al, 1989) were used in this study.

A factorial analysis was conducted on the pre-test data and it yielded the same sub-scale categories and item loadings as the PATT-USA studies (Bame et al, 1989) described above. The results of the *t*- test on the six PATT-USA sub-scales identified differences in only 5 of the 24 sub-scales from the pre-test and the post-test of the four technology education approaches. In the Integrated Approach and the Modular Approach, students exhibited more a negative attitude towards the „consequences of technology" sub-scale on the post-test than on the pre-test. In the Problem Solving Approach, students exhibited a significant change towards the „technology is difficult" sub-scale, indicating that students believed that technology was difficult before being at the beginning of the nine-week programme than at the end of it. No statistically significant differences were found in any sub-scale for the Industrial Arts Approach.

The results of the MANOVA performed on the combined pre-test and post-test data for all sub-scales and all technology education approaches to determine the impact of gender indicated that statistically significant differences occurred on three of the five affective/behavioural attitude sub-scales. The analysis indicated that girls consistently perceived technology to be less interesting than boys did. Girls perceived technology to be an activity for both boys and girls more than boys did. The Industrial Arts Approach was the only approach that caused this bias to improve over the duration of the nine weeks in which students were enrolled in these technology education approaches. Girls in all the technology education approaches believed that technology was a difficult subject to a greater extent than boys did.

Differences attributed to gender were also examined within each of the technology education approaches. Significant differences were found on three sub-scales. Girls in the Industrial Arts Approach responded more negatively towards the „technology is difficult‟ sub-scale, indicating that girls thought technology was more difficult to use and understand than boys did. Girls in the Modular Approach responded more positively towards the „concept of technology‟ sub-scale than boys, indicating that girls in this approach had a better understanding of technology than boys.

England

In England, Welch et al (2005) investigated student‟s experiences with the use of design portfolios in design and technology. This research was a follow-up to a study conducted previously to investigate the use of portfolios by professional designers, teacher educators, and secondary school teachers working in England and Canada (Welch and Barlex, 2004, p. 175). Unlike in the international studies discussed earlier in this section, which were essentially quantitative, a case study of seven, purposefully sampled cases of year 10 students from a 11-16 comprehensive, specialist technology college in England was used. Two separate focus group interviews were conducted, one involving four boys and another involving three girls. Thematic analysis and concept analysis were used to analyse the interview data.

The results of this study indicated that conceptions of students about the purpose, contents and utility of the portfolio did not match the primary purpose of the portfolio in technology education. Instead of the portfolio to be a tool to empower students as a designers, to generate, develop and communicate design ideas, students regarded it as a place to store ideas for later reference, as an aide-memoire for use in later lessons (Welch et al, 2005, p. 178). Because of this view of the portfolio by students, its purpose for learning, teaching and assessment was compromised. As a result, students perceived portfolio production as an unnecessary burden, destructing their enjoyment of the subject, and more useful in meeting the requirements of the examinations than their learning needs. Similarly, teachers, in the previous study (Welch and Barlex, 2004) indicated that the development of a portfolio in a design and technology educational context is driven by an inflexible assessment criteria imposed by examining bodies.

In these studies (Welch and Barlex, 2004; Welch et al, 2005), the authors conclusions, suggesting the use of different types of portfolios for different purposes, i.e. sketchbook, job bag, and show case portfolios, could help deal with negative attitudes of students towards design and technology, resulting from their negative perception of the portfolio.

Unlike in the previous studies discussed above, some of which were conducted more than two decades ago, the emphasis of technology education in the 21st century is different. Also, the use of mixed methods in the current study provided a better insight or perspective of the same issues that were identified in these previous studies.

CHAPTER 4: RESEARCH DESIGN

4.1 Introduction

This chapter outlines the research methodology and procedures used in this study. It describes the methodological paradigm and the mixed research methodology that guided the research procedures and the research questions addressed. Within this methodological framework, the research design, methods for data collection and analysis are discussed.

The study was designed to capture and describe the experiences and opinions of the participants about design and technology, as a relatively new subject area, in the junior secondary school curriculum in Botswana, thus making it exploratory in its nature. According to Gray (2004) exploratory studies seek to examine what is happening and to ask questions about it. Not enough is known about attitudes and perceptions of students towards design and technology since it was declared a core subject in 1996 in junior secondary schools in Botswana. The decline of performance and of enrolment numbers in design and technology over the last fourteen years or so have impacted negatively on the views of people, resulting in a nation-wide perception that students are no longer interested in the subject.

It has been fourteen years since the recommendation to make design and technology a core subject was made, but it has not been fully implemented. Instead the enrolment numbers in design and technology have been declining over the years. Between 1999 and 2007 there has been a steady decline in design and technology uptake in junior secondary schools. Figures show that since 1999, male enrolment at junior secondary schools has declined by roughly 6.2% and female enrolment by roughly 3.7% (see linear regression lines in figure 4.1). A

Ministry of Education and Skills Development official in Botswana observed that the enrolment in secondary design and technology has dropped to about 35% (Nyerenda, 2007). The rate at which the male enrolment has declined is quite striking, given that historically this was a discipline associated with masculinity. Throughout this period, male enrolment has consistently been around three times higher than female enrolment, implying a gender bias in uptake. This state of affairs could have profound social and political consequences for the future of technology in Botswana. Keirl (1999), quoting Grant, observed that to deny females an adequate technological education was to deny them a most basic freedom, and could lead to a fear of technology. In the present technological world, technological literacy is one of the basic needs that every government should strive to provide for its citizens.

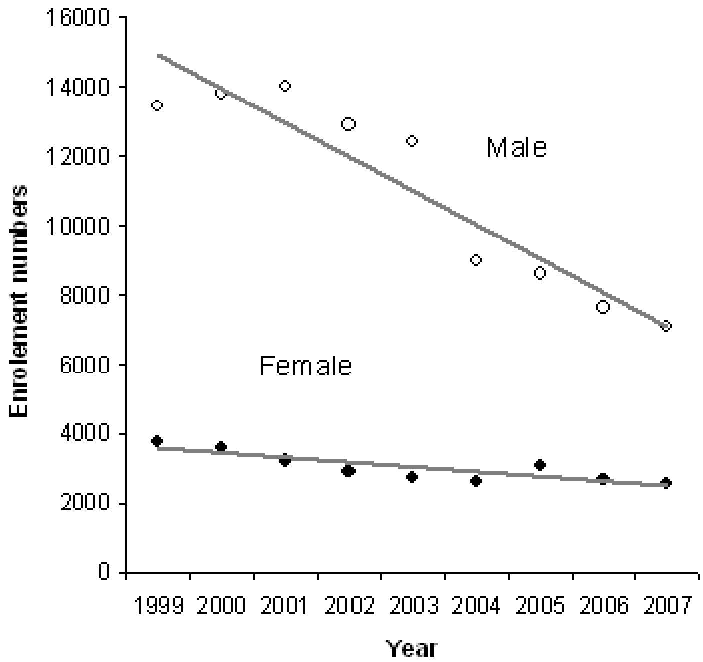


Figure 4.1: Enrolment numbers in design and technology of Junior Certificate between 1999 and 2007. Regression lines represent linear trends in the data for males and females (Source: designed by the author).

This poses concerns and questions about future levels of technological literacy and expertise in Botswana, particularly as it has been observed that effective delivery of design and technology is crucial to a country‟s economic development and democracy (Nyerenda, 2007; Keirl, 2003; Roth and Lee, 2004; Matheson, 2006; Liyanage and Poon, 2003). Lack of the necessary skills and knowledge to understand and cope with the technology that impinges on every aspect of life would mean that the society would increasingly rely on technical experts for simple technical repairs and important daily decisions regarding the very nature of society (Keirl, 1999, p. 78). It was against this background that the present study investigated factors that influence attitudes to and perceptions of junior secondary school students towards design and technology in Botswana.

4.2 Research aims and research questions

While consideration of the research paradigm is important, Punch (2005) advised that it is best, in the first instance, to step back from an examination of methods and give consideration to the purpose of the study and its associated research questions. Similarly, Johnson and Onwuegbuzie (2004) observed that what is most fundamental is the research questions and that research methods should follow research questions in a way that offers the best chance to obtain useful answers.

The research methods used in this study were influenced and informed by the following research aims and research questions.

Research aims

The aims of this study were: to investigate attitudes and perceptions of form three design and technology students towards the subject in junior secondary school; to examine how the views of these students help to explain the problem of declining enrolments in the subject; and to establish and address factors leading to the decline in enrolments in design and technology in junior secondary schools in Botswana.

Research questions

1. What factors influence students" attitudes and perceptions of design and technology?
2. How does examining the views of form three design and technology students help explain the problem of declining enrolment in the subject?
3. How could the decrease in uptake in design and technology be tackled?

Research questions one, two, and three complemented one another, in that data gathered about one question was used to examine the other questions. This study took a design approach that allowed mixed design components. This offered the best chance of answering the specific research questions. Although some proponents of quantitative research and of qualitative research advocate the incompatibility thesis (Howe, 1988), which posit that the two research paradigms, including their associated methods, cannot and should not be mixed, mixed methods research has recently been recognized as a methodological paradigm that draws from the strengths and minimizes the weakness of both in a single research study or across studies (Gilbert, 2001; Johnson and Onwuegbuzie, 2004; Creswell and Clark, 2007).

The research methodology adopted to address these questions is discussed in the next section and the design is illustrated in Figure 4.4 to show how the mixed methodological approaches were combined.

4.3 Research methodology

The research methodology in this study was based on well-established educational research design approaches of using surveys and interviews. They are used in a complementary way, since both quantitative and qualitative approaches were found to be appropriate for triangulation and complementarity purposes. According to Gibson (2005), the choice of paradigm influences the research questions asked, the methodology employed and the methods used. The research design used in this study, though influenced by the PATT (Bame et al, 1989) studies around the world and the ATP study in South Africa (Ankiewicz et al, 2001), which were essentially quantitative, emerged from the need to utilize all possible methods to answer the research questions in the best possible way. A qualitative aspect was added, as was suggested in Ankiewicz et al (2001), to corroborate the findings and to add depth to the study; hence the study is located within the mixed methods paradigm.

The possibility of mixing philosophical frameworks that traditionally promoted a methodological divide between realism and constructivism as ways of knowing, or between objectivity and subjectivity as stances of the inquirer, remained for many years one of the highly contested areas in the theory of mixed method research (Greene, 2008). However, there is growing literature showing successful stories of mixed methods research from diverse disciplines, as articulated in a newly established American journal, *Journal of Mixed Methods*

Research. Johnson and Onwuegbuzie (2004) defined mixed methods as:

> The class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study (Johnson and Onwuegbuzie, 2004, p. 17).

Creswell and Clark (2007) observed that mixed methods may involve collecting and analyzing qualitative and quantitative data within a single study, or within multiple studies in a programme of inquiry (Creswell and Clark, 2007, p. 8). According to this understanding of mixed methods research, it is clear that there are various ways in which quantitative and qualitative research techniques, methods, approaches, concepts or language could be mixed or combined for different purposes. The basic premise for mixed methods, however, is to provide a better understanding of research problems than either quantitative or qualitative alone.

The values of both qualitative and quantitative methods are considered to be significant to add depth and breadth in this study. The use of mixed methods did not arise from theoretical and epistemological concerns, but from practice. The methodology used was essentially mixed and exploratory in nature, and designed to capture and describe the experiences and opinions of the participants. The use of quantitative data was meant to identify attitudes and perceptions, while qualitative data was used to explore them in greater depth

As has been identified, not enough is known about attitudes and perceptions of students towards design and technology since it was declared a core subject in junior secondary schools in Botswana in 1996; and there has not been any study conducted to investigate this. Consequently, qualitative and exploratory methods are particularly useful in informing the present study. The use of mixed methods is supported by the following reasons, as presented by Greene et al (2007):

- The use of mixed research methods adds depth and breadth;
- Data obtained from surveys identifies issues and follow up interviews could explore these;
- Surveys and semi-structured interviews allow methodological triangulation to take place; and
- Interviews can reveal issues that surveys fail to identify.

The purpose of using mixed methods, or methodological triangulation, is to minimise any inherent bias and as an aid to obtaining a more rounded/balanced picture of the situation. Denzin and Lincoln (1994) suggested that the use of triangulation reflects an attempt to secure an in-depth understanding of the phenomenon in question and that it is not a tool or strategy of validation. Blaikie was also reported in Ma and Norwich (2007) as having argued that it was inappropriate to view triangulation as a validation strategy, because empirical procedures are themselves underpinned by different ontological and epistemological assumptions. Noting this observation, it was not my intention to use triangulation for purposes of validation. Validation procedures were carried out as outlined later in this chapter.

Gray (2004) observed that all methods have their strengths and weaknesses, including mixed methods. Some of the potential disadvantages of using mixed methods include the difficulty for a single researcher to carry out both qualitative and quantitative research, in terms of: learning the different approaches and understanding how to mix them appropriately, paradigm mixing, costs in time and money. In this study the methodological justification for using mixed methods outweighed the potential disadvantages. Not only did the use of mixed methods assist in data triangulation, it also helped to balance out any of the potential weaknesses in each single method. According to Punch (2005) the methodological justification for bringing quantitative and qualitative methods together, is to capitalize on the strengths of the two approaches, and to compensate for the weaknesses of each approach in general. Besides the general theoretical and philosophical reasons advanced for using mixed methods, the research questions discussed above lend themselves to both qualitative and quantitative methods.

Finally, this study adopted a phenomenological research perspective (Gray, 2004) using a collective case study consisting of five junior secondary schools in Botswana, see figure 4.2. The choice of these junior secondary schools was based on their 2007 performance in the junior secondary school examinations and the number of students enrolled in design and technology in those schools in the same year, see table 4.3 for details. Also, these schools were found to be within easy reach from Gaborone, where, as the researcher, I was based. Gray (2004) provided the following points, which were relevant to my study, to illustrate phenomenological research:

- Emphasizes inductive logic, which means that engaging with theoretical perspective occurs after undertaking the research;
- Seeks the opinions and subjective accounts and interpretations of participants;
- Relies on qualitative analysis of data (though in this case numerical data was also collected); and
- Is not so much concerned with generalizations to larger populations, but with

contextual description and analysis.

4.4 Research methods

A collective, as well as an instrumental, case study of five junior secondary schools in Botswana was used to illustrate issues regarding form three design and technology students‟ attitudes towards and perceptions of the subject. A collective case study consisted of multiple cases. According to Creswell (1998) an instrumental case study is one which focuses on a specific issue rather than on the case itself. The case is used as a vehicle to better understand the issue.

Case studies have the advantage of supporting a researcher‟s capacity for understanding complexity in a particular context, even though there is difficulty in generalizing from a single case. Noting this difficulty, five junior secondary schools were selected, as discussed earlier, ensuring some degree of generalisation to a wider population. The selection of five junior secondary schools was based on the number of candidates registered for the 2007 design and technology examinations in each of the schools and the performance of the schools in design and technology examinations of the same year.

The five case study junior secondary schools were selected from three of the ten geographical regions in Botswana. Two junior secondary schools were selected from Gaborone. Gaborone is the capital city of Botswana in the South East region, with a population of 186, 000 according to the 2001 census (Republic of Botswana, 2008), and has a total of thirteen junior secondary schools. Two junior secondary schools were selected out of the five from Selebi Phikwe, a mining town in the Central region, with a population of 48,825 according to the

2001 census (Republic of Botswana, 2008). One school junior secondary was selected out of the three from Tonota, a village in the proximity of Francistown, the second largest city of Botswana. Tonota is in the North East district and has urban characteristics. As may be seen in Figure 4.2, all the case study junior secondary schools were selected from the eastern part of Botswana, which is occupied by about 80% of the country‟s population.

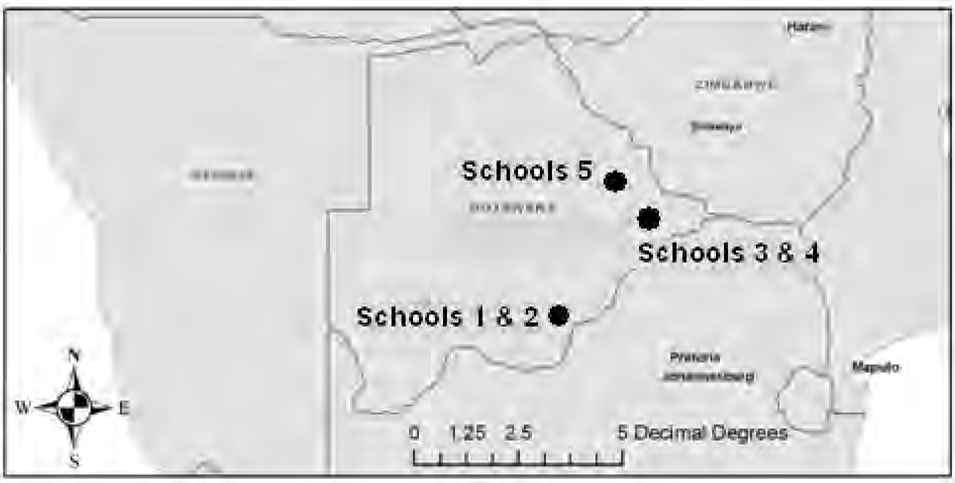


Figure 4.2. Location of schools, see table 4.3 for details. Background map ESRI 2008.

Figure 4.2 shows the location of case study schools within Botswana. Details about the specific location, enrolment in design and technology, and performance of year 3 design and technology students in the five case study junior secondary schools in 2007 is given in table 4.1 below. Although the locations from which the case study junior secondary schools were selected are given in table 4.1, the identities of the specific schools remain anonymous as there are several schools in each of the locations.

Table 4.1: Location, enrolment and performance of year 3 DT students in 2007
Source: Personal communication with Botswana Examinations Council and Ministry of Education in Botswana.

School	Location	Enrolment of year 3 DT students (%)	Total number of students	Grade C+better in %
1	Gaborone city	49 (5.7)	865	18
2	Gaborone city	73 (6.1)	1190	23
3	Selebi Phikwe town	51 (8.7)	589	71
4	Selebi Phikwe town	52 (8.0)	630	82
5	Tonota village	107(15)	691	15

In table 4.1, the enrolment of form three design and technology students per each case study school in 2007 is given in numbers, and in the percentage of form three design and technology students of the total number of school enrolment is given in brackets. Performance is shown in percentages indicating quality passes (grade C and better) of form three design and technology students for each school in 2007.

A study of enrolments and performance of design and technology in these junior secondary schools in the previous year (2006) indicated that a dramatic increase in enrolments affected performance in school five. In the year 2006, school five had registered 52 design and technology candidates for the junior certificate [15]examinations, and it had 27.4% of grade C or better, as opposed to the 15% of grade C or better after an increase of 50% in enrolment. There was generally a decrease in performance across all schools, except in school three, which had an improvement in performance, from 45.6% of grade C or better in 2006 to a 70.6% of grade C or better in 2007. Although schools one and two had insignificant

[15] Junior certificate is the award students get at the end of junior secondary school.

reductions of two and nine students, respectively, in enrolment, their performance dropped. School one performance dropped from 64.7% of grade C or better to 18% while school two dropped from 48.8% of grade C or better to 23%.

The case study junior secondary schools were government junior secondary schools, all of which were classified as group two schools (see appendix 7 for school classifications), four of which were 18 stream schools, and one was a 24 stream school. One of the four 18 stream schools operated a double-shift as explained in chapter two. These schools all followed the same six day timetable and their teacher establishments are prescribed by the Ministry of Education in Botswana (see appendix 7 for details). Botswana education operates a centralized curriculum system, so all schools offered the same curriculum and all students across the nation sit for the same national examinations. There were no notable differences in the day to day running of the schools that could be used in the interpretation of the results of the study.

All the case study schools were selected from within urbanised areas. Only school one was selected from a village, but this was a relatively urbanised village within the proximity of a city. There was no notable geographical difference in the areas that could affect the results of this study, except the fact that the one junior secondary school, school five, was a village school. Certainly, the socio-economic background of the majority of parents of students in a village school would be different from those of parents in a city such as Francistown and Gaborone. This difference could explain some of the students" attitudes towards and perceptions of design and technology explored from the different schools. It should be noted that although the socio-economic background of the majority of parents from these areas may be different, the majority of children from affluent families do not go to public schools such as these case study schools, but to affluent private schools.

Students" performance was determined by the junior certificate results for 2007. The junior certificate grades are A, B, C, D, E and U. According to Botswana Examinations Council standards, grade C or better, are regarded as quality passes. Grade D and E are passes and grade U is a fail or ungraded.

The rationale of sampling from schools with different performance rates and enrolment numbers was to enable the case study to include cases that showed different perspectives on the problem being pursued. A case study of five junior secondary schools also enabled a better understanding of the experiences of the students and teachers in those schools. Focusing on a case study of five junior secondary schools provided a depth of information about the situation in these schools and an opportunity for a cross comparison of cases.

The study employed the use of a questionnaire survey, as well as semi-structured and focus group interviews in a sequential manner as illustrated by a model of the research design in figure 4.3.

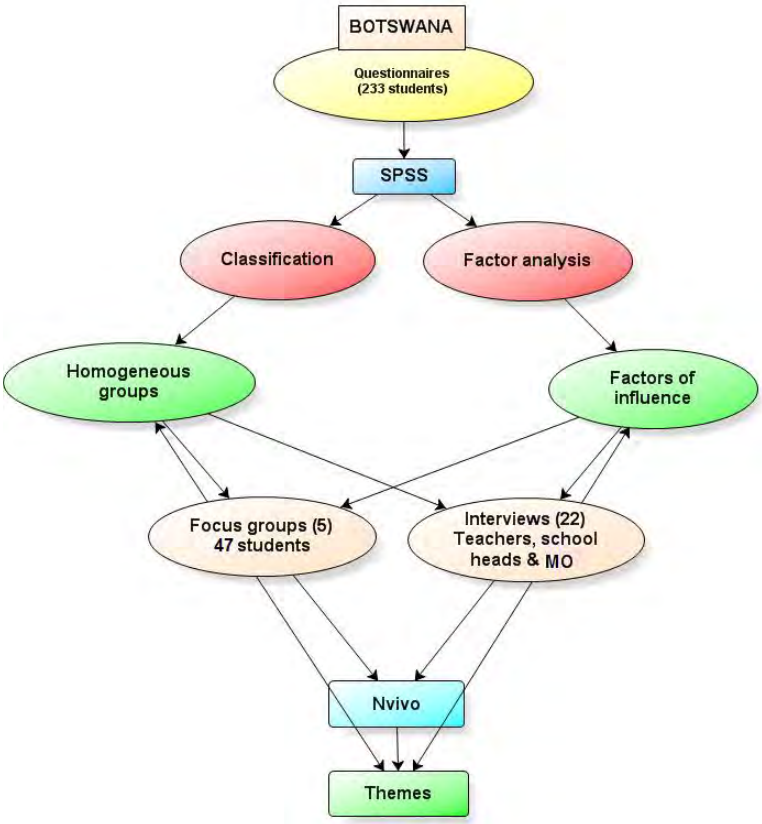


Figure 4.3: Model showing the research design.

The study population involved groups, whose relative position or relationship with the problem being investigated was different from one another, rendering methods used in one group not necessarily appropriate for another. For example, the population consisted of only 22 design and technology teachers and other staff, and 233 design and technology students. This meant that one particular research method such as one-on-one interviews was not suitable for both groups. Cohen et al (2000) suggested that total reliance upon one method could distort the researcher‟s picture of what is being investigated. The questionnaire survey was used to explore the research questions and associated issues. The use of questionnaires to explore the issue of attitudes and perceptions in design and technology is common and has been used widely around the world (Rogers, 2004; Hine, 1997; Hendley, Stables & Stables, 1996; Benson & Lunt, 2007; Bame et al, 1989; de Vries, 1984; Ankiewicz, 2001). According to McNamara (1999), questionnaires are an easy and quick way of getting lots of information from people in a non- threatening way. Although, nowadays people are overwhelmed with questionnaire surveys for different purposes, I still found McNamara‟s statement true when comparing questionnaire surveys to interviews.

Since students could easily become inhibited and since they formed the largest part of the population in my study, a questionnaire survey appeared more appropriate than other data collection methods. In a study conducted in Australia, Fritz (1996) reported that many twelve year olds would not be able to answer complex questions clearly and fully, let alone truthfully, in an interview. Hine (1996) found the use of closed type questions to provide a more reliable and objective basis for comparisons between students than would open questions. However, questionnaires surveys have their limitations, including poor response rates and not being able to supply detail or depth.

To add to the questionnaire survey, and for purposes of gaining more insight into attitudes and perceptions, focus group interviews with students and personal interviews with design and technology teachers and other staff were conducted. One focus group with between seven and ten students was conducted in each case study school. I found focus groups more suitable for students than the one-on-one interviews. For example, when the students were asked questions in a group they were less inhibited and spoke more freely. Focus group interviews may have been considered the most suitable in this context but they have their own weaknesses and these are discussed in section 4.6.

Sequential procedures were adopted for the data collection including students, teachers and other staff. To begin with, the questionnaire survey was conducted in order to generate issues related to the problem being investigated. These were followed by focus group interviews with students and personal interviews with teachers and other staff, with detailed exploration of issues that emerged from the survey. Hendley et al (1996) used the same sequential arrangement to determine the perceptions of pupils towards the foundation subjects at key stage three in South Wales. They used a stratified selection of pupils from those originally completing an attitude scale to be interviewed to validate further the attitude scale and gain insight into pupils‟ attitudes and perceptions. In this study, convenient sampling method (Cohen et al, 2007) was used to select students from those who completed the survey to participate in the focus group interviews. Since the focus groups were conducted during lunch breaks, any student who was available at that time and willing to take part did so, if numbers allowed. In school three students had to be encouraged to volunteer and in school five there were too many volunteers and so some students had to be left out, even though they wished to take part. Every effort was made to try to balance the numbers of girls and boys in the focus groups interviews, but this was not always possible given the gender imbalance in design and technology.

4.5 Quantitative methods

Questionnaire survey

The aim of this research was to investigate attitudes to and perceptions of junior secondary school students towards design and technology as a subject in junior secondary schools in Botswana. Attitudes and perceptions of pupils towards technology have been investigated in the past using questionnaire surveys (Van Rensburg et al, 1999; Bame et al, 1989; Meide, 1997; Ankiewicz et al, 2001).

The advantage of using a questionnaire survey in this study was the ease of administration and the potential to have many students taking part. Taking into consideration the reported low response rates associated with questionnaire surveys, all design and technology students in their final year of study (form three) in the case study schools were asked to take part in the survey. A debriefing session was conducted at each school with the students, where information concerning the purpose of the research and what was expected of the participants was explained. Each student willing to take part, and their parents or guardian, completed a written consent (see appendix 4) to indicate their willingness to complete the questionnaire and take part in the focus groups interviews. A total of 233 (74 females, 158 males and 1 unidentified) students with ages ranging from 15 - 18 participated in the study.

The questionnaire

In an attempt to draw out of the students, responses relevant to the research questions posed, issues related to students‟ primary affective associations with design and technology from literature and from the pilot study, as well as my personal experience with design and technology in Botswana, were used to formulate items in the questionnaire. Items focused on students‟ attitudes to and perceptions of the subject and its associated content within the school curricula, its status and value, the relationship between design and technology, science, mathematics and English. These issues were considered important in addressing the questions concerning the decrease of enrolment in design and technology in Botswana, as well as students‟ attitudes and perceptions towards design and technology in general. Furthermore, resulting from my connections with the subject in Botswana, I was aware of a range of issues being raised. For example, the perceived value and usefulness of design and technology in the society Botswana: most students and parents believed that the only career directly related to design and technology was teaching of design and technology. Perhaps this perception resulted from the fact that students and most parents did not have access to role models in this area, other than their teachers.

The introduction of the core status of design and technology under impractical conditions in most schools, appeared to be a concern to students and teachers, hence, I perceived this to be of significance. The items in the questionnaire were a reflection of the kind of issues involved, and, in addition, provided a means of understanding them. Finally, there were items dealing with curricula practices within design and technology in relation to making design and technology a core subject at junior secondary school and how this has impacted upon students.

Questionnaire construction

In section A of the questionnaire (appendix 1), which was the demographic data section, participants were requested to place a tick in the appropriate box. This section established the profile of the people responding to the questionnaire. The demographic information of the respondents was used to establish any associations between different variables (e.g. gender, age, and school) and respondents‟ views on the issues raised.

Section B consisted of Likert statements similar to those used in the PATT, ATP and other attitudinal studies (Volk and Ming, 1999; John, 2003), and participants were requested to place a tick in the box that most closely matched their chosen response to the various statements made. The box ticked represented the respondent view about the statement made.

Likert scales are probably the most widely used tool to give an approximate indication of people‟s attitudes. Gilbert (2001) suggested that, 'questions about attitudes usually employ scales: a statement was made and individuals were asked to indicate their level of agreement in a positive or a negative direction' (p. 91). In using Likert scales a list of statements were made and the respondents were asked to indicate an attitudinal response against these statements, where the intensity that a particular view was held could be expressed to varying degrees. Likert scale statements were a type of closed format questions that enabled percentage and other statistical calculations over the whole group, or over any subgroup of respondents. Although the use of closed format questions provided a more reliable and objective basis for comparisons between respondents than would open questions, Hine (1997) identified differing interpretations on the options as subjective and a possible area of weakness of Likert scales.

In constructing categories for the degree of agreement with the statements, I decided on four categories of response, i.e. Strongly Agree, Agree, Disagree and Strongly Disagree. Using an even number scale eliminated chances of neutral answers, which are reported in Oppenheim (1996) to be over-utilised by bored questionnaire takers, particularly with students at the age of 15 – 18 who may not understand the value of undertaking research studies. However, it is not uncommon to find odd numbered scales, as these allowed neutral or no opinions, which some scholars (Oppenheim, 1996) believe to be accurate, since often the respondents may actually have no opinion. Garland (1991) agued, though that a four-point Likert scale minimised the tendency for respondents to give what they perceived to be socially accepted answers.

Hine (1997) reported that students found it often easier to indicate „U" (undecided) than to make a decision if they found the question difficult. Since the questionnaire was going to be administered with the help of the teachers, students may, in an odd numbered scale, overuse the mid-point in an attempt to keep the teachers happy, or even to appear helpful to their teachers. On the other hand, from my experience as a teacher, respondents, particularly students at the age of 15 – 18, have a tendency to modify things when they felt that they were not properly represented, some would squeeze in a mid-point category, while some would just leave out some statements as a way of protesting for their misrepresentation. When the questionnaire was piloted (see section 4.7), respondents did not show any signs of feeling misrepresented by the omission of a midpoint and so there was no need of modifying the four point scale to five point scale.

Input from colleagues with an education background, and the current research study supervisors as well as from the pilot study, led to a final version of the questionnaire (see appendix 1).

The questionnaire used in this study was designed to provide nominal (qualitative) and ordinal (quantitative) data within a statistical analysis frame. The nominal data was obtained from „Section A" of the questionnaire which was about the demographics of the population completing the questionnaire. This information allowed me to check if gender, school and age had any bearing on students" attitudes towards and perceptions of design and technology.

Section B of the questionnaire provided ordinal data. The ordinal data was obtained from the Likert type scale statements, in which respondents were asked to select by circling or ticking a response on a point scale, i.e. SA = Strongly Agree, A = Agree, D = Disagree, and SD = Strongly Disagree. Seventeen of these statements were on students" primary affective associations with design and technology. Seven were to assess students" perceptions of the subject and its associated content within the school curricula, subject status and value, the relationship between design and technology, science, mathematics and English. Table 4.2 below lists the questions and how they were abbreviated in further analysis.

Table 4.2. List of questions in the questionnaire

Number	Abbreviation	Question
1	DT+career	DT is important for future career
2	DT=personal	DT is important for personal benefit
3	DTcompulsory	All students at JC should study DT
4	Work>Folio	DT involves too much work in folio work
5	Work>Practical	DT involves too much work in practical work
6	Work>PbSolving	DT involves too much work in problem solving
7	Homework>	DT home work takes too much time
8	ToolsOK	Enough DT tools in my school
9	WorkbenchesOK	There are enough DT workbenches
10	Work>Time<	Too much to do in too little time
11	DT=Maths	DT just as important as Maths
12	DT=Science	DT just as important as Science
13	DT=English	DT just as important as English
14	HardFolio	In DT I find folio work difficult
15	HardPractical	In DT I find practical work difficult
16	HardPbSolving	In DT I find problem solving work difficult
17	EnjoyFolio	In DT I enjoy Folio work
18	EnjoyPrac	In DT I enjoy practical
19	EnjoyPbSolving	In DT I enjoy problem solving
20	EnjoyDesign	I enjoy the design aspect of DT
21	Satisfaction	I find satisfaction in making with my hands
22	DT=boys	DT is a boys' subject
23	DT+work	DT prepares for work
24	DT=life	DT prepares for life

4.6 Qualitative methods

The rationale for seeking qualitative data in this study was to achieve triangulation, which, extrapolated the quantitative practices of comparing different measurements of the same element, the point being that qualitative methods could be seen as another way of achieving multiple observations on quantitatively measured phenomenon (p. 6). The need for the application of qualitative strategies to investigate some of the issues identified from quantitative strategies has been expressed by some research in pupils‟ attitude towards technology education (Van Rensburg et al, 1999; Ankiewicz et al, 2001).

Focus group interviews

According to Gilbert (2001), a focus group is simply a group interview or a group discussion consisting of about six to ten individuals who meet together to express their views about a particular topic defined by the research. According to Heary and Hennessy in Welch et al (2005, p. 176), focus groups encourage students to provide diverse responses, express their own views and genuinely engage in good quality discussion. Focus group interviews were conducted to refine the interpretation of the results of the survey.

These interviews were arranged for students through the assistance of the individual school‟s teachers and one student focus group interview was conducted, at each of the five case study schools. These were carried out after the completion of the questionnaire survey and the identification of main factors affecting students‟ appreciation of design and technology. The purpose of these focus group interviews was to gain more information and feedback on some of the issues raised from the questionnaire survey.

Convenience sampling was used to select participants for the focus group interviews. The criterion was that those willing to take part must be those who would have completed the questionnaire. Five focus group discussions with numbers ranging between seven to ten students were conducted during study time, i.e. outside the time-table time and were scheduled to last between half an hour to about one hour and a total of 47 students (33 boys and 14 girls) between the five case study schools took part.

A focus group interview guide (see appendix 2) was used for the interviews. The focus group interviews" guide was formulated after an initial statistical analysis (ordination) of the survey questionnaire and hierarchical clustering, which determined which factors had the strongest overall effect on how students appreciated design and technology and ranked them by order of importance.

Each group sat around a table with the researcher and two voice recorders in the middle of the table. The voice recorders were used to capture the interviews, which were later transcribed verbatim, i.e. every effort was made to try and capture how respondents were expressing themselves by preserving all the regional terms and grammatical expressions (Gibbs, 2007). Pseudonyms were assigned to each participant to ensure confidentiality. Prior to each focus group interview briefing sessions were conducted with participants to explain the purpose of the research, to urge them to be as honest as possible and to express their opinions without pressure and influence from their peers. During these briefings, participants were also assured of confidentiality and anonymity. Participants were informed about its voluntary and anonymous nature and that they were free to leave at any time they felt they did not want to continue anymore.

Semi structured interviews

Semi-structured interviews were conducted with the teachers and other staff following the students‟ questionnaire survey and the focus group interviews. These interviews, it was hoped, would allow insightful comments from teachers and other staff, which might shed more light and explanation concerning students‟ attitudes to and perceptions of design and technology.

Respondents were free to answer however they wished, because there were no predetermined set of likely responses. However, some parameters were given as the questions suggested areas that the respondents could comment on (see appendix 3). The interview questions were formulated from the information gained after the analysis of the questionnaire and the focus groups interviews. For example, because shortage of tools and equipment was a major concern during focus group interviews, I decided to follow it up with the teachers and other staff to get more information and a better understanding of the issues.

Semi-structured interviews are, according to O‟Leary (2004) neither fully fixed nor fully free, and are perhaps best seen as flexible. Flexibility played an important part during the interviews as it ensured that interviews were relaxed, to establish rapport and to gain trust. Denzin and Lincoln (1994) observed that there was no single interview style that fits every occasion or all respondents. This meant that even though I had an interview guide, I was flexible enough to make adjustments according to respondent differences.

Design and technology departments at junior secondary school level had, on average, a staff complement of three teachers. All teachers of design and technology in the case study schools were included in the study, removing the need to sample this group. However, not all teachers in the five case study schools participated. Some teachers could not take part for various reasons. Table 4.3 below gives a summary of staff members who were interviewed.

Table 4.3: Summary of staff members interviewed

	Teacher	S/Teacher	D/School Head	School Head	MO	Total
Male	10	4	1	2	1	19
Female	1	1	2	0	0	4
Total	11	5	3	2	1	**22**

S/Teacher = Senior Teacher
D/School Head = Deputy School Head
MO = Ministry of Education official

Two voice recorders were used to record the interviews, which were later transcribed verbatim. Participants were assured of confidentiality and anonymity. Prior to the interviews, briefing meetings were held with the interviewees to inform them about the purpose of the research and what was expected of them. The interviewees were asked to complete a written information consent form (see appendix 4) to indicate their willingness to take part. At the beginning of each interview, interviewees were informed about its voluntary and anonymous nature and that they were free to withdraw at any time they felt they did not want to continue anymore.

4.7 Ethical procedures and considerations

Several ethics approval procedures and other considerations were taken to ensure that participants were protected and that my position as the researcher did not affect any stage of the study in a negative way. The research proposal was first submitted to the University of Wales, Institute, Cardiff (UWIC) School of Education research ethics committee, which approved it in principle in the first instance. Adjustments suggested by the UWIC research ethics committee were that separate information and consent forms, one for the student and one for the parents / guardian be designed. Initially one consent form that required the parent / guardian (in loco parentis) and the potential student participant to sign on the same form was designed. As a result of the ethics committee suggestion, three separate information and consent forms were made, one for the teachers and other staff participant, one for parents / guardian and the other one suitable for 15 – 18 year old students participants (see Appendix 4). Another suggestion made by the ethics committee was an addition to letters addressed to the various participants and authorities of a statement promising that the sole use of the data collected would be in the context of the doctoral study, the content of which might be later published in academic or professional journals.

Approval of the study by the UWIC"s School of Education ethics committee was only one step towards piloting the study, and conducting the main data collection. Other steps included getting permission to access the participants, which in the context of this study were Key Stage Three pupils in a school in Wales (for piloting only) and junior secondary school students of ages ranging between 15 and 18 years old in Botswana, junior secondary school teachers and other staff in and outside the schools in Botswana.

In the case of a school in Wales, a Criminal Record Bureau (CRB) clearance certificate was obtained before arrangements could be made with the local school authorities. A CRB clearance certificate is issued to individuals who intend to work with children or vulnerable adults after the individual has been checked and cleared of such as, convictions, cautions, reprimands and warnings in England and Wales. In the case of schools in Botswana, a letter (appendix 8) requesting permission to conduct the study was written and sent to the relevant authorities in the Ministry of Education in Botswana. The letter stated the purpose of the research, the population sample and how it was going to be conducted. Apart from the letter, the research proposal and the researcher"s curriculum vitae were also submitted as is the procedure for conducting educational research in Botswana. The Department of Planning, Statistics and Research (DPSR) in the Ministry of Education in Botswana responded by sending research permit guidelines and application forms (see appendix 10) which I completed and sent back before permission was granted in the form of a letter (appendix 9). This permission letter was used to gain access to the pilot study schools and the case study schools through the school administrators.

Ethical procedures and considerations ensured that participants were protected and were provided with information relating to the nature and purpose of the research, to understand and consent to participate without coercion (Burns, 2000). As an ethical measure, the names of all participants and all participating schools in this study were treated in strict confidence and anonymity. At every stage participants were advised that they had the right to withdraw at any time. The research was approached and conducted as objectively as possible. Every effort was made to ensure that laid down procedures and professional code of conduct were followed at all times to ensure that my position as a former teacher and as a teacher trainer did not prejudice any stage of the study.

4.8 Pilot study

A small scale pilot study was conducted before the main data collection. Piloting the study was a necessary validation procedure, as Groundlund and Linn (1995, p. 46) indicate that validity refers to the appropriateness of the interpretations made from test scores and evaluation results. I intended to use the pilot study results to evaluate my instruments. According to Kothari (2001, p. 91) validity refers to the extent to which differences found with measuring instrument reflected true differences among those being tested: in simple terms, what was measured was what was intended to be measured. According to Gibson (2005) a pilot study ensures that the proposed instruments are capable of fulfilling the purpose for which it is intended.

Piloting the study was conducted in Wales and in Botswana. Arrangements for piloting in Wales started with changing a few items in the questionnaire that was originally designed for the context of Botswana, to suit the context of Wales. These included replacing the word „students" with the „pupils", replacing junior secondary with Key Stage Three. Arrangements were made with a local school through the UWIC, School of Education design and technology department links with the schools. Arrangements for piloting and conducting the main research in Botswana started with an email to the Department of Planning, Statistics and Research (DPSR) and to the Department of Secondary Education, both in the Ministry of Education and Skills Development in Botswana, explaining the purpose of the research, the population sample and how the research was going to be conducted as described earlier. In response to this email, an officer from DPSR sent the research permit guidelines and application forms (Appendix 10) which I completed and sent back before permission was granted.

Upon successful completion of all procedures necessary for access to the students in the schools, a total of thirty one Key Stage Three students from two year nine classes in a school in Wales completed the draft questionnaire. Two focus group interviews involving twenty of the thirty three students who completed the questionnaire were also conducted. The use of Key Stage Three students from a school in Wales for piloting purposes was facilitated by the fact that I was resident in Wales during this study and so it was a convenient location to conduct a pilot. Key Stage Three students in Wales were the same age range as junior secondary school students in Botswana, so the results from the pilot study provided useful information for the study. The pilot study in Wales also provided an opportunity for a comparative perspective concerning the issues involved in this study. Moreover, piloting in Wales gave me the opportunity to experience the whole process of conducting research before carrying out the main data collection. Piloting the study in Botswana alone would not achieve this since only the questionnaires were administered, and by somebody else on my behalf.

In Botswana, a total of seventeen students from two classes, one form two class and one form three class in a junior secondary school not included in the actual study, completed the draft questionnaire. No focus group interviews were conducted in Botswana during the pilot phase of the study, as the two focus group interviews conducted in Wales were deemed sufficient to provide the necessary information and experience and because it would have been a costly undertaking to conduct focus group interviews in Botswana during the pilot phase. A junior secondary school was considered appropriate for the pilot study because the main data collection was going to be conducted in junior secondary schools in Botswana. Junior secondary schools in Botswana have similar characteristics (e.g. mixed ability, co-educational and the use of English as a medium of instruction) necessary for establishing whether the instructions and questions were appropriate, understandable and easy to use. According to Gibson (2005), a pilot study ensures that the proposed instruments were capable of fulfilling the purpose for which they were intended. In December of 2007 I had a week"s visit to Botswana, during which I made arrangements with one of the education officers for design and technology in the Northern region to administer the questionnaires on my behalf in a junior secondary school in that region. All the necessary documentation, including consent forms and a letter explaining the purpose of the study were left with this officer. The officer managed to administer the questionnaires and posted them back to me after a period of one month. The officer administered the questionnaires with relative ease because he had been a teacher of design and technology in this region before he was appointed Education Officer. Moreover, as an Education Officer he was a well known and respected person in the schools and this meant that access was easily granted.

Over and above the advantages of conducting a pilot study as discussed above, there were also specific changes made as a result of conducting the pilot study. These included changing the design of the questionnaire, refining the study population, and changing some terminology used in the questionnaire. The font used on the questionnaire was changed from plain Times New Roman to Comic Sans MS, as the latter font was considered more interesting, captivating and user friendly, to attract the attention of junior secondary school students. Students in their first and second year of junior secondary schooling (forms one and two) were found not to have sufficient grounding and information on design and technology to be able to provide useful information for the study as those in their final year (form three), so a decision was taken to exclude form one and form two students from the study.

4.9 Data collection

Data collection for this study was conducted by the researcher during the summer of 2008. Sequential procedures, as has been said, were adopted for data collection. Questionnaires were administered by the researcher with the help of design and technology teachers in the case study schools during the months of June and July. Except in two schools, schools two and school three, where students were given questionnaires and consent forms (appendix 4) to complete and bring them back to school, students were given consent forms for them and their parents to complete and bring them back to school the following day, after which the questionnaires were administered to them in the presence of the researcher. In school two and school three the teachers chose to administer the questionnaires themselves and they distributed the questionnaires and the consent forms to the students to take home and bring them back completed to school. This arrangement resulted in some students not completing the questionnaires properly, hence some questionnaires were discounted. Unfortunately, it could not be predicted from the pilot study that any school could chose to administer the questionnaire themselves in the manner that these two schools did.

A total of 233 (74 females, 158 males and 1 unidentified) completed questionnaires were received from design and technology students in their final year of junior secondary school (form 3) with ages ranging from 15 to 18. Table 4.4 below shows the distribution of students completing the questionnaires from the five case study junior secondary school.

Table 4.4: Number of boys and girls completing the questionnaire per each case study school.

School	Girls	Boys	U	Total
1	15	37	1	**53**
2	16	31		**47**
3	7	25		**32**
4	20	25		**45**
5	16	40		**56**
Total	**74**	**158**	**1**	**233**

U = Undisclosed.

The questionnaire set was made up of 27 variables (see appendix 1), three of which were defining variables of gender, age and school and 24 were four-point Likert scale variables ranging from strongly agree (4) to strongly disagree (1). Information from the questionnaires was transferred into a data matrix (spreadsheet) from which an SPSS (Statistical Package for Social Sciences 14.0) data file was created.

A code book (see appendix 5) was created to compile all the information about the coding adopted for the data. The information from the code book was then used to complete the SPSS Data Editor (see appendix 6) for this data. The information on the SPSS Data Editor was the same as the information on the code book, only that on the SPSS Data Editor more information was necessary in order for SPSS to understand the data. For example SPSS needed to know what type of data it was to deal with, e.g. string, numeric, date, currency, nominal or ordinal/scale.

To ensure data tabulation accuracy, 20% of the original instruments were compared to the entered data files to identify any errors. Initial statistical analysis discussed in the next section was carried out before the focus group and the semi-structured interviews were conducted.

Focus groups and semi-structured interviews were also conducted in a sequential procedure. Focus group discussions were carried out during the month of August then followed semi-structured interviews in the month of September. All the focus group interviews and the one-on-one interviews were conducted in the five case study schools.

Focus group interviews lasted between thirty to forty minutes, teachers‟ interviews lasted between six and fifteen minutes. Interviews with senior teachers lasted between three – twelve minutes, School heads and deputy school heads‟ interviews lasted between five and ten minutes. The interview with Ministry of Education and Skills Development official lasted for sixteen minutes. Both the audio files and the transcripts of the focus group interviews and the one-on-one interviews were imported into NVivo 8.

NVivo 8 was used to facilitate qualitative data analysis. NVivo 8 allowed or enabled data sources such as interviews, focus groups, field or case notes and any other sources to be stored in folders. These files could then be accessed, managed, shaped and analysed without the manual tasks involved in managing detailed textual and/or multimedia data.

NVivo 8 allowed or enabled these files to be accessed and specific codes or ideas to be contained in „Nodes‟. Nodes were containers for ideas. For example, I created a node called „enjoyment‟ and in this node there was information about enjoyment from all the data sources. This facility also allowed coloured „highlighting‟ of the text that is considered relevant to the analysis.

4.10 Data analysis

The questionnaire used in this study was designed to provide nominal (in a statistical sense) and ordinal (quantitative) data. The nominal data was obtained from „Section A‟ of the questionnaire which was about the demographics of the population completing the questionnaire. This information allowed me to check if gender, school and age had any bearing on students‟ attitudes and perceptions of design and technology.

Section B of the questionnaire provided ordinal data. The ordinal data was obtained from the Likert type scale statements.

Scores of 233 samples for 24 variables were analysed using multivariate statistical analysis. This involved ordination of the data, as well as its classification.

A correlation was conducted to look at correlated variables which could have the same explanation about students‟ attitudes and perceptions, then ordination of the data by correspondence analysis (CA) was carried out to quantify how much the variables in the questionnaire explained students‟ attitudes and perceptions towards design and technology. This was achieved through assessment of the eigenvalues (cut-off points), those with eigenvalues less than 1.0 were dropped because they did not have much effect on how students appreciated design and technology. The ones with eigenvalues of 1.0 and above (the first three axis) were the most influential and they were retained. The ordination also provided a visual understanding through a graphical projection of the first axis of the ordination of how each variable related to another, e.g. students who enjoyed design and technology also did not find it difficult.

Classification (clustering) was also conducted to define groups of students that responded in a similar way to design and technology. Finally, the scores or their group classification were used for comparative purposes to other variables such as age, school and gender through general linear model analysis.

The qualitative data was analysed through coding the data into analytic themes in order to apply initial codes or labels to segments of the data. This enabled the data to be analysed by simple descriptive statistics, and then compared to the findings of the quantitative data analysis. It also allowed ready access to key elements in the transcript data for illustrative purposes and further analysis.

4.11 Limitations and delimitations of the study

Due to the current limited uptake of design and technology in junior secondary schools in Botswana the ratio of girls and boys who participated in this study was unequal and the number of participants involved was relatively small. Therefore, caution must be excised when generalizing the findings for the entire population. However, according to Yin in Welch et al (2005, p. 176) small sample size is not a barrier to external validity provided that each case is detailed and analysis of data reveals elements of practice relevant to the study.

A substantial amount of questionnaires were eliminated or discounted from the statistical analysis because the students did not complete the questionnaires properly as explained in chapter five. It appears that enough guidance was not given to students on how to complete some of the multi-part questions in the questionnaire and so some students only responded to one part of the multi-part questions. However, some information from these questionnaires was still useful for descriptive analysis and it complemented both the statistical analysis and the qualitative analysis.

This study focused on a small number of determinants affecting students‟ attitude and perceptions towards design and technology, but research studies in this area have shown that there is a complex interaction of underlying factors that may be at play than simply gender, age and school performance. Such underlying factors could be the technological nature of the family‟s professions, parental attitudes and perceptions towards technology, and the existence of technological toys and facilities in the home.

The study deliberately focused on the affective component of the technological content so that the length of the questionnaire used was within a reasonable limit so as to maintain respondents‟ focus and interest.

One of the parameters set for this study was to collect information from students already enrolled in design and technology, who would have sufficient knowledge about design and technology to shed some light on the problem of declining enrolments in the subject. The focus of the study on design and technology students only would provide a baseline on which subsequent studies could rely. However, views of non design and technology students would have been helpful also to provide a comparison of attitudes towards and perceptions of design and technology between the two groups. Studies conducted in South Africa (Van Rensburg et al, 1999) and (Ankiewicz et al, 2001) did not find any significant differences in attitudes towards technology between learners that were exposed to technology education and those not exposed to it. However, it was assumed by the authors of the study, that the indifference could have been caused by among other things, the little experience within the schools with regard to technology education which had just been introduced.

CHAPTER 5: QUANTITATIVE RESULTS

5.1 Introduction

This chapter outlines the procedures and results from the quantitative (questionnaire) survey and how they addressed two of the three research questions of the study. The questions were: What factors influence students" attitudes towards and perceptions of design and technology and how could the decline of enrolments in design and technology be tackled? These questions were explored through quantitative multivariate analysis. The results of the quantitative analysis and qualitative analysis are reported in two separate chapters, five and six, respectively. The two analyses were designed to complement each other, and they are brought together in the chapter seven, to answer the three research questions. In an effort to counter the potential drawbacks of using traditional qualitative analysis alone, quantitative analysis was used, which provided more quantifiable assessments, for example, number of students adopting a given attitude, or number of students with that attitude that were males. Most often these complementary analyses used simple descriptive analysis, or simple comparative statistical tests, for example ANOVA and chi-square. This was perhaps because many forms of data used to address social science questions are non-linear and categorical. However, multivariate methods that can take into account most attitudes and potential determinants simultaneously, as in qualitative analysis are also available (Tabachnick and Fidell, 2001; Bryman and Cramer, 2008). The availability of statistical tools capable of dealing with categorical data, most frequently used in social science research has lately increased dramatically. Options included clustering techniques, ordination or categorical principal component analysis, used to investigate patterns in attitude surveys (Lingting et al, 2007). These are widely used in other fields (Durance and Ormerod, 2007).

A code book (see appendix 5) was initially created to compile all the information from the completed questionnaires into the SPSS compatible coding adopted for this data. A value was assigned to each response category, for example, 1 for strongly disagree to 4 for strongly agree. The information from the code book was then used to complete the SPSS Data Editor (see appendix 6) in preparation for further statistical analysis. Although a total of 233 questionnaires were collected, during the analysis it became apparent that many students responded to only one part of the three-part questions, as they would do in response to a multiple choice question. For example question three was in three parts (a, b and c) but most students chose to respond to either question three (a), three (b) or three (c), rather than all of them. As a result of this misunderstanding 104 questionnaires, distributed across the case study schools as shown in Table 5.1 below were eliminated or discounted from the statistical analysis, due to the fact that respondents had responded to less than 80% of the questionnaire, or had not responded to more than four questions. Unfortunately, during the pilot phase this problem did not transpire and so was not anticipated. The results reported in this chapter were obtained from 129 of the 233 questionnaires, distributed across the case study schools as shown in Table 5.2 below. Although 104 questionnaires were discounted for statistical analysis they were used to supplement the findings by analysing the data question by question.

Table 5.1: Distribution of discounted Questionnaires per case study schools.

School	Girls	Boys	Total
1	4	7	**11**
2	5	18	**23**
3	6	19	**25**
4	9	9	**18**
5	6	21	**27**
Total	**30**	**74**	**104**

Table 5.2: Distribution of usable questionnaires per case study schools.

School	Girls	Boys	U	Total
1	11	30	1	**42**
2	11	13		**24**
3	1	6		**7**
4	11	16		**27**
5	10	19		**29**
Total	**44**	**84**	**1**	**129**

U = Undisclosed.

Statistical procedures using Statistical Package for the Social Sciences (SPSS, Version 14.0 for Windows) were used to analyse the students" responses to the questionnaire used in the study. The suitability of the data for statistical analysis was assessed looking at the sample size and the strength of inter-correlations among the variables. Considering both the overall sample size and the ratio of subjects to variables, statistical factor analysis was found to be appropriate. The strength of inter-correlations, assessed through statistical measures of Bartlett"s test of sphericity and the Kaiser-Meyer-Olkin (KMO) also confirmed the factorability of the data. The Bartlett test was significant ($p < .05$) and the KMO index was 0.574. According to Pallant (2001) 0 .6 is the maximum value for a good factor analysis.

5.2 Statistical analysis

Several statistical analysis procedures were performed to look at all the Likert scale variables to determine which variables might be combined, because they clustered together for one reason or another. Exploratory factor analysis was thus conducted to establish the inter-relationships among the variables.

The following statistical analysis procedures were performed for different reasons and will be reported separately. Hierarchical cluster analysis and correlation analysis procedures were performed to eliminate variables with high collinearity. Principal component analysis (PCA) procedures were performed to extract from a high density of information the main patterns (also called factors) that described students‟ attitudes and perceptions towards design and technology. Once the main patterns were extracted and understood, classification procedures were performed to collect the students‟ responses into groups with similar attitudes (also called clustering). Potential explanatory causes for variations in student perceptions were investigated in line with my hypothesis that school enrolment and performance, and gender could have an impact on perceptions. To identify whether students‟ attitudes and perceptions depended on gender and school background, or a combination of these factors, General Linear Model (GLM) analysis was performed on the first three PCA scores.

5.3 Hierarchical cluster analysis

A hierarchical cluster analysis using the Ward"s classification with square Euclidian distance (Ward, 1964) was performed on the basis of students" responses to the questionnaire. Hierarchical cluster analysis is a data segmentation statistical method for grouping a collection of objects (observations, individuals, cases, or data) into subsets of relatively homogeneous clusters based on measured characteristics. Objects within each cluster are more closely related to one another than objects assigned to different clusters. Classification techniques, typically transformed similarity between objects into distances and then grouped close objects together. This technique preliminarily identified six clusters of variables from the 24 questionnaire statements (see table 4.2). These were discussed later in the chapter. The dendrogram (Figure 5.1) provided a graphic expression of similarity between the variables. Similar variables were grouped together hierarchically and dissimilar variables were separated from each other. In figure 5.1, similar variables were represented as closely linked (i.e. the distance path from one variable to the other through the tree is short).

On the dendrogram, a distance measure was selected to determine how the similarity of two elements was calculated. This influenced the shape of the clusters, as some elements may be close to one another, according to one distance, and further away according to another. In the first instance, I chose a distance indicated by the dotted line across the dendrogram, this reduced my data so that I could concentrate on a smaller number of key issues during the focus group discussions.

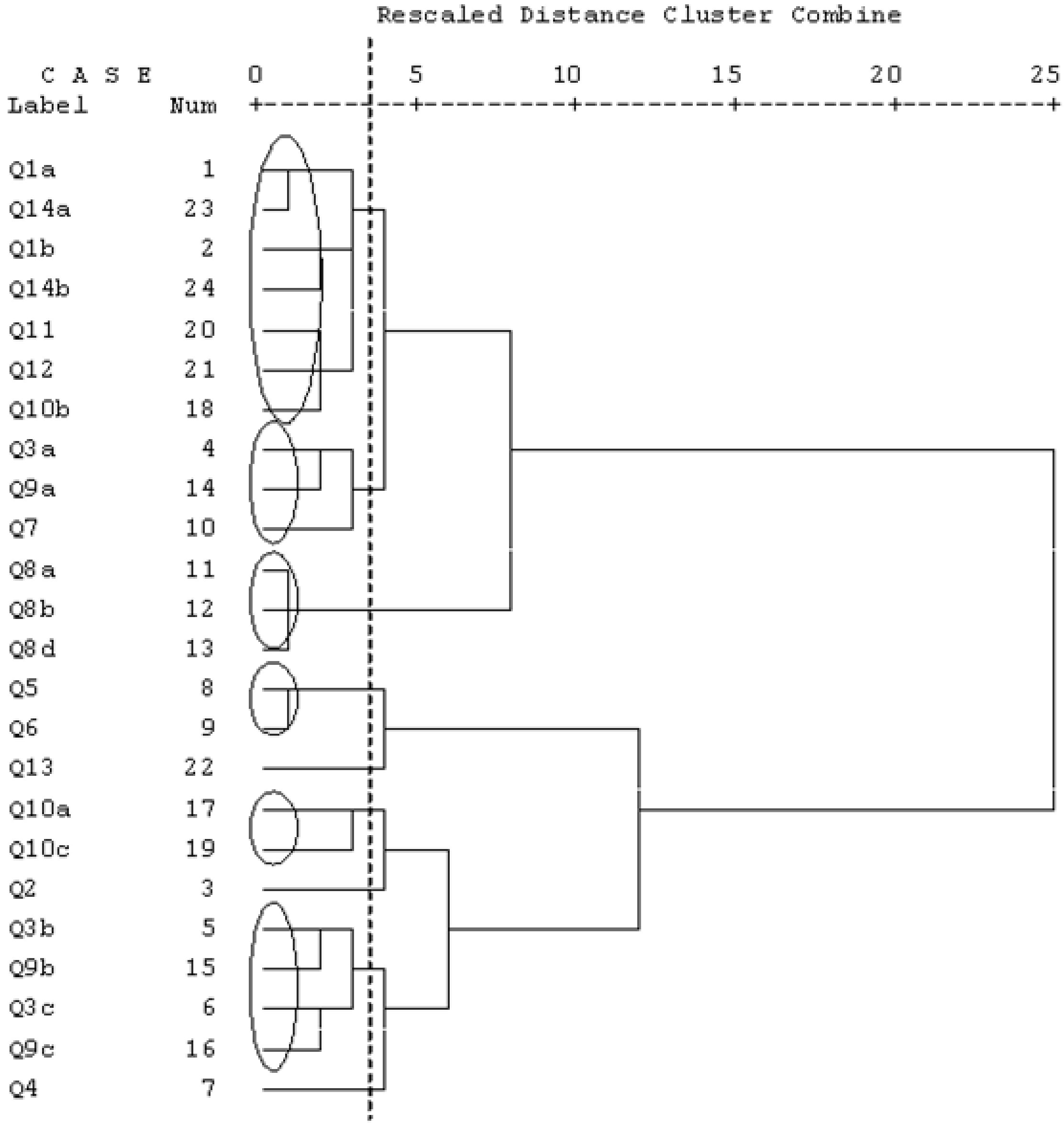


Figure 5.1: Dendrogram using ward method.

According to the distance selected (dotted line), even though the questionnaire is made up of 24 Likert statements, some of them were similar to one another and they could have been understood to mean the same thing by the respondents. For example, statements Q1a, Q14a, Q1b, Q14b, Q11, Q12, and Q10b were linked, indicating that they were similar in one way or the other. Responses to this cluster of questions would indicate whether the respondent perceived design and technology to be important for a career and/or for personal benefit. The six main clusters were identified as follows:

1. Importance of design and technology for career development and or for personal benefit;
2. Importance of design and technology in comparison to other core subjects;
3. Amount of work and level of difficulty in folio work;
4. Resources and facilities in design and technology;
5. Enjoyment of design and technology; and
6. Amount of work and level of difficulty in practical work and problem-solving.

These six preliminary issues were the basis for the focus group interviews that followed, the results of which were discussed in chapter six.

5.4 Correlation analysis

A matrix of correlation coefficients among all the questions (variables) was performed to show the relationship between the variables. The correlation coefficients between variables express the degree of relationship between the row and the column variables of the matrix, and therefore, enable one to objectively assess the extent to which one variable influences another. When there is a close relationship between the correlated row and column variables, the coefficients would be close to 1 and the closer to 0 the coefficient, the less the relationship. A negative coefficient indicates that the variables are inversely related.

The following significant correlations between the variables in the questionnaire were identified from the matrix of correlation coefficients table. The table is too big to be included in here, and so only variables with significant correlations are discussed. "*DT prepares for work"* had a Pearson correlation factor of 0.526 (significance = 0.000) to *"DT is important for future career"*. *"DT as important as Science"* had a Pearson correlation factor of 0.664 (significance = 0.000) to *"DT as important as Mathematics"*. *"DT as important as English"* had a Pearson correlation factor of 0.607 (significance = 0.000) to *"DT as important as Mathematics"*. *"DT as important as English"* had a Pearson correlation factor of 0.555 (significance = 0.000) to *"DT as important as Science"*.

These coefficients give the percentage variation in common for the data on the two correlated variables. For example $0.526^2 \times 100 = 27.6676$, so 28% of the variation of the 129 students on "*DT prepares for work"* and *"DT is important for future career"* was in common. If we knew a student perception about one of the two variables (*DT prepares for work* and *DT is* *important for future career*) we could predict or account for 28% of their perception about the other.

Similarly, 44% of the variation of the 129 students on *"DT as important as Science"* and *"DT as important as Mathematics"* was in common, 37% of the variation of the 129 students on *"DT as important as Mathematics"* and *"DT as important as English"* was in common, and 31% of the variation of the 129 students on *"DT as important as English"* and *"DT as important as Science"* was in common.

The correlations between the variables discussed above were highly significant, meaning that either these statements were perceived to mean the same thing to the students or that students, for example, who perceived design and technology to be preparing them for work were those whose career prospects were in line with design and technology, or were likely to find design and technology important for future career.

Students" attitudes and perception of the importance of design and technology did not matter, whether design and technology was compared to Science or to Mathematics. The relationship indicated that if students perceived Mathematics and Science to be important, they were likely to perceive design and technology in the same manner and vice versa.

The correlation of English and Science was an indication that valuing Science or English as a subject did not have an effect on how students perceived the importance of design and technology. It was also an indication that if students perceived English and Science to be important, they were likely to perceive design and technology in the same manner and vice versa.

Key interpretations, such as these highlighted above from the correlation matrix, were a basis for understanding the qualitative data and describing such empirical relationships between these variables. These results illuminated the importance attached to the subject of design and technology, for whatever reason, as a potential factor influencing students" attitudes towards and perceptions of the subject. They also illuminated the fact that these statements were interpreted to mean the same thing, so further follow up analysis could consider these correlated variables in relation to „the importance of design and technology".

5.7 Principal component analysis

A principal component analysis was performed to further extract the number of underlying factors for analysis. A principal component analysis is an ordination analysis that allows visualisation in an n-dimensional factorial plan how objects of study (here students) and the variables of study (here questions on attitudes to and perceptions of design and technology) are related to each other. Objects or variables that are similar to each other are represented close in space, dissimilar ones far apart. This visual understanding provides a clear synthesis of patterns involved and their underlying mechanisms. Smith, online (2002) observed that a PCA is a way of identifying patterns in data, and expressing the data in such a way as to highlight their similarities and differences.

The PCA synthesized the data from a mass of variables (here questions on attitudes and perceptions to design and technology) into a set of compound components (factors) where the first component (factor) explained most of the variation, the second the next most variation and so on. Therefore comparison of the weightings of variables on the first few components indicated which variables (design and technology characteristics) contributed most to differences between students" attitudes to and perceptions of design and technology. These design and technology characteristics are the factors leading to the decline of the subject uptake, therefore answering the first research question.

Table 5.3 presented the unrotated component (factor) matrix of the 24 variables analysed from the data. The rows of the matrix referred to the variables while the columns defined the components or factors. The intersection of rows and columns showed the loading for the row variable on the column component.

Table 5.3: Component Matrix.

	Component								
	1	2	3	4	5	6	7	8	9
D&T just as important as science	.737	.080	-.383	.046	-.127	-.036	.088	-.075	.125
D&T just as important as english	.680	.034	-.357	-.271	-.131	.176	.028	-.055	-.037
D&T just as important as maths	.676	.068	-.456	.017	-.093	.313	.148	-.074	.140
D&T is important for future career	.595	.045	.189	.033	-.412	-.327	-.013	.119	.165
D&T prepares for work	.510	.136	.273	-.076	-.226	-.253	-.237	.366	.175
All students at JC should study DT	.467	-.071	.052	.251	.081	.306	-.056	-.012	-.233
In D&T I find practical work difficult	-.131	.590	.048	-.149	.282	.401	-.206	-.041	.132
In D&T I find problem-solving work difficult	.070	.578	.208	-.245	.164	-.110	.190	-.425	.012
In D&T I enjoy problem-solving	-.075	-.513	.259	.252	-.153	.300	-.292	.072	-.272
D&T involves too much work in practical work	.195	.461	.197	-.242	.050	.212	-.450	.201	.052
There are enough D&T workbenches	.071	.246	.506	.227	-.413	.197	.285	-.182	.009
D&T is a boys' subject	-.364	.148	-.424	-.109	-.233	.237	.116	.222	-.275
D&T involves too much work in folio work	.096	.344	.009	.540	.110	.103	-.392	.173	.101
In D&T I enjoy Folio work	.204	-.194	.513	-.518	-.005	.066	-.006	-.041	.089
In D&T I find folio work difficult	-.029	.491	-.207	.505	.100	-.179	-.138	-.301	-.034
In D&T I enjoy practical	.196	-.379	.240	.402	.157	-.045	-.084	-.363	.251
D&T is important for personal benefit	.374	.045	.121	-.039	.454	-.057	.264	.189	-.373
I find satisfaction in making with my hands	.261	-.357	.069	-.029	.379	-.215	.168	-.036	.017
Too much to do in too little time	.199	.286	-.033	.229	.378	-.359	.081	.239	-.015
I enjoy the design aspect of D&T	.257	-.256	.083	-.102	.279	.443	-.069	-.273	.184
Enough D&T tools in my school	-.075	.322	.284	.409	-.261	.239	.476	.067	-.004
D&T prepares for life	.356	-.186	.174	.223	.297	.274	.262	.413	.001
D&T involves too much work in problem-solving	.339	.425	.272	-.159	-.026	-.082	-.076	-.161	-.577
D&T home work takes too much time	-.355	.334	.081	-.130	.148	.133	.291	.270	.417

Extraction Method: Principal Component Analysis.
a 9 components extracted.

The number of columns (nine) indicated the number of substantially meaningful independent (uncorrelated) patterns of relationship among the variables. In other words, there were nine independent patterns of relationship in the data and these may be thought of as evidencing nine different kinds of influences on the data. This indicated that there were nine categories by which these data may be classified; it illuminated nine empirically different factors describing the students‟ attitudes towards and perceptions of design and technology.

The loadings in the PCA gave a measure of which variables were involved in which factor pattern and to what degree. The order defined the rate of influence. The first pattern defined the greatest influence and influence decreased successively with each factor, thus making PCA a more powerful procedure as compared to hierarchical cluster analysis, which was used to identify topics prior to focus group interviews. Investigating these loadings revealed which attitudes and perceptions towards design and technology (among the 24 available) generated the differences between students, and which did not. Variables with the highest loadings on the first component were the most influential in differentiating between students and thus explained most of the pattern in attitudes and perceptions towards design and technology.

A factor pattern was limited to those variables with a loading of 0.5 and above (table 5.3), which is calculated as $0.5^2 \times 100$ to get a percentage of their variation involved in that factor pattern. For example, the first pattern of interrelationships involved *DT as important as Science* (.737) (54%), *DT as important as English* (.680) (46%), *DT as important as Mathematics* (.676) (46%), *DT is important for future career* (.595) (35%), and *DT prepares for work* (.510) (26%). The percentages showed the amount of data on a variable that could be predicted by knowing what a student perceived about design and technology on that pattern, or on the other variables involved in the same pattern.

By comparing the factor loadings for all factors and variables, those particular variables involved in an independent pattern could be identified and those variables most highly related to a pattern identified.

The first and most influential pattern was made up of variables loading high on the first column. Therefore it was clear that the first factor that was most influential had to do with how important design and technology was perceived as a subject by the students. The second influential factor had to do with the level of difficulty of design and technology. The third factor was loading high on enjoyment of folio work and on resources. The positive and negative strength of the responses was not entirely clear in the third factor, and qualitative interviews, discussed in chapter six, helped to clarify this issue. The fourth factor was loading high on too much work on folio work and difficulty on folio work. Columns 5, 6, 7, 8 and 9 referred to; *DT important for personal benefit, I enjoy the design aspect of DT* , *enough DT tools in my school, DT prepares for life* and *DT homework takes too much time,* respectively. These latter columns did not have any variables loading above 0.5 and they were not considered because they did not contribute much to the explanation of variance on the data. However, there were different methods used to decide how many components to keep, i.e. which were the most important ones that explained most of the pattern of interest. The total variance explained table (Table 5.4) and scree plot (Figure 5.2) provided a summary of how this variability was distributed among the different components.

Table 5.4: Total Variance Explained.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.275	13.647	13.647	3.275	13.647	13.647
2	2.527	10.530	24.176	2.527	10.530	24.176
3	1.765	7.355	31.531	1.765	7.355	31.531
4	1.715	7.147	38.678	1.715	7.147	38.678
5	1.422	5.925	44.603	1.422	5.925	44.603
6	1.377	5.736	50.339	1.377	5.736	50.339
7	1.225	5.104	55.443	1.225	5.104	55.443
8	1.168	4.869	60.312	1.168	4.869	60.312
9	1.081	4.503	64.815	1.081	4.503	64.815
10	.966	4.027	68.841			
11	.933	3.886	72.727			
12	.791	3.297	76.024			
13	.763	3.179	79.203			
14	.733	3.055	82.258			
15	.639	2.662	84.920			
16	.615	2.563	87.483			
17	.561	2.338	89.822			
18	.488	2.032	91.854			
19	.467	1.945	93.799			
20	.387	1.612	95.411			
21	.377	1.569	96.980			
22	.293	1.222	98.202			
23	.232	.966	99.167			
24	.200	.833	100.000			

Extraction Method: Principal Component Analysis.

Table 5.4 showed each component and how much they contributed to the total variance in the data. Total variance explained was expressed in eigenvalues. Components with eigenvalues of 1 or higher were the ones having the most effect on perceptions of students towards design and technology. Components with eigenvalues below 1 contributed very little to the explanation of the variance (Field, 2009) and were left out for further statistical analysis. The first four components accounted for much of the total variance explained (39 %) out of 24 questions in the questionnaire.

The scree test (Figure 5.2) plotted components as the X axis and the corresponding eigenvalues as the Y axis. The general rule of a scree plot was that as the plot ceases to drop and starts to form an elbow, all the components after the one starting the elbow of the plot should be dropped (Field, 2009). Deciding where the elbow starts was somehow subjective but in this case an inspection of the scree plot revealed a clear break after the third component, confirming the decision to retain three components (identified earlier) in the analysis. There were other techniques available to help decide how many components to retain (Tabachnick and Fidell, 2007) when the cut-off point was not so clear.

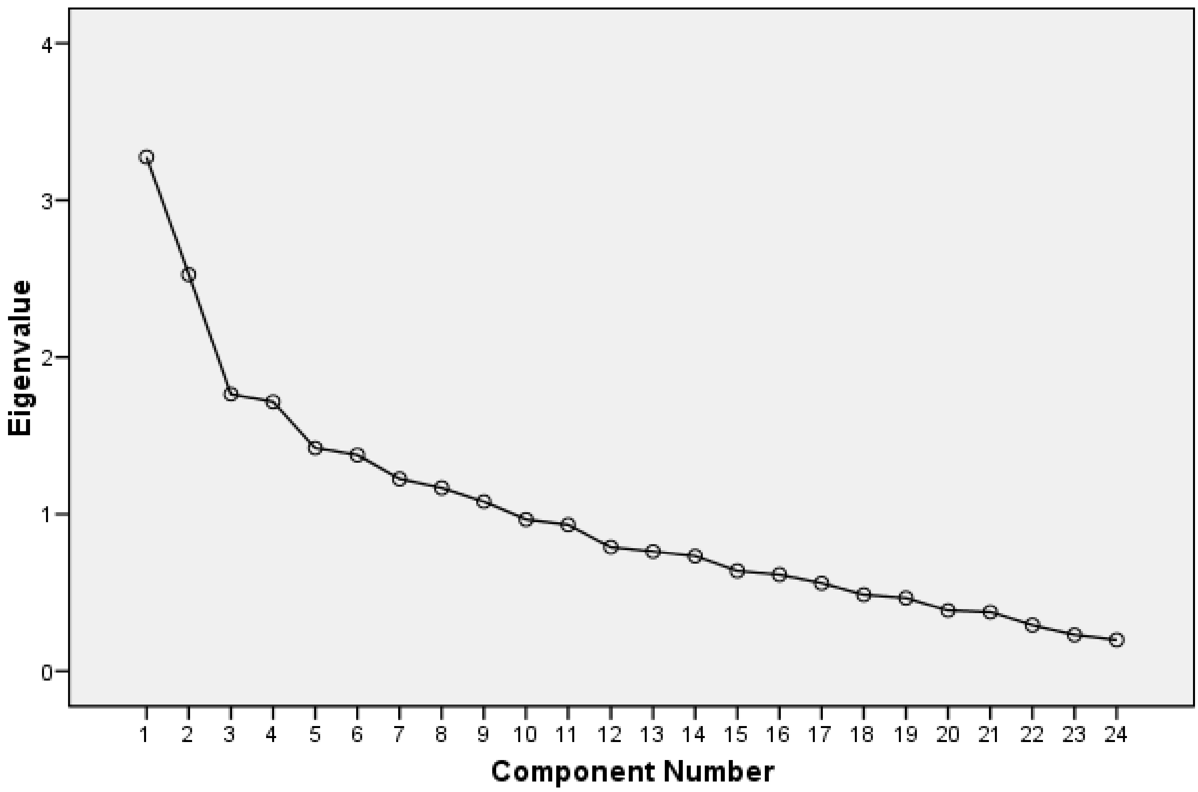
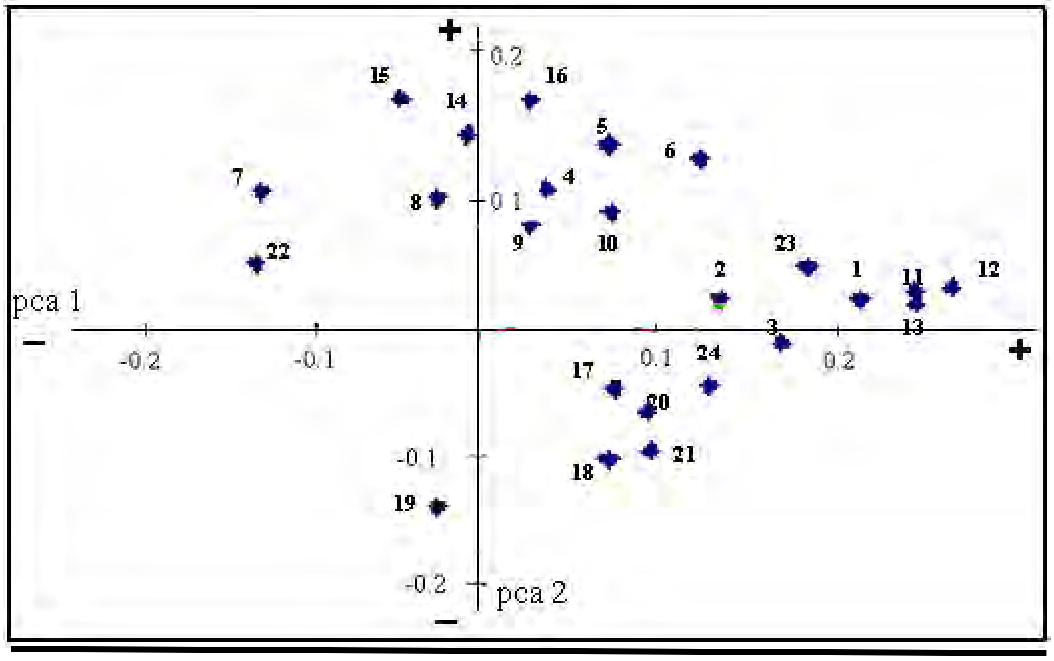


Figure 5.2: Scree Plot.

The importance attached to design and technology (component one) by students was an important variable showing a Total Variance of 3.275 and accounting for about 14% of the total variance explained. Level of difficulty (component two) also appeared to be an important variable in how students perceived design and technology with a Total Variance of 2.527 and accounting for about 11% of the total variance explained followed by resources in design and technology (component three) and enjoyment with Total Variance of 1.765 and 1.715, respectively and accounting for about 7% each, of the total variance explained. According to the PCA and the results obtained thereof, it was concluded that factors leading to the decline of design and technology uptake were: 1. Perceived importance, 2. Level of difficulty, and 3. Resource availability.

The PCA analysis provided two sets of results (Figure 5.3(a) and Figure 5.4). Figure 5.3(a) was the weighting of each variable used to generate the axes. Investigation of these weightings revealed which perceptions towards design and technology (among the 24 available) were influential in generating the differences between students and which were not. Variables with the highest weightings on the first axis were the most important in differentiating between students and thus explained most of the pattern in perceptions towards design and technology. Figure 5.4 shows the position of the students on the axes, and the distances between students are proportional to their similarity in attitude and perceptions to design and technology. The position of students on these axes was subsequently used in variance analysis discussed later in the chapter, to see if gender, age or school background had any effect on students" perceptions towards design and technology.



Labels: numbers 1 – 24 are the questionnaire variables

Figure 5.3 (a): Projection on axis 1 and 2 of the PCA weightings of 24 variables (numbered as per table 8) describing different perceptions towards design and technology.

Figure 5.3(a) illustrates a pattern of variation of students" perceptions (among the 24 available) towards design and technology. This pattern of variation indicated how the different perceptions were related. It was clear from this figure that students who perceived design and technology as important also perceived it as an enjoyable subject. This figure illustrated the configuration of each variable against the two factor axes (pca1 and pca 2) as actually derived from the PCA. The X-axis (pca 1) represented the importance attached to design and technology, and the Y-axis (pca 2) represented the level of difficulty attached to design and technology. The numbers along the axes indicated the weightings of each variable (i.e. each point in space) on each of the two axes.

This figure defined a pattern of relationships and the association of each variable with the two patterns of factors (importance and level of difficulty).

Projecting a line with an arrowhead from zero to each of these points representing the variables gave us a vector representation of the data (Figure 5.3(b). The 24 variables plotted as vectors in an imaginary space of the 198 students describe a vector space. In this space, the angle between any two vectors measured the relationship between the two variables for the 129 students.

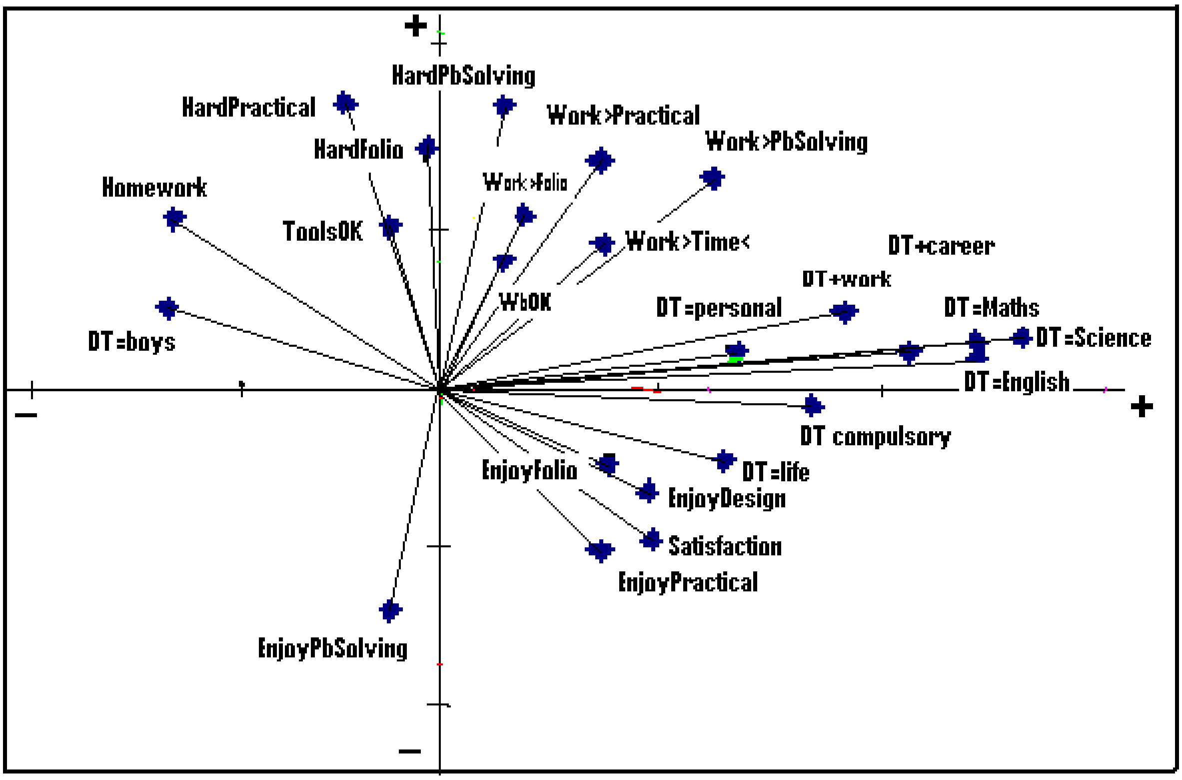


Figure 5.3 (b): Vector representation of figure 4.3 (a) with 24 variables labelled as per table 6.

The closer the angle between any two vectors is to zero is an indication of a stronger relationship between the variables. An angle of zero means that students high or low on one variable were proportionally high or low on the other. For example, in this analysis, students who perceived design and technology as important for their future career also perceived design and technology just as important as Science, Mathematics and English. The close to ° 90° the angle was, the less the relationship, this meant that the variables represented by these two vectors were uncorrelated, they had no relationship to each other. An angle of 180° between vectors meant that the two variables were inversely related, for example students who perceived design and technology to be important did not perceive design and technology as a subject for boys.

In figure 5.3(a) we can see that the variables form patterns of relationships clustering around the graph. These clusters represented the main factor patterns developing from the data, how they relate to the two patterns of factors of „the importance of design and technology", and „the level of difficulty of design and technology".

Figure 5.4 is similar to figure 5.3(a) but instead of illustrating a pattern of variation of students" attitudes and perceptions towards design and technology, it illustrates a pattern of variation of students across their attitudes and perceptions toward design and technology, and then groups them by their profile of similarity. The students profile of similarity was shown in four groups or clusters, group one (N=31), group two (N= 43), group three (N=32), and group four (N=23).

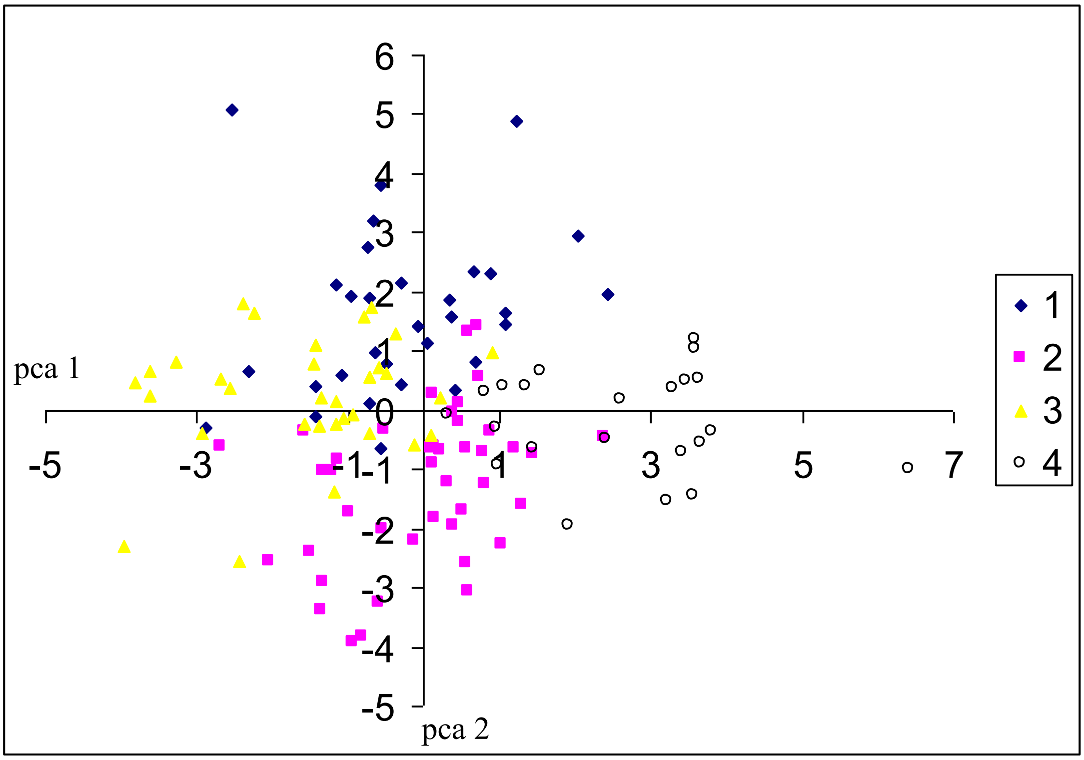


Figure 5.4: Projection on the same axis (PCA 1and PCA 2) of the 129 students.
Labels: Blue diamonds (◆): Group 1 students considering DT an unimportant and difficult subject, Purple squares (■): Group 2 students considering DT an important subject for their career, Yellow triangles (△): Group3 students considering DT an enjoyable craft, White dots (○): Group 4 students considering DT an unimportant subject with too little problem-solving. See text for details.

The results in figure 5.3 (a) and figure 5.4 give an indication of the different groups of students and their attitudes and perceptions towards design and technology. If we align the two figures, one on top of the other we get group four students around the „D&T is importance" factor pattern. This means that the students in this group four (N=23) were the ones whose perceptions were positive about the importance of design and technology. This group of students considered design and technology to be an important subject for career and for life skills, as important as other core subjects (75 - 95% agreed or strongly agreed on questions 1 (95%), 2 (88%), 11 (75%), 12 (81%), 23 and 24 (88%) (see table 4.2 for questions). However, this group also found design and technology a difficult subject demanding much work, more than 80% of the students in that group agreed (31-38%) or strongly agreed (56%) that design and technology was difficult in folio and practical work (questions 14 and 15) and more than 80% agreed these aspects of design and technology demanded too much homework. Table 5.5 gave a summary of how different groups responded to the questionnaire.

Table 5.5: Response in % of each group to the questionnaire.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Group 1	***Disagreement***	38	33	71	4	46	71	21	71	88	50	75	75	79	13	46	54	75	29	25	38	25	75	29	17
31	***Agreement***	63	67	29	96	54	29	79	29	13	50	25	25	21	88	54	46	25	71	75	63	75	25	71	83
Group 2	***Disagreement***	2	5	45	15	36	58	67	91	85	38	7	9	22	29	65	58	55	5	42	11	5	91	4	7
43	***Agreement***	98	95	55	85	64	42	33	9	15	62	93	91	78	71	35	42	45	95	58	89	95	9	96	93
Group 3	***Disagreement***	6	12	85	12	21	41	59	88	85	35	47	53	41	47	56	50	38	12	44	12	24	88	9	18
32	***Agreement***	94	88	15	88	79	59	41	12	15	65	53	47	59	53	44	50	62	88	56	88	76	12	91	82
Group 4	***Disagreement***	6	13	81	13	6	50	31	75	75	19	25	19	38	6	13	31	50	56	81	38	19	69	13	13
23	***Agreement***	94	88	19	88	94	50	69	25	25	81	75	81	63	94	88	69	50	44	19	63	81	31	88	88

The students in group one (N= 31) were characterised by the fact that they dominantly disagreed that design and technology was an important subject (75 to 80% disagreed or strongly disagreed with questions 11, 12, 13) and thought the problem-solving aspect of design and technology was underdeveloped (Question 6: There is too much problem-solving work in DT).

Group two (N= 43), like Group four, considered design and technology to be an important subject and again more than 70% agreed or strongly agreed to questions 1,2, 11,12, 23, and 24. They particularly enjoyed the hands-on and design aspect of design and technology but not the portfolio (more than 70% agreed or strongly agreed in response to questions 20 and 21).

Finally, group three (N=32) mainly considered design and technology an enjoyable craft. In this group of students more than 80% agreed or strongly agreed in response to questions 18, 20, 21, 23, and 24.

All groups disagreed or strongly disagreed with the assertion that there were enough resources available for design and technology: 71-91% thought there were insufficient tools, 76-88% thought there were insufficient workbenches. Also, all groups disagreed or strongly disagreed that design and technology was a boys‟ subject (69%-91%).

The discounted questionnaires were scanned to supplement or complement the results of the quantitative analysis. Responses from this group did not indicate any difference in attitudes and perceptions of students towards design and technology, from the results of the multivariate analysis. Table 5.6 below gave a summary of students‟ responses in numbers to each of the questions in the questionnaire.

Table 5.6: Response in numbers of the discounted questionnaire.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Disagreement	3	4	46	8	11	14	49	82	87	41	31	13	13	17	21	22	38	8	24	16	19	83	6	7
Agreement	95	37	54	84	32	19	54	21	14	60	57	35	32	69	28	18	47	50	16	84	71	16	77	47

As in groups two, three and four, the majority of these students agreed or strongly agreed to questions 1, 2, 23 and 24, indicating that they considered design and technology to be an important subject. Again, like all the attitude groups, the majority of these students agreed or strongly agreed to question four, indicating that they considered the portfolio to involve too much work. They also disagreed or strongly disagreed with the assertion that there were enough resources available for design and technology. Eighty three disagree or strongly disagreed, while only sixteen agreed or strongly agreed that design and technology was a boys‟ subject. All the attitude groups and the majority of this discounted group agreed or strongly agreed to question 21, indicating that design and technology students generally found satisfaction in designing and making artefacts with their own hands.

5.6 General Linear Model

According to Research Methods Knowledge base online (2008), The General Linear Model underlies most of the statistical analyses that are used in applied and social research. The General Linear Model specifies the linear relationship between a response variable (Y), and a set of independent variables (X^s). A General Linear Model is an analysis of variance (ANOVA) for unbalanced designs (Quinn and Keough, 2002: Tabachnick and Fidell, (2001) and was suitable in the case of this study.

A General Linear Model was performed to specify the relationship between the two variables of PCA1 and PCA2, and the supplementary variables of gender, age, and school performance. The results of the General Linear model indicated that age and the interaction between school performance and gender affected PCA1. These two sources explained little variation in PCA1 (respectively 6.5 and 4.3%), however they were both significant (respectively $F_{3,125}=3.4$ with $P<0.05$ and $F_{1,125}=6.5$ with $P<0.05$). Figure 5.5a showed how age affected results along PCA1, with younger students having a more positive view of design and technology than older ones.

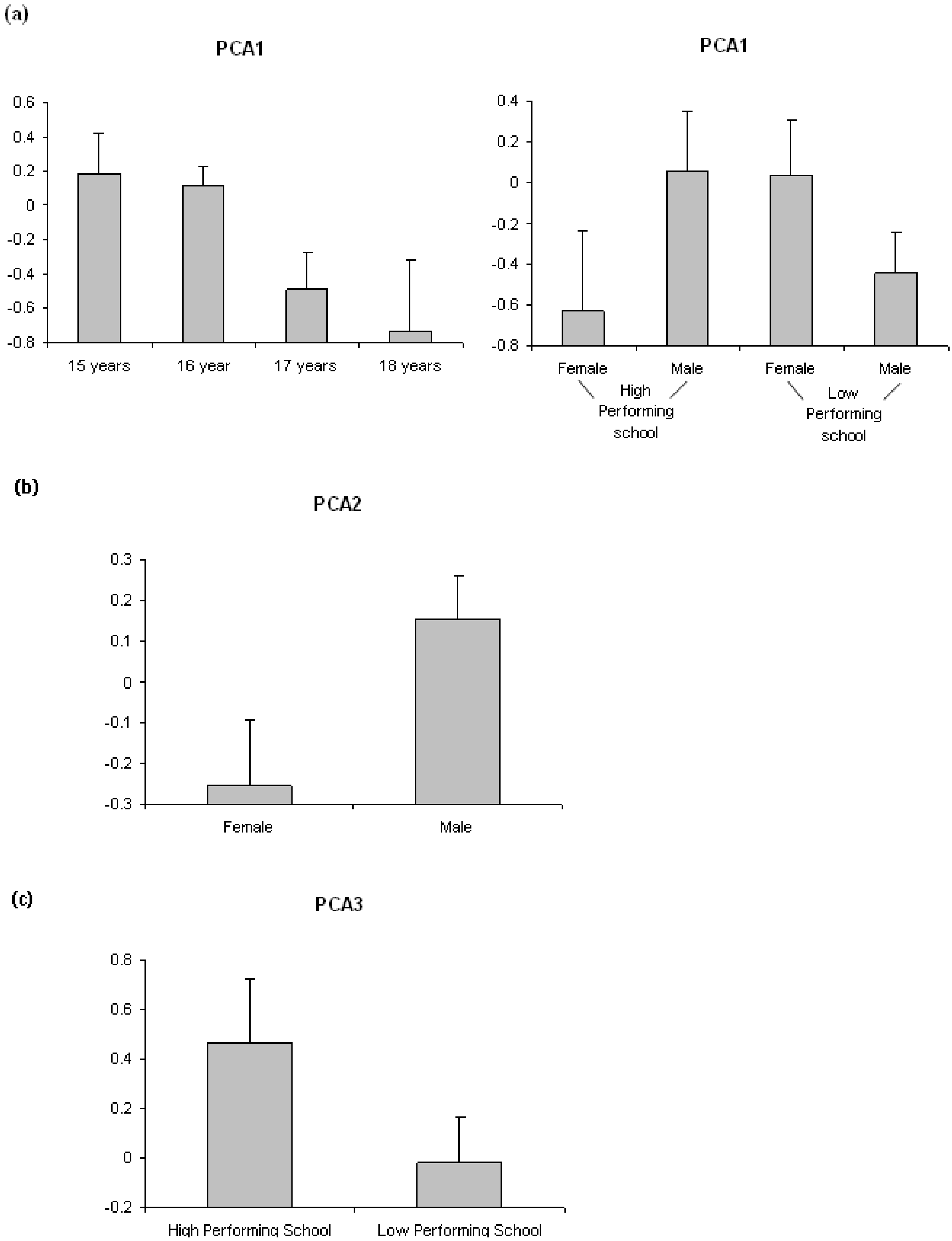


Figure 5.5: Results of the GLM analysis investigating potential effect of (a) Age and Gender*School Performance, (b) Gender, and (c) School Performance on the response of students to the questionnaire.

Interaction between school performance and gender indicated that girls in the high performing schools and boys in the low performing schools had a negative view of design and technology. Similarly gender affected PCA2 (Figure 5.5b) but explained only 3.8% of variation in PCA2 scores although this effect was significant ($F_{1,\ 125}$= 4.9, P<0.05). Weightings on these axes (Table 5.1) suggested that males might enjoy the craft aspect of design and technology and females believed this was a less important subject more adapted to boys. School performance affected PCA3 significantly ($F_{1,125}$=4.8, P<0.05) and explained 3.9% of variation in PCA3. High performing schools were more associated with the attitude "Enough DT tools in my school" than low performing schools (Figure 5.5c).

The unbalanced numbers in the sample of the study, for example between boys and girls did not affect the results of the General Linear Model discussed above because this procedure was designed to deal with unbalanced designs. Also, because of the highly significant *p* values observed, the unbalanced numbers were not an issue. According to Quinn and Keough (2002), and Tabachnick and Fidell (2001), unequal sample size matters when the results are close to critical level, in which case random re-sampling and checking several times is necessary.

5.7 Summary of the quantitative results

The results obtained here provided a basis for answering the research questions one and three in this study; however, it was necessary that these were followed up qualitatively to have a better understanding and interpretation. Some of these results came as a surprise, and did not support my initial hypothesis about certain issues. For example, my first hypothesis was that "Student uptake of design and technology was low because the subject was considered as unimportant", the results did not support this hypothesis. Many students considered design and technology as an important craft subject[16], meaning that its low uptake was attributable to its craft nature and other factors; for example, the individual aptitude of students. Another hypothesis that was not supported by the results was that "Girls uptake of design and technology was low because they perceived it as a male oriented subject". In the ordination of the principal component analysis, this variable had no weight because none of the groups agreed on that point. Although this was in contrast to most studies in Europe (Hannover, 1992; Brotman and Moore, 2008) and in Africa (Meide, 1997), it resonated with the USA study (Bame et al, 1989, which found that girls perceived technology as being an activity for boys and girls, to a greater extent than boys did. However, the focus group interviews indicated that girls were generally less positive towards the subject than their male counterparts.

The General Linear model analysis gave two important results for the three supplementary variables of gender, age, and school background. First, it indicated how much each of these

[16] Practical skill"s competence based.

variables explained the variation between students. Secondly, it indicated how significant these variables were in explaining the variation. Gender, age and school background were found to affect some perceptions significantly, even though they all explained little variation between students. These results also needed to be followed up qualitatively for a better understanding and interpretation. The quantitative and the qualitative results converge in chapter seven and are discussed in line with the research questions to give a general view of what the finding of the study are.

CHAPTER 6: QUALITATIVE RESULTS

6.1 Introduction

This chapter presents findings from the qualitative part of the study which followed the quantitative multivariate analysis. It particularly addresses research question two: how does examining the views of form three design and technology students help explain the problem of declining enrolment in the subject? Focus group interviews with students and semi-structured interviews with teachers and other staff were used to examine the views of students concerning their attitudes towards and perceptions of design and technology, as well as their underlying drivers as revealed in chapter five. The views of students, teachers, and other staff expressed during the focus group and the semi-structured interviews, helped to explain in detail the problem of declining enrolment in design and technology, and how this could be tackled. This chapter complemented the quantitative results reported in chapter five by providing an in-depth insight into students‟ attitudes towards and perceptions of design and technology.

Five focus group interviews were conducted across the five case study schools involving 47 students selected through convenience sampling from the original population that completed the questionnaire, the results of which were reported in chapter five. In addition to the focus groups, 22 semi- structured interviews with staff (see table 6.1 for details) were also conducted during the summer of 2008.

To maximise consistency, a semi-structured schedule (appendix 2), informed by the experience gained from the preliminary research reported in chapter five and the results of the hierarchical cluster analysis, was used for the focus group interviews. Issues raised during the focus group interviews with students were also used to inform the semi-structured interviews with teachers and other staff conducted through a semi-structured schedule (appendix 3).

A digital recording machine and an audiocassette recorder were used concomitantly to record the focus groups and the semi-structured interviews as a precautionary measure in case any one of these machines failed to function. A typist familiar with the subject matter was employed to do the typing of the transcripts. Transcribing the data was done verbatim as mentioned earlier, to try and capture how respondents expressed themselves by preserving all the regional terms and grammatical expressions (Gibbs, 2007). All the transcriptions made by the typist were checked against the original recordings by the researcher and any mistakes identified were corrected. It was not practicable to send the transcripts from Wales to the participants in Botswana for checking.

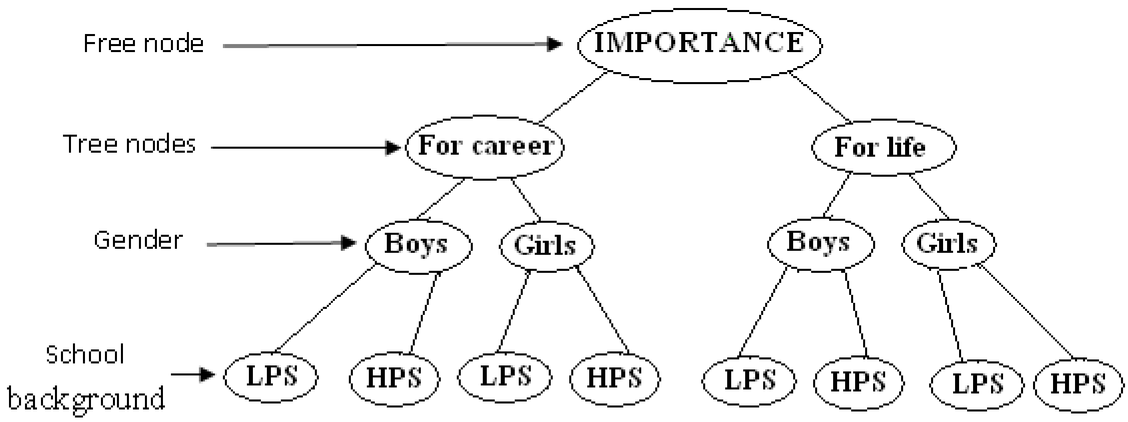
The transcribed data was then imported into NVivo 8 (QSR, 2007), a software programme developed by Qualitative Solutions and Research International (QSR). In NVivo 8*,* fragments of text, representing individuals‟ speech are ascribed to categories of responses contained in specific folders known as „nodes‟. Through these nodes it was easy to access specific responses, analyse, and present them in a variety of ways such as graphs and models. This software also enabled correlations between features to be easily identified and new data to be incorporated and analysed within an existing coding structure. The map of „nodes‟ could be traced and re-inspected. This improved objectivity and accountability in this study, because any other researcher could interrogate the data using the same nodes.

Transcriptions described above were imported into NVivo 8 as sources contained in different folders, namely School one, School two, School three, School four, School five and Teachers. The data was explored by querying the themes (factors) identified in chapter five as those having a major influence in students" attitudes towards and perceptions of design and technology. Queries were explored and results were saved as „free nodes" included the following perceptions about design and technology, which had already been identified through the quantitative analysis: Importance; Level of difficulty; and Resources.

The process of content analysis through NVivo 8 involved data reduction in which relevant information was gathered in the above „free nodes" to begin with. Free nodes contained coded information from the sources, which were yet to be organised. The coded information contained in „free nodes" was organised further into subcategories contained in „tree nodes". „Tree nodes" are an organised, compressed assembly of information that enabled one to draw conclusions, formulate hypothesis and represent findings in different forms, for example charts and tables.

Original transcriptions contained in source folders, and the discounted questionnaires were re-visited from time to time during interpretations (hypothesis) and conclusions for verification. This included searching for counter-examples. The whole procedure was carried out separately for focus groups with students and semi-structured interviews with teachers and other staff. Hence their results were reported separately in this chapter. Overarching themes were then synthesized in the final section discussing the key findings arising from the qualitative data.

The following data analysis model (figure 6.1) illustrates the processes involved in data analysis for this part of the study. At the initial stages of analysis extracts from the interview transcripts were categorized into the different themes as free nodes. The extracts contained in free nodes were then further subdivided into sub-themes contained in tree nodes, some free nodes were subdivided into two or three sub-themes tree nodes. Each of these tree node were further subdivided into further tree nodes such as those reflecting differences between boys and girls, also these were sub-divided to reflect differences in views from the different schools. The more the level of sub-themes the more the detail of data analysis and the better the interpretation of the results.



LPS = Low performing school
HPS = High performing school

Figure 6.1: Data analysis model.

The findings reported here, not only complimented the quantitative findings in terms of corroboration but also, provided graphic representations and in-depth understanding that would not have been achieved through the quantitative analysis alone.

6.2 Focus group interviews with students

The 47 participants for the focus group interviews with students were distributed between the five case study junior secondary schools (see Table 4.1 for details of the schools) as shown in figure 6.2.

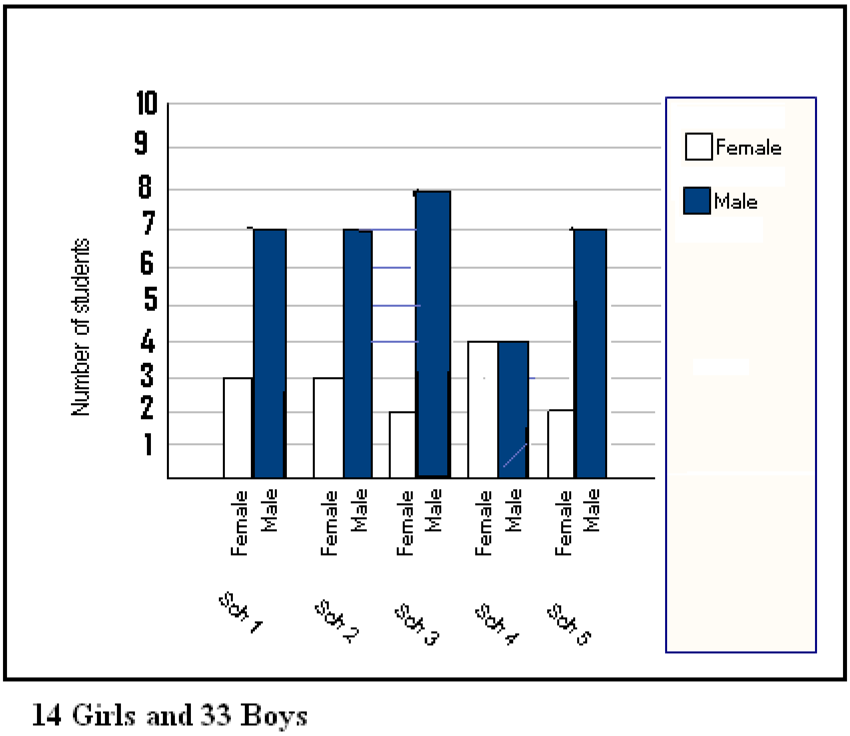


Figure 6.2: Numbers of focus group participants by gender and school.

6.2.1 Perceived importance of design and technology

The uptake of a curriculum subject, where there is choice as is the case with design and technology in Botswana depends not only on its availability, but most importantly, on students" perceptions about its importance. The results of the quantitative analysis reported in chapter five clearly highlighted the perceived importance of design and technology in the case study schools as a main factor (PCA 1) which divided opinions between students.

To explore this perception during the focus group interviews with students, two questions (see appendix 2) were asked. First, students were asked if they thought design and technology was important for their future career and for their life after school. Secondly, they were asked if they perceived design and technology to be as important as Mathematics, Science, and English, which are core (mandatory) curriculum subjects. The importance of design and technology for life referred to cases where students perceived the subject important for general life skills as opposed to career, in which case students considered it as a basis for their career prospects.

The majority of responses to the perceived importance of design and technology were positive. Out of the 47 participants, 32 indicated that design and technology was important and only five indicated that it was not important in any way. The results are discussed below as per the themes that were explored.

1) Design and technology important for career.

Ten out of the 32 sources who considered design and technology important were of the view that it was important for career. The knowledge of these ten students about careers available in design and technology seemed to be limited to career opportunities in the field of engineering and architecture, as indicated in the following comments:

> I think it‟s important for my career because I am interested in doing architecture. **(Pako / School 1)**
>
> Yes *nna* [me] I would say D&T is important for my career cause *nna* [me] what I basically want to be is a mining engineer and comparing engineering with D&T they are a lot of stuff in D&T that involve engineering, so it‟s in line with my career but with my life I don‟t think so. **(Rotlhe / School 1)**

Careers mentioned in particular, included aircraft engineering, mining engineering and architecture. Engineering was mentioned in six of the ten comments made, other careers mentioned, though not as much as engineering, were, teacher, electrician, and carpentry. Also some general comments about design and technology and engineering were made, even though they did not indicate a specific engineering field, for example:

> Yes it is so much important to me because it involves engineering. **(Tumelo / School 3)**
>
> D&T has got important careers like engineering, those are good careers. **(Mpho / School 2)**

This is an indication that perceptions of students concerning career prospects in design and technology were limited to the experience based or handicraft aspects. These perceptions are a result of the subject emphasis on competence, which only a few people need in order to do a job as technicians or engineers. Previous research, for example, in Wales (Hendley et al, 1996) discovered that design and technology was seen by very few as a route to a job. There is need to emphasise technological literacy in design and technology in schools because technological literacy is not limited to the experience based or handicraft aspects, which only a few people need in order to do a job as technicians or engineers. Technological literacy supports education for democracy in which students may see possibilities of an array of careers open for them. This indicates that students whose career prospects are not related to engineering and architecture would not find design and technology to be important for their future career and may not choose to study it. Although the perceived importance of design and technology for engineering and architecture careers was not gender related as both girls and boys expressed the same views, it is common that these careers are associated with masculinity. In which case, design and technology may also be associated with masculinity and therefore not attractive to girls.

An interesting finding was that none of these ten students who perceived design and technology important for career was from low performing school five, the only school selected from a village. Although school background did not emerge as major direct determinant in student attitudes and perceptions towards design and technology in the multivariate analysis, these results confirmed that it affected attitudes and perceptions about the importance of the subject for career. It is likely that students in village schools are less exposed to career opportunities in design and technology than those in urban centres such as Gaborone. Such students would likely be attracted to subjects that open up opportunities in careers they are exposed to, such as in agriculture, business, nursing, administration, and may not find design and technology attractive. Unless determined strategies are developed to expose such students to opportunities available outside their environment, in the area of design and technology, students in village schools are likely not to view design and technology as a subject with opportunities for employment and they would choose not to study it.

2) Design and technology important for life

Two thirds (22) of the 32 comments made about the perceived importance of design and technology were about its importance for life in general, rather than for a career. Typical comments made included the following:

> I think it is important for my future only because I apply it at home and in school. **(Gregory / School 3)**
>
> I think it"s important because in future you will not rely on others to fix this and that, you can fix it yourself. **(Joseph / School 2)**

Interestingly, these students perceived the importance of design and technology in the light of a subject that would impart in them skills to enable them to start craft businesses once they finished their junior secondary education and failed to proceed to senior secondary school, as indicated by the following statements made during the interviews.

> Yes I think it is important, it gives us skills to do most works like (pause), as you can fail form three you can do eeh! You can make a business like doing wardrobes. **(John / School 2)**
>
> I think Design and Technology is important in my life because when I fail form three I can do a workshop and do some products. **(Bright / School 5)**

There were two key perceptions held by these students about the importance of design and technology for life. Almost half (8) comments referred to the importance of design and technology to somebody who has failed form three, this is an indication that these students did not view the subject as an academic subject or as a subject for those hoping to go far with their education. Over half (11) comments referred to the importance of design and technology to enable one to make products and sell to make a living. This is an indication that these students perceived the subject as a practical craft subject. As it has been discussed in the literature chapter the vocational / practical nature of design and technology is the same reason why some students, especially those who view themselves as academically strong, do not want to study the subject.

The majority of students who perceived design and technology to be important for life were boys (20), only two girls perceived it as important for life. These boys perceived the importance of design and technology in the light of a craft subject suitable to empower the academically weak who might not proceed to senior secondary school. The majority of this perception was from low performing school five as indicated by the following comments from that school.

> Design and Technology is important because we can be able to produce some market stuff and earn some money. **(Gomolemo / School 5)**
>
> Design and Technology is very important in my life because I can produce goods for myself and sell to people. **(Mokgabo / School 5)**

The two girls, also from school 5 commented that:

> Design and Technology, it is important because it helps people maybe those who have failed to proceed in life. **(Portia / School 5)**
>
> Design and Technology is very important in our lives because for example when you have failed form three you can go out and make things for yourself. **(Josephine / School 5)**

It must be noted that low performing school five was the least performing among the five case study schools, confirming that school performance linked to gender affected perceptions about the importance of design and technology (PCA1, see fig 5.5 (a)).

For boys, design and technology has a strong reference to a valued social practice (Volman and ten Dam, 2007). It represents a realistic perspective in relation to activities which they already participated in, outside school. It was not surprising that boys would associate the importance of design and technology with its craft skills, which they already valued in their general life outside school. The evidence presented above may help explain why enrolment numbers are declining in design and technology. As a practical craft subject, design and technology does not serve the needs of most students. For example, those whose career prospects are not in line with engineering and architecture do not see it leading them anywhere in terms of career. Those who do not have a practical inclination, including most girls, will not be attracted to design and technology.

3) Tension between design and technology as core (official status) and design and technology as optional (as is practised).

While design and technology has officially been declared a core subject in the junior secondary school curriculum in Botswana, this never materialised in practice. So there is tension between design and technology as a core subject and design and technology as an optional subject. In exploring the views of students concerning the importance of the subject, I also wanted to find out what they thought about its importance when compared to other core subjects in the school curriculum.

Asked if they perceived design and technology to be as important as Mathematics, Science, and English, which are core (mandatory) curriculum subjects, more than half (27) students across the five case study schools, the majority of which were boys, indicated that it was just as important as these subjects. Typical comments included the following:

> I think D&T is as important as Maths, Science and English because it will help us in our everyday lives just as those subjects will. **(Queen / School 4)**
>
> No there are all important including D&T, D&T is as important as the other subjects as you mentioned because its related to my career, all of those subjects are related to my career. **(Boiki / School 4)**

Some perceived design and technology to be more important than these subjects. Two common reasons were given for perceiving design and technology to be just as important as mathematics, science, and english. See these comments below:

> *Nna* [me] I think it"s important because it contains all the three subjects and it also teaches us to be creative. **(Anita / School 1)**
>
> But on the other hand D&T if you just analyse and look at it, it involves all those subjects as well such as Maths, Science and English so I also think it is very very important. **(Queen / School 4)**

These comments, of which there were many in the focus group data, indicated that students were aware of the cross curricular nature of design and technology. This is one of the strengths of design and technology that has not been explored to the full advantage of the subject. Also, students made comments that suggested that they were aware of the advantage of design and technology over other subjects, such comments such as:

> OK. I feel D&T is better than those subjects because you can use D&T for your general life after finishing school or failing school. **(Lorato / School 4)**
>
> *You think it"s more important?* **(Researcher)**

> Yes. **(Lorato / School 4)**
> D&T is important than those subjects because if you have studied Maths and you fail Maths you cannot do something better than D&T.
> **(Mokgabo / School 5)**

According to these comments, design and technology offers something more than other subjects, since it is more applicable in real life after school than these other core subjects. Although Thato‟s comment below is not fully clear, it recognizes the importance of technological literacy over competence and academic knowledge. By talking about using technology as opposed to knowing maths and science, Thato‟s comment resonates with the theory that technological knowledge differs from scientific knowledge (Compton and Jones, 2004; Havice, 2006). But the evidence from the rest of the focus group interviews suggest that there is more of knowing (competence or experience based) as opposed to using, understanding and evaluation (technological literacy).

> *Nna* [me] I think it‟s far more important, why? because some of the skills we learn in Maths are also there like construction and if we look at the world today the development, it is more based on technology than manpower and if we use technology we will produce more in agriculture and many other sectors and then when we know Maths and Science only then we will have to use manpower and our brains. **(Thato/ School 2)**

4) Design and technology not important

Less than a quarter (8) students perceived design and technology to have no importance at all. Five of these students referred to the fact that there were not enough careers in the field of design and technology. Comments were made suggesting that graduates from other fields had better job opportunities than those with design and technology background. Typical comments included the following:

> No, it is not important because you cannot (pause) more jobs are based on Maths, Science and English it's not that important. **(Portia / School 5)**
>
> Design and Technology is not important because more jobs are want people who are pass Science and Maths. **(Bokani / School 5)**

The comment below suggested that design and technology was not important because it is not a necessary pre-requisite for further study and for university entrance as other subjects are. This is true even for design and technology courses. Candidates with credits in Science, Maths and English stand a better chance of being considered for a design and technology course at university than candidates with credits in design and technology but not in the other three core subjects. So the system values these other core subjects more than it does design and technology and this sends a strong message to students:

> I donʽt see D&T as important as other subjects like Maths, Science and English because D&T, if you fail these Maths, Science and English you won't go to form four. Like if you just pass D&T you canʽt go to form four or five at times, but if you pass these core subjects you can go. **(Joseph/ School 2)**

Joseph went on to give an example from his past experience, this is what he said:

> For example, right now there is a person who got Eʽs on these theory subjects then got A on art so he didnʽt go anywhere he is just home there. **(Joseph/ School 2)**

Other comments suggested that design and technology was perceived as a practical, and vocational subject and so students whose career prospects were not vocational did not consider it as important. For example these students commented that:

> I donʽt think itʽs important compared to Maths, English and stuff like that because some us want to be presenters, football players and stuff like that so we donʽt need D&T in our lives for us to like get to our goals. **(Joseph/ School 2)**

Figure 6.3 below indicated that overall, males were more positive about the importance of design and technology than their female counterparts. The percentage shown gives an indication of the number of boys and girls coded within each of the three sub categories of, design and technology important for: life, career, and just as important as other core subjects. These results corroborate with the results of the General Linear model which indicated that gender affected PCA1 significantly, suggesting males valued the practical/ craft aspect of design and technology and females believed this was less important and more adapted to boys.

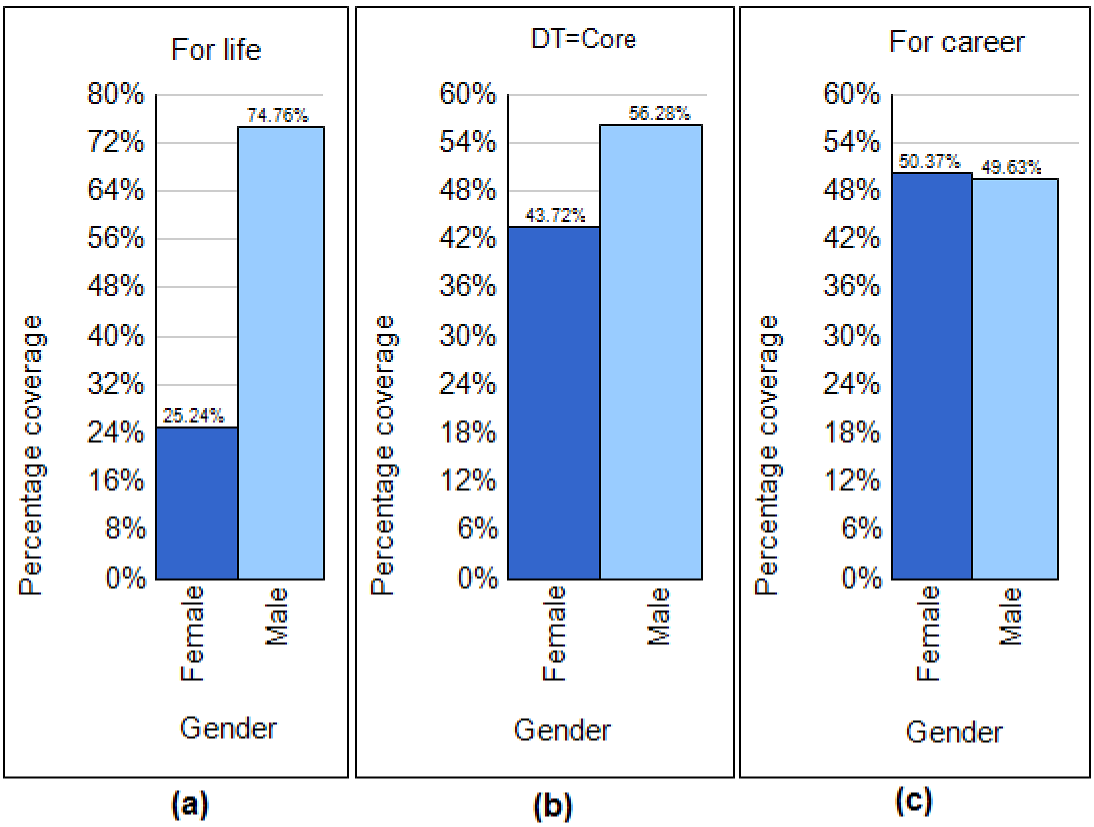


Figure 6.3: Perceived importance of design and technology - Coding by gender for: a). Life, b). Reasons of comparing it to core subjects, and c). Career.

Although girls might perceive design and technology as representing a realistic prospect in relation to future employment (figure 6.3(c)), they associated it with boys and masculinity. This is reflected in the gender bias in the subject uptake as indicated in table 2.4. Volman and ten Dam (2007, p. 858) observed that, because of the „liberal ideology" that everyone could choose for themselves, and that men and women were equal, this discouraged students from explicitly mentioning a relationship between the subject and gender. So it may not be surprising that all attitudinal groups (69% -91%) identified in chapter five disagreed or strongly disagreed that design and technology was a boys" subject. Gaotlhobogwe (2004) found that most girls in Botswana enrolled in design and technology for reasons including being forced to do it, being persuaded by teachers and friends and to prove that they were as capable as boys.

Generally, students perceived design and technology as an important subject for a variety of reasons, but there was a sizeable group (five of the 47 students interviewed, 3 out of the 104 discounted questionnaires, and 19% of students surveyed) who did not think that it was an important subject. Identifying this group of students with possible determinants to their attitude (figures 5.3 and 5.4) would be an effective way in which policy makers could begin to target particular groups in tackling the problem of declining numbers in design and technology. According to Volman and ten Dam (2007) when students appreciate technology, it is mainly because of the practical element that makes it different from other subjects, and this was confirmed during the focus group interviews as reported in the next section.

6.2.2 Enjoyment in design and technology

As a subject that is neither entirely vocational nor academic, design and technology has three major elements as discussed earlier in chapters two and three. There is the practical element, the design element and the theory element. There is evidence from various studies internationally that some of these elements impact upon the enjoyment of the subject by students. Enjoyment is also an influential aspect in the uptake of any curriculum subject and cannot be overlooked. To explore this aspect during the focus group interviews, students were asked if they enjoyed design and technology, and if there was any particular aspect that they enjoyed more than others. The aspect of enjoyment was explored also because it appeared to be affecting PCA2 negatively (-0.513).

Just over half of the students (25) said that they enjoyed design and technology and the practical aspect was the one they enjoyed the most. Twenty two sources of which 16 were boys and six were girls identified the practical as the most enjoyable aspect, followed by the design (portfolio) which was mentioned in six sources. Only one source mentioned the theory aspect.

1) <u>Enjoying practical</u>

More students across the case study schools indicated that they enjoyed the practical aspect of design and technology than they did the folio work. In high performing school four and low performing school five no student indicated that they enjoyed the folio work. In the majority of cases, enjoyment of the practical aspect of design and technology came as a result of satisfaction in using tools and machines to produce products. Some of the comments made included the following:

> I enjoy this subject because during practical times I enjoy using tools and materials, but with folio work it‟s very stressful with me because it‟s very difficult I don‟t (interrupted). **(Mary / School 1)**
> *You don't enjoy folio work?* **(Researcher)**
> Yes! **(Mary / School 1)**

> I enjoy practical because it helps us *gore dirisa ditools* [to use tools], *dilo ka bontsi bomachine jaana* [many things such as machines.] **(Peter / School 1)**

This confirms the findings by Volman and ten Dam (2007) and many others such Welch et al (2005), and has implications for the future of design and technology. Certainly, technological literacy emphasises less on the practical use of tools, materials and machinery, which on the other hand, is the main attraction to most of these students studying design and technology. Van Rensburg reported that girls in South Africa viewed boys as more competent at technology education and that this is a typical South African female value judgement which should be addressed, so that girls will have a more positive self-image (Van Rensburg, 1999, p. 149). This attitude may not be easily overcome in a craft-intensive design and technology.

2) Enjoying design (portfolio)

The few who indicated that they enjoyed the design aspect were those who did not like the practical because either they found the practical hard or they just did not like practical work. This is what some of the said:

> I enjoy folio better than practicals because I am bad at practicals. **(Anita/ School 1)**

> I would rather choose the folio work I hate practical work I don't like the saw dust, dirt that's what I hate. **(Mpho/ School 2)**

3. <u>Disliking design and technology</u>

A few interviewees in the focus groups(3 girls and 3 boys) indicated that they disliked design and technology and the reason given by most of these boys and girls was that there was too much work in the subject, as Bokani lamented in the quote below. David on the other hand (see comment below) indicated that he did not enjoy the subject because there was little practical work done. If there is too much work in design and technology (which students dislike), and there is little practical work done (which boys like), then the too much work the boys were lamenting about must be in the design (portfolio), or the theory. There was evidence that the majority of boys enjoyed the practical aspect and so if there was more of it the boys would not be complaining about too much work. The „too work" therefore refers to the design or portfolio work.

> I don"t like Design and Technology because there is a lot of work to do. **(Bokani / School 5)**
>
> *Nna* [me] I dont enjoy D&T because *ga re dire* practical *e ntsi re dira ga one fela mo ngwageng.* [I don"t enjoy D&T because we don"t do much practicals, we only do it once in a year]. **(David / School 1)**

A number of comments, from mostly girls, indicated that they did not like the practical aspect of design and technology as reflected in the following typical comments made by girls to show that they did not appreciate design and technology because of the practical aspect.

I donʽt like D&T and I donʽt enjoy it. **(Gloria/ School 3)**

Were you forced to do D&T? **(Researcher)**

Yes sir. I donʽt think it is important to my life or to my future. **(Gloria/ School 3)**

Um! D&T is not very difficult when you are dealing with the theory part of it but when you come to the practicals just thinking of something to create is difficult. **(Queen/ School 4)**

D&T is not good it gives us a hectic time and hard time to think about a lot of things and the practical work is really hard. **(Sephiwe/ School 4)**

I don't like Design and Technology and enjoy it because there is a lot of work is done. **(Josephine/ School 5)**

Mostly it is the practical aspect of design and technology that girls did not appreciate and, on the other hand, this is what boys appreciated. For example, while Josephine, a girl in school 5 thought design and technology was very important in life, she still did not like it nor enjoy it because it involved too much work. Mpho, quoted above, could not hide her strong feelings about disliking the saw dust and dirt associated with the practical aspect of design and technology. Volman and ten Dam (2007) also reported the same findings in their study in the Netherlands.

These results were consistent with the results of the General Linear model reported in chapter five, which indicated that males in low performing schools one, two and five and females in high performing schools three and four had a negative view of design and technology. In this case, students from the two low performing schools one and two in Gaborone, perceived design and technology to be important for career and not so much for life; and not a single student in low performing school five (a village school) perceived design and technology to be important for a career. Although school background did not emerge as major direct determinant in student attitudes and perceptions towards design and technology in the multivariate analysis, it was confirmed that it affected attitudes to and perceptions of the importance of the subject.

The results for enjoyment by gender and school indicated that design and technology was enjoyed more by boys in low performing schools than by girls. As indicated in the multivariate analysis in chapter five, perceptions of the folio work and practical work affected PCA2 and so during the focus group interviews students were asked if they enjoyed the folio work or the practical work or both.

When asked which aspect of design and technology they enjoyed most, 23 students (17 boys and six girls) indicated that they enjoyed the practical aspect of it while seven students (five boys and two girls) indicated that they enjoyed the design aspect (folio work). Considering the ratio of boys to girls who indicated that they enjoyed design and technology and the ratio of boys to girls who indicated that they enjoyed the practical aspect, it confirmed the GLM analysis reported in chapter five, which flagged gender as having a significant impact on PCA2. This suggested that females tended to perceive design and technology as a difficult subject, involving too much homework and little enjoyment.

6.2.3 Perceived level of difficulty of design and technology

Many studies, for example, Lyons (2005), have concluded that the perceived level of difficulty of a subject affects its uptake by students. Previous PATT studies (Meide, 1997; Bame et al, 1989; Boser et al, 1998) identified difficulty of technology as a factor that impacted upon pupils‟ attitudes towards technology. PCA2 (10.53% variance explained) discussed in chapter five reflected a shift from students viewing design and technology as a practical, problem-solving and enjoyable subject to those viewing it as a difficult subject demanding too much homework. To explore this perception, students were asked questions pertaining to level of difficulty of design and technology. Less than half (17) of the students indicated that design and technology was a difficult subject. However, the level of difficulty of design and technology was perceived differently between the practical work, the portfolio work, and the theory. Nine of these seventeen students said design and technology was difficult in portfolio work. Seven indicated that the practical work was difficult and only one indicated that the theory was difficult.

The majority (six) of these were from low performing school five and only one was from high performing school 3 (Fig 6.4). Although school performance was not found to affect PCA2, these results indicated that perceptions about the level of difficulty of design and technology between low performing schools and high performing schools were different. Students in high performing schools were more likely to perceive design and technology as not difficult in contrast to students from low performing schools.

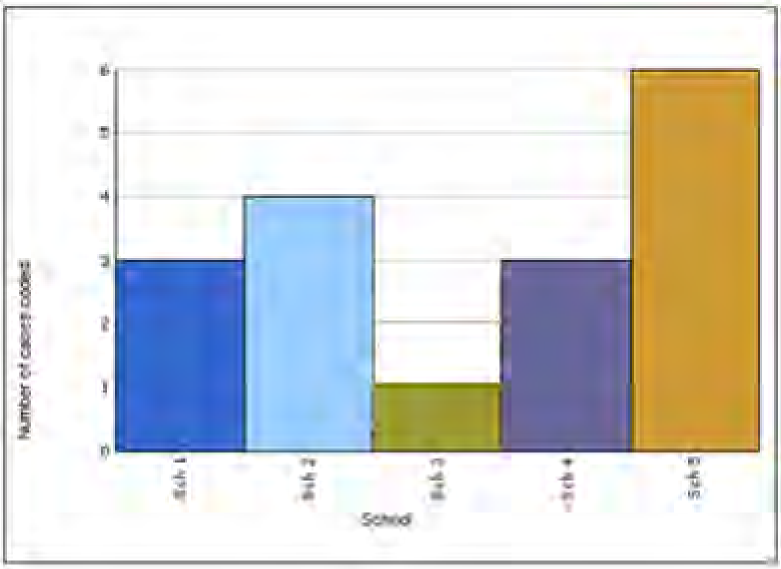


Figure 6.4: DT difficult - coding by School.

1) Level of difficulty in portfolio work

The majority of these students felt that design and technology was difficult because of the portfolio work, which they said was weighted more in terms of marks than the other aspects, i.e. the practical and the theory. The reason why the portfolio carried more marks is what Welch et al (2005) explained as the conversion of a portfolio as a record, into a portfolio as a product, the constraints of which are imposed by examining bodies. While the portfolio work carried more weight in terms of marks, these students indicated that their drawing skills were limited and that the amount of time allocated for this work was not sufficient. Welch et al (2005) reported the same finding that students who did not enjoy the portfolio were those who found drawing difficult. These are some of the comments that students made during the focus group interviews:

> Yes I think D&T is a difficult subject for some us who are challenged by not knowing how to draw and stuff, so it really affects our marks, so I think it is difficult and it needs a lot of practice. **(Lorraine / School 2)**
>
> D&T is very difficult when it comes to drawing and doing sketches it is very difficult. **(Gloria / School 3)**

John, who was not among those who perceived design and technology to be difficult, indicated that the working drawing, which is a part of the stages of „the design process", with allocated marks for satisfying assessment criteria, was the one posing a challenge to students. At the same time John indicates how important this working drawing is to those who were going to be „*plan-makers*"[17] and that this part takes more marks. Also, Lorraine commented above that the challenge of not knowing to draw affected their marks. Certainly not all

[17] architects

students doing design and technology want to be *plan-makers* and they may not understand why the working drawing is so important that it should be allocated more marks than other aspects that may be important to them.

> Students find working drawings difficult but it takes more marks and it can help us like when we grow up to be plan-makers. **(John / School 2)**

As indicated by Lorraine and Gloria above, generally girls perceived themselves as not able to draw and so if the drawing aspect of design and technology was allocated more marks, girls would view the subject as not for them, because they are disadvantaged. Arguing a similar case Van Rensburg et al (1999) observed that because of cultural and societal influence some aspects of technology may not be related to basic needs and interests of particular groups, in this case, girls. It would, therefore, seem inevitable that girls would rather study Food Technology than Electronics or Structures, for example (Van Rensburg et al, 1999, p. 148). Figure 6.5 below shows a comparison between the number of boys and girls coded in „*design and technology difficult*" and „*design and technology difficult in folio work*". As shown in the figure, almost all the girls who perceived design and technology difficult did so because of the portfolio work. On the other hand less than half of the boys associated the level of difficulty of design and technology with the portfolio work.

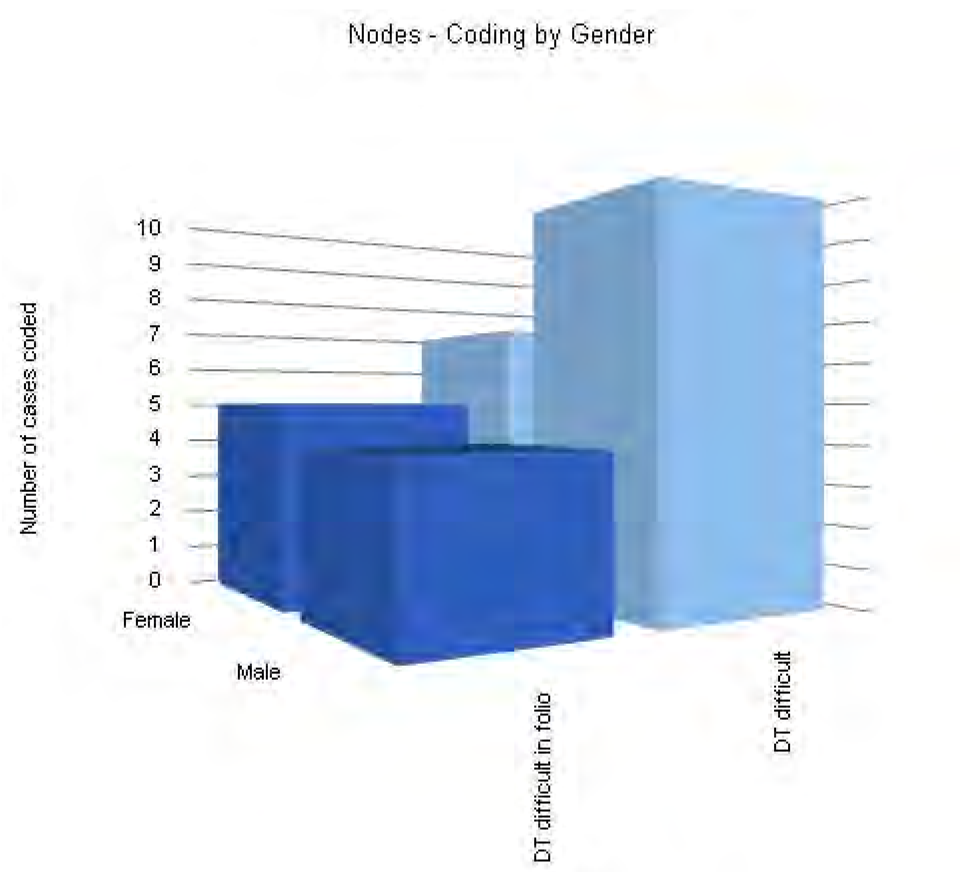


Figure 6.5: Association of level of difficulty of DT with portfolio work, coding by gender.

On the whole, ten boys, representing a third of the total number of boys indicated that design and technology was difficult. Seven, representing half of the total number of girls indicated that design and technology was difficult. The results confirmed those of the GLM analysis which indicated that gender affected PCA2. Further questioning to establish which aspect of design and technology was perceived to be difficult revealed that the folio work is the one posing a challenge to most students across the case study schools. The challenge that seemed prominent to girls in folio work was that they perceived themselves not able to draw well. The other challenge about it was that it involved too much work. These are some of the comments that students made about folio work:

> ….folio work its very stressful with me because it"s very difficult I don"t (interrupted). **(Mary/ School 1)**

> Design and Technology is very difficult when it comes to drawings and other stages to make when making a project. **(Bright / School 5)**

Welch et al (2005) reported the same finding in their study which revealed that students in England regarded the portfolio as a burden requiring the production of material that did little to enable the generation and development of ideas (p. 175). In their study, Welch et al (2005, p. 1) quoted the Office for Standards in Education in England as having noted that attainment in design and technology was often limited because students spent too much time on superficial work associated with the presentation of their portfolios at the expense of the main core of designing and making activities.

2) <u>Level of difficulty in practical work</u>

Seven students indicated that design and technology was difficult in practical work, and in the majority of comments, they cited shortage of tools and materials as the reason why they perceived the practical work to be difficult. This perception came from two schools only, three students from high performing school four and four students from low performing school five perceived the practical aspect of design and technology to be difficult. Unlike in the case of portfolio work, in which case students associated the level of difficulty with their inability to draw and the amount of work involved, in the case of practical work, the problem was with shortage of tools and materials, as indicated in the comments below.

> Design and Technology it is difficult when it comes to making projects there could be shortage of material. Then we take a lot of time waiting for materials to be brought to school. **(Mokgabo / School 5)**
>
> Design and Technology is difficult on the project because sometimes there is a shortage of material so we must spend a lot of time waiting for the material to be brought in the school. **(Gomolemo / School 5)**

Ngwako, a boy from high performing school four made two important points about lack of tools and materials. In his first comment below he indicated that lack of tools and materials takes a lot of time, meaning that they waste time queuing for tools or waiting for materials to be made available. In the second comment below he indicated that due to shortage of tools, they end up using alternative tools or improvising, which impacted negatively in their performance in the theory examinations. For example, because of this problem it is common to find students using files[18] to waste wood in junior secondary schools in Botswana. While this practice may work fine practically, theoretically it is wrong to file wood, so if students write that they use files on wood in a theory examination they are marked down.

> . . . the problem is the practical, due to lack of tools and other materials it makes it kind of difficult and takes a lot of time so I have a problem with that. **(Ngwako / School 4)**
>
> Yes it"s difficult because the problem is there is lack tools. *Ke gore* [it"s like] it"s sort of like we use alternatives. Due to lack of tools but then when exam comes you know gore I used this tool for my project and when you write it down you find *gore* [that] you get it wrong but there is a special tool for that. **(Ngwako / School 4)**

In figure 6.6 below a comparison between the number of boys and girls coded in „*design and technology difficult"* and „*design and technology difficult in projects* (practical work) indicates that about half of the girls who perceived that design and technology was difficult, did so because of the practical work. On the other hand, less than half of the boys who perceived that design and technology was difficult, did so because of the practical work.

[18] A file is a rough surfaced blade tool with a handle. It is used to cut fine amounts of material from a workpiece.

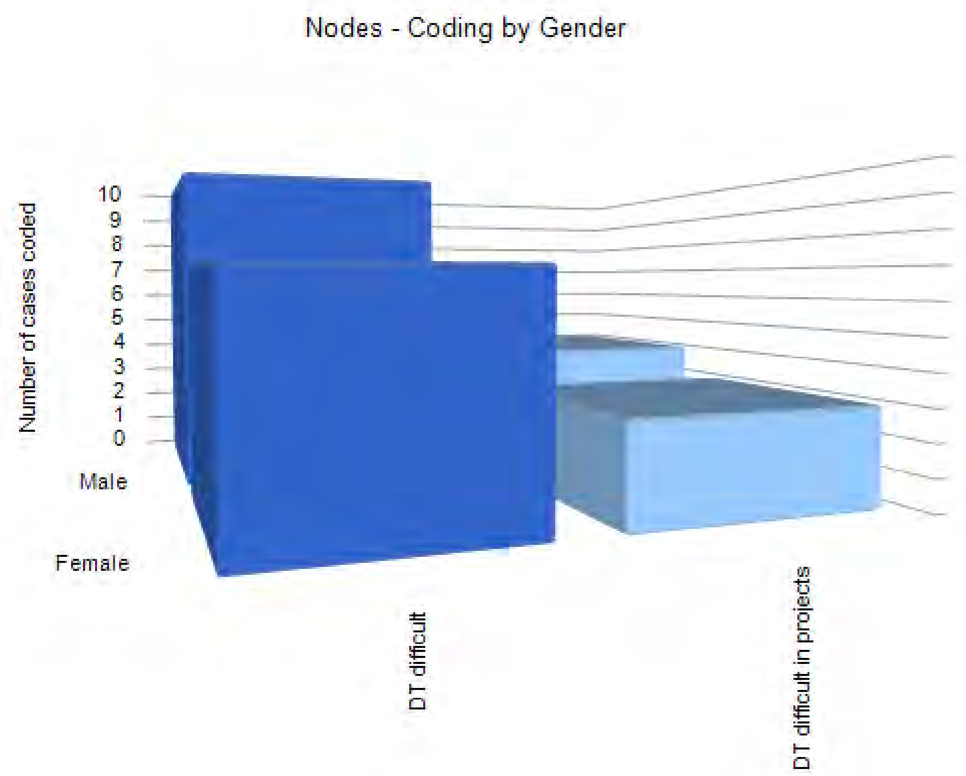


Figure 6.6: Association of level of difficulty of DT with practical work, coding by gender.

Considering the findings for level of difficulty in portfolio work and level of difficulty in practical work, it is clear that girls are the most affected. This helps to explain the low enrolment of girls in design and technology.

Only one student from low performing school 5 indicated that design and technology was difficult in theory.

3) <u>Design and technology not difficult</u>

Nineteen students across four case study schools, as shown in figure 6.7 perceived design and technology to be not difficult and none of these students came from low performing school five. Coding by gender revealed that 15 boys, nearly half of the total boys in the focus groups perceived design and technology not to be difficult as opposed to 11, representing a third of the boys who indicated that it was difficult. This means that more boys found design and technology easy rather than difficult. On the other hand, four girls representing around a quarter of the total girls in the focus groups perceived design and technology not to be difficult as opposed to six, representing half of the girls who indicated that it was difficult. This means that more girls found design and technology difficult rather than easy. The same findings were reported by Boser et al (1998) who observed that girls in all the technology education approaches in the USA believed that technology was a difficult subject.

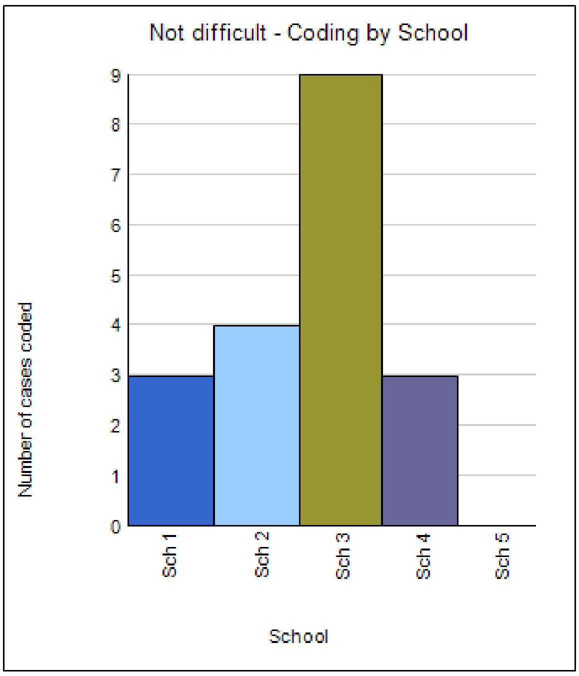


Figure 6.7: DT not difficult - coding by School (Source: designed by the author)

Two typical comments below indicated that design and technology was perceived to be not difficult because it dealt with everyday life situations

> Yes D&T is not a difficult subject because it needs your application whether you know most of the things you see at home and apply it when you write so I don't think is a difficult subject. **(Dumang / School 3)**
>
> *Ke tseela gore D&T gase subject e thata ka gore go thoka (pause) ke dilo tse re di dirang tsatsi le tsatsi mo botshelong a rona.* [I take it that D&T is not a difficult subject because it needs (pause) it‟s about our everyday life]. **(Bakang / School 1)**

6.2.4 Resource constraints

PCA3 underlined the perception that „In design and technology I enjoy folio work‟ (0.513) and it also underlined the perception that „There are enough design and technology workbenches‟ (0.506). During the focus group interviews it transpired that the issue of resources was more pressing than that of enjoying folio work. In fact, the issue of resources was found to be impacting on the overall attitudes and perceptions of students towards design and technology. Availability of materials, tools and other equipment also affected students‟ enjoyment and perceived level of difficulty of design and technology, as reflected in the following typical comments:

> Yes it‟s difficult because the problem is there is lack of tools. **(Ngwako / School 4)**
>
> I think it's a great subject but I am not happy with a lot of things in our school such as shortage of materials and tools. **(Robert / School 1)**

As discussed in chapter two, resources in design and technology include tools, equipment, machinery, materials, workshops and other specialist rooms. Resource constraints include shortage of resources as well as poor or insufficient maintenance of such resources.

1) <u>Shortage of tools</u>

Asked if they had enough tools and equipment in their schools, 33 students out 47 indicated that there was shortage of resources in design and technology. Shortage of tools was the most coded at 30 of the 33 comments indicating that there was lack of resources. There was an indication also that some of the tools available were not safe to use due to poor or insufficient maintenance, for example, two students commented that:

> Even the tools which are there, some of them are just not safe to use even though we just use them. **(Anita / School 1)**

> *Gape* [again] the other problem with the tools, you will find *gore* [that] some parts of them are missing, like take for example a Hacksaw, you find *gore* [that] we have to sacrifice and use another tool instead of it, just because there is no blade and sometime we use wrong tools for a certain job. **(Rotlhe / School 1)**

The problem of shortage of tools was spread across the five case study junior secondary schools as shown in figure 6.8 below.

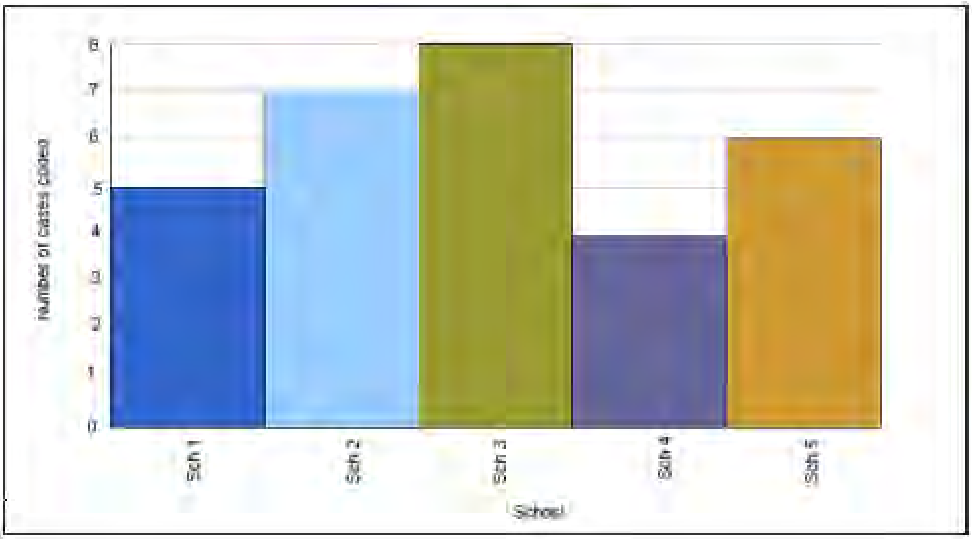


Figure 6.8: Shortage of tools – coding by school.

2) Shortage of equipment and machinery

The next most coded after shortage of tools was shortage of equipment and other machinery in design and technology. Unlike shortage of tools, shortage of equipment and machinery was not spread across the case study schools. Figure 6. 9 below show that low performing village school five was the most affected by this problem.

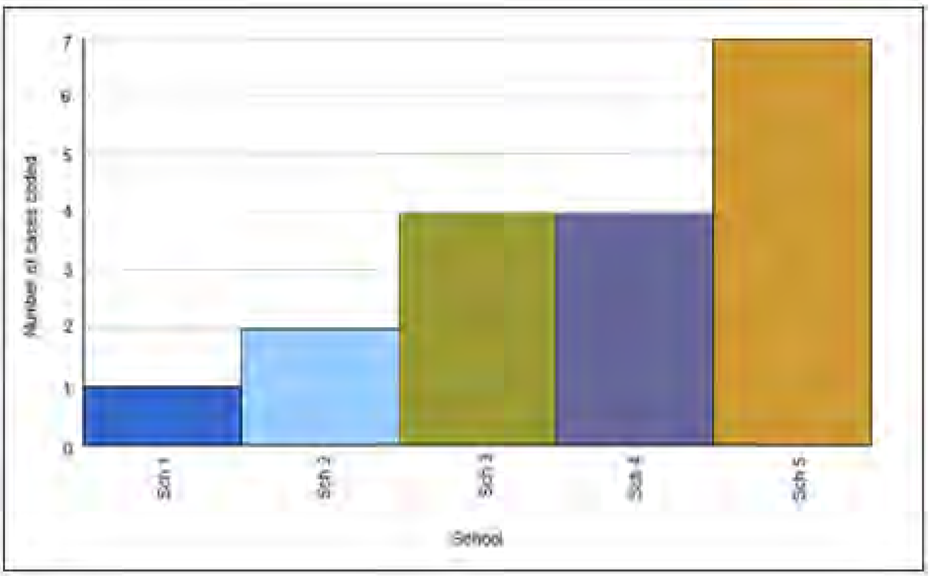


Figure 6.9: Shortage of equipment and machinery – coding by school.

These results seem to suggest that case study schools one and two, in Gaborone, the capital city were the least affected. This could be explained by the location of the schools, as the senior teacher in the case study school five in a village explained in the comment that:

> There is shortage of equipment, even the facilities just there is not enough because even the teachers are always saying *kana* we could be doing this but there is no this „you see" so there is a shortage of tools. **(Senior teacher 1 / school 5)**

When asked why there was shortage of equipment and other facilities as she affirmed, she continued to say:

> Sometimes it"s the procedure of getting the tools „you know" when the teachers want to buy, purchase tools they will be told to get five quotations whereas the suppliers are not even five and then where do they get the quotations? It"s a hassle really to buy. **(Senior teacher 1 / school 5)**

According to this explanation from senior teacher 1 / school 5, even when funding is available, in areas where there are no suppliers of design and technology equipment, tools and materials such as in villages, the procurement procedure of having to get five quotations makes it impossible to purchase equipment and other things. The only other way to make purchases would be to rely on suppliers from urban centres, in which case it may be a lengthy process. These two comments made during the focus group interviews confirm this problem:

> Design and Technology it is difficult when it comes to making projects there could be shortage of material. Then we take a lot of time waiting for materials to be brought to school. **(Mokgabo / School 5)**
>
> There is shortage of materials in the school like right now we are waiting for a welding machine but the project will soon be collected like on Friday. There will be collecting of projects but we haven‟t started welding yet. **(Alfa / School 5)**

3) Shortage of materials

Shortage of materials was the least coded, at six of the 33 comments indicating that there was lack of resources. Interestingly, none of this perception came from the two high performing schools three and four as indicated in figure 6.10. Although shortage of materials was only mentioned in six comments, in each of these six cases it was mentioned in conjunction with shortage of tools or shortage of equipment. This suggests that shortage of materials is not as bad as shortage of tools and equipment, possible because materials do not need regular maintenance and servicing as would be tools and equipment.

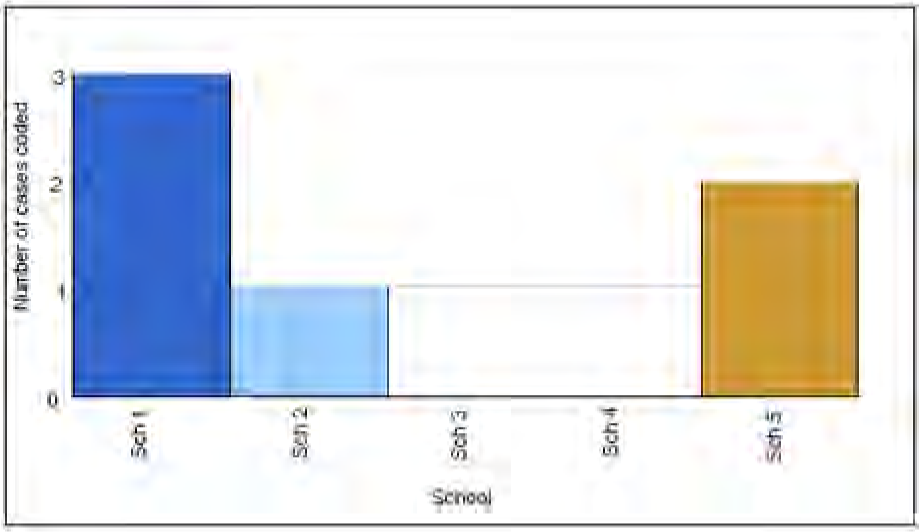


Figure 6.10: Shortage of materials – coding by school.

These results confirmed the results of the questionnaire analysis which indicated that all attitude groups discussed in chapter five and 82 to 87 of the discounted respondents disagreed or strongly disagreed with the assertion that there were enough resources for design and technology available: 71 to 91% thought there were insufficient tools, 76 to 88% insufficient workbenches. This perception was prevalent across the five case study schools as shown in figure 6.11 below.

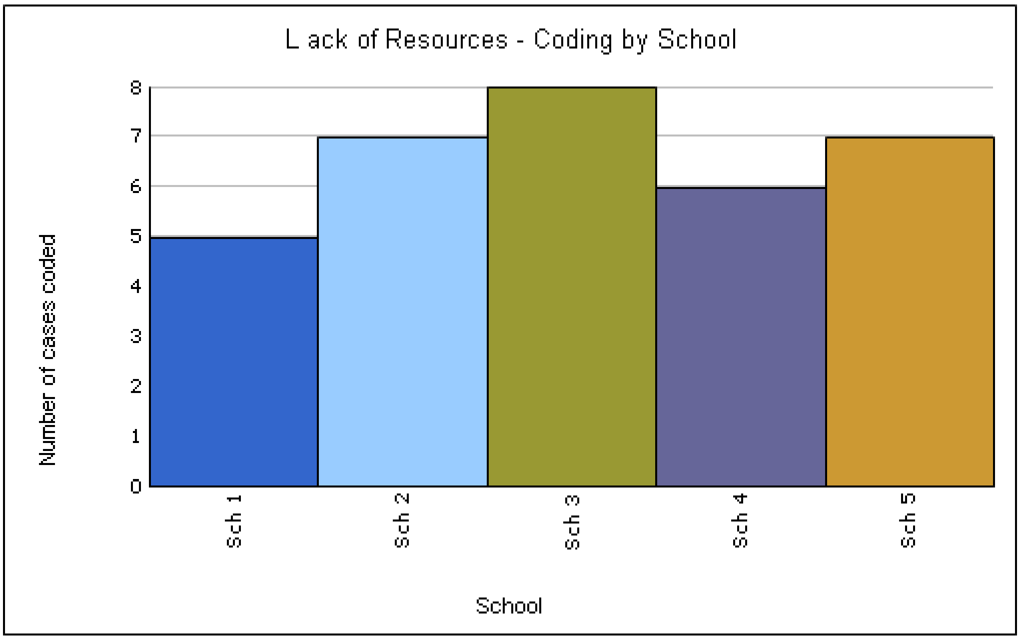


Figure 6.11: Students‟ perception about lack of resources – coding by school.

Although the General Linear model (fig 5.5 (c)) indicated that school performance affected PCA3 significantly as would be expected, with high performing schools more associated with the attitude "There are enough DT tools in my school" than low performing schools, the results of the focus group interviews did not confirm this, nor did the results of the discounted questionnaires. According to figure 6.9, lack of resources was highlighted across all the case study schools regardless of school performance. In fact, eight out of ten students in high performing school three, and six out of eight students in high performing school four, associated their schools with this attitude. Five out of ten students in low performing school one, seven out of ten students in low performing school two, and seven out of nine students in low performing school five associated their schools with this attitude. However, the results of shortage of materials confirmed the results of the General Linear model (fig 5.5 (c)).

The lack of resources has been associated with other attitudes such as enjoying the subject, interest, level of difficulty and performance of students. Some comments made related to the fact that finishing tasks or projects took too long as students had to queue for tools and other machinery, resulting in poorly finished or unfinished work.

> I also enjoy D&T but the problem is the practical, due to lack of tools and other materials it makes it kind of difficult and takes a lot of time so I have a problem with that. **(Ngwako/ School 4)**
>
> Design and Technology is difficult on the project because sometimes there is a shortage of material so we must spend a lot of time waiting for the material to be brought in the school. **(Gomolemo/ School 5)**

6.2.5 Tackling declining enrolments in design and technology: student‟s views.

Students were not necessarily asked any questions regarding declining enrolments in design and technology. However, majority of response to question three of the questionnaire indicated that majority of them were not in support of the idea that design and technology should be made a core subject. During the focus group interviews, only one student made a comment in support of that recommendation:

> I think the idea of the government trying to create Design and Technology into a core subject is a very good idea because if you look at the students in the school they don‟t know how to create, they don't have that ability to imagine things or create new things. So I think that if the government makes D&T into a core subject, I think that uhm! People would have a better life, sort of. **(Queen / School 4)**

Some students, however, made important comments that could be useful in tackling the problem of declining enrolments. The following comments indicated that, because design and technology had not been offered at primary school level in Botswana, students did not have any background in it when they came to junior secondary school, and therefore were either not performing well or were not eager to study it in junior secondary school.

> *Nna* [me] I think for the betterment of D&T . . . we could start D&T at primary level for us to get more, for us to have something so that when we go to the secondary education we can have more experience. **(Mike / School 2)**

This student continued to say:

> . . . like we know that, social studies, things like sciences, we have learned them from primary that"s why we are better on theory rather than D&T. **(Mike / School 2)**

Another student raised the same concern about the exclusion of design and technology at primary school level, and this student speculates that government takes the subject lightly.

> . . . in Botswana we are only doing D&T when we are in junior schools not in primary. I am thinking that sometimes the government thinks that D&T does not need much to educate students. **(Ebo / School 2)**

These students raised important concerns that have been raised before. For example, Maolosi and Molwane (2007) made the same observation, that the exclusion of design and technology in primary schools in Botswana, prior to 2002, made technology education foundation very weak. In 2002, CAPA was introduced in primary schools, with the hope that it will impact positively upon attitudes of pupils towards creative and performing arts subjects, which includes aspects of design and technology. While the introduction of CAPA in primary schools is a positive step in tackling the problem of declining enrolments in design and technology, there has been pessimistic views about the structure and management of the subject (Gaotlhobogwe and Mannathoko, 2009; Mannathoko, 2009).

6.3 Semi-structured interviews with school staff

Twenty two semi- structured interviews were conducted with twenty one staff from across the case study schools and one official from the Ministry of Education and Skills Development (see table 4.3 and 6.1 for details). The interviews were conducted after the focus groups, to establish the views of staff concerning issues of concern raised during the focus groups.

Table 6.1: Casebook for the semi-structured interviews.

	Staff	School	Gender	Age
1	Teacher 1	1	Male	31 - 40
2	Teacher 2	2	Male	21 - 30
3	Teacher 3	2	Male	31 -40
4	Teacher 5	5	Female	31 -40
5	Teacher 6	5	Male	21 - 30
6	Teacher 7	5	Male	21 -30
7	Teacher 8	4	Male	21 -30
8	Teacher 9	4	Male	21 -30
9	Teacher 10	4	Male	21 -30
10	Teacher 11	3	Male	21 -30
11	Teacher 12	5	Male	31 -40
12	S/ Teacher 1	5	Female	41 -50
13	S/ Teacher 2	4	Male	31 -40
14	S/ Teacher 3	3	Female	31 -40
15	S/ Teacher 4	1	Male	31 -40
16	S/ Teacher 5	2	Male	31 -40
17	D/ Schoolhead 1	5	Male	51 -60
18	D/ Schoolhead 2	4	Male	41 -50
19	D/ Schoolhead 3	3	Female	51 -60
20	Schoolhead 1	1	Female	41 -50
21	Schoolhead 2	2	Male	51 -60
22	MO		Male	41 -50

Details about the number of staff interviewed per school, their gender and their age are provided in table 6.1. Of all the twenty two staff interviewed, twelve were teachers of design and technology and only one of these was a female. The five senior teachers interviewed were responsible for practical subjects in their schools, which includes design and technology. Two of these senior teachers were males with a design and technology background, one male with an art and design background, one female with a home economics background and one female with a business studies background. Three deputy head teachers were interviewed, two males and one female. The deputy school head from case study school three was from a science background. The background of the other two deputy school heads could not be established. These backgrounds were important indicators of how supportive these staff were to design and technology, as one teacher commented during the interviews that poor performance of design and technology in junior secondary schools was a administrative problem, because:

> There are no proper structures for example if we can calculate the number of junior secondary schools across the country you are going to realise that there is a few about five percent at the most of the teachers who did woodwork technical studies or DT who are part of the administration so the support system for the subject is not adequate. And that's why maybe we still have a problem with for an example the vote for the tools, so until we have such, maybe that's when the turnaround can be experienced. **(Teacher 3 / School 2)**

For example, one of the deputy school heads was not aware of the decline of enrolment numbers in design and technology. When the purpose of the study was explained to her to sign the consent form, she was unaware of the problem, in fact she denied that there was such a problem until the teacher of design and technology in her school acknowledged that this was a problem they were facing. The unawareness of the deputy school head about what was happening in her school design and technology was a sign that the subject was not an area that she had an interest in. On the other hand, the deputy school head from case study school three, knew quite a lot about design and technology because he had interest in the subject.

Semi-structured interviews were conducted to complement the findings of the focus group analysis by providing an in-depth understanding of the factors established during the quantitative analysis from the point of view of staff responsible for design and technology. It was also hoped that the use of both focus groups and semi-structured interviews would add to the rigor necessary in appraising students‟ attitudes in design and technology. Teachers and other staff responsible for the subject in the case study schools were a valuable source of information that helped to cross check with findings from the focus group interviews.

Teachers and other staff interviewed were asked to give their opinions about students‟ attitude towards and perceptions of design and technology in their schools with regard to the same issues that were explored during the focus group interviews (see appendix 3).

6.3.1 Students‟ attitude towards design and technology: teachers views

1) <u>General attitudes</u>

According to teachers and other staff interviewed, students‟ attitude towards design and technology were generally negative. The teachers and other staff were asked if students perceived design and technology to be an important subject, and if students liked or enjoyed design and technology. The majority of these teachers and other staff expressed the view that they struggled to convince students to take up the subject, as indicated in the following typical comments:

> We have seen that a lot of them were not that very keen, they wanted to go to the other options, even though the idea was to have as many of them doing D&T at form one level but because of the attitude they are getting from their brothers and sisters they are not having a lot of interest. **(Deputy School head 1 / school 5)**
>
> . . . they seem not to like it. Some parents also discourage them. It appears parents have a bit of knowledge about DT or they have some myth about DT. **(Senior teacher 5 / school 2)**

These two comments suggested that the general attitude of society towards design and technology was negative and so students are influenced against the subject by their parents and siblings. Similar views about the negative attitude towards design and technology by the general public were expressed by the official from the Ministry of Education and Skills Development, who said:

> The general view I would say from students, people, the public at large, even the parents they don‟t like the subject, they say we don‟t like that subject and *nna* [me] I believe that they don‟t understand what it can do and it has many implications because it depends on how the subject is taught, the resources and all that stuff, they come into it.

In trying to explain why people were negative about the subject, the official from the Ministry of Education and Skills Development made three interesting points below. It must be noted that the official from the Ministry of Education and Skills Development was informed about what was happening in the schools through school inspection reports. Unfortunately, these reports could not be accessed or used in this study because they were confidential.

First, he made the point that people did not understand the value of design and technology. This is troubling, considering that design and technology has been in the junior secondary school curriculum for two decades. In fact, as discussed in chapter two, during its early stages in the school curriculum, when people did not understand much about the subject, there was much expectation but the subject did not live up to the people‟s expectations. Secondly, the official from the Ministry of Education and Skills Development said that attitudes towards design and technology depend on the how the subject is taught and this has to be addressed to change the negative attitudes. Thirdly, he said that attitudes towards the subject depend on resources. This point resonates with the findings from the focus group interviews, which indicated that shortage of resources impacted on the general attitudes towards and perceptions of design and technology.

Most teachers expressed the view that students‟ perception about design and technology was that it was a difficult subject. There were comments such as these two below suggesting that there was too much work in the subject, which alienates students.

> . . . they feel they are doing this woodwork but when they come over here the folio part of it *tota* [really] it makes them to dislike the subject. For the past two years I have seen that now they dislike the subject in a way, so in a way it‟s like we are forcing them into it. **(Teacher 7)**

> . . . they think it‟s too difficult for them. It‟s too difficult and also there is a lot of work, this thing *ya* [of] *di*projects, it‟s a lot of work, it‟s taxing for them. Because they always see others running around during the third year, especially form threes will be running around with projects, with that, coming to school on weekends and this is what is maybe making them draw back. **(Senior teacher 1 / school 5)**

Three staff said that attitudes of students were positive, and only one said that attitudes were equally divided. The official from the Ministry of Education and Skills Development also said that students who were doing well in design and technology liked it and perceived it as an important subject. It could be said that this assumed that doing well in a subject is a result of perceiving the subject to be important, but the results from the focus group interviews contradicted this opinion. Although case study schools three and four were high performing schools, they had few students who were more positive about design and technology than those in low performing schools.

Similar views to that of the official from the Ministry of Education and Skills Development were expressed by the three staff whose views seemed to suggest that students‟‟ attitudes to design and technology were positive. This is what they said:

> I think only a few of them do not like the subject. Why I‟m saying this simply because we had to follow about six students who did not complete their projects this year and that really shows lack of interest on their part. I wouldn‟t say it‟s a majority of them because those who have done the project, it shows they are interested in the subject. (**School Head 1/ School 1**)

In the comment above the school head one thought only a few students did not like design and technology because they (staff) had to follow six students who did not complete their projects, while the majority had done their projects. The project is part of the examination and students would do it, regardless of whether they liked the subject or not, because they wanted to pass. The results of focus group interviews in school one contradicted this opinion that only a few students in this school did not like the subject.

> I think they have interest in DT as you find that most of the time students are out there in the lab they are spending most of their time in their lab, I think they like it. (**Senior teacher 3/ School 3**)

The second comment also suggested that, because students spent most of their time in the design and technology laboratory, this was a sign that they liked the subject, but the findings showed that this was impacting negatively on students‟ attitudes towards the subject. Of the thirty two students in school three who completed the questionnaire, twenty five of them agreed or strongly agreed that there was „too much to do in too little time in design and technology‟. Twenty seven agreed or strongly agreed that „design and technology involved too much work in folio work, practical work or problem-solving‟. Twenty one agreed or strongly agreed that „homework and or after school work in design and technology took too much of their time‟. So spending most of the time in the design and technology laboratory could not be attributed to their liking the subject. It is clearly because of the fact that there was too much to do in the subject and that they were attempting to complete their tasks.

> In my opinion most of the students they do enjoy DT in the sense that apart from Agriculture it is the only other subject that is practical . . . and as I have realised DT has got a lot of (Pause) the subject has been theoretised, that‟s why I am saying that the students do have the interest but the practical application is less than the theoretical part. (**Teacher 1/ School 1**)

The third comment above seemed to suggest that students enjoyed design and technology because it was a practical subject, which was consistent with most views expressed during the focus group interviews and the literature reviewed, that students appreciated design and technology for its unique aspects that other subjects did not provide. The same teacher, who commented that students enjoyed design and technology because it was a practical subject, went on to say that the subject has been „theoretised" and that the practical application was less than the theoretical part. Most students indicated that they enjoyed the practical aspect of design and technology, and so, if the practical application was less, then most students would not enjoy the subject.

One teacher seemed to suggest that attitudes and perceptions of student towards design and technology were equally divided between those appreciating the subject and those who did not, but when prompted further, his statement changed, as can be seen in the interview extract below:

> OK. They are some, some of them see it as important and some of them does not, some of them enjoy it, some of them don"t. (**Teacher 10 /School 4**)
>
> Would you say most of them enjoy it or most of them don"t or is it fifty-fifty? (**Researcher**)
>
> Mostly boys are the ones who seem to enjoy it, but girls are not interested. (**Teacher 10 /School 4**)
>
> OK. When they come in and they have to opt for option subjects don"t you struggle to get students to do Design and Technology? (**Researcher**)
>
> Yes we do struggle to the point that we end up forcing some. Because *akere* [isn"t] they have to do the options so you find that most of them they go for *bo*H.E (Home Economics), *bo*Business Studies and those choosing DT you will find that there are just a small number then you have to take some from *bo*H.E, *bo*Business Studies so that we can balance, at least we have some students. (**Teacher 10 /School 4**)

These results corroborated with the results of the focus group interviews and they were consistent with the results of the multivariate analysis in chapter five. While a few students did not perceive design and technology as important, most did not take it up. So their reasons for not taking up the subject could not be attributed to their perception of its importance alone, but also to the nature of the subject and to gender-related reasons, as expressed in the following typical comments from teachers and other staff.

> Well they take it to be a difficult subject where most of the time you got to struggle through the processes and other things, hence they feel that it is really demanding and it‟s taking their time. (**Teacher 12 /School 5**)
>
> So here it‟s like mostly the girls don‟t like DT. They feel it‟s a difficult subject and it‟s more of using muscles than brain so they feel it‟s for boys only. (**Teacher 2 /School 2**)
>
> You see the boys I think they are the ones that shows much interest. I don‟t know maybe it's because they are using their hands when they do the project or what. Because some of the girls but some girls they don‟t have a problem, but some it's like they are not interested, even when it comes to the projects you see that the way they are doing the projects is not that they don‟t know how to do it, it's like they don‟t have interest in it. (**Teacher 6 /School 5**)

The views of the teachers and other staff interviewed about students attitudes towards and perceptions of design and technology are consistent with what is reported in the literature from elsewhere (Mottier, 1999; Neale, 2003; Van Rensburg et al, 1999). Interviews with teachers and other staff confirmed that level of difficulty, amount of work and resource constraints were some of the factors leading to the negative attitudes towards design and technology.

2) Level of difficulty

One of the factors leading to the negative attitudes of students towards design and technology was the perceived level of difficulty of the subject by students. According to the teachers and other staff interviewed, the perceived level of difficulty of design and technology by junior secondary school students was linked not to the subject content or students‟ aptitude per se, but to several things, including the amount of work involved in the subject; inadequate preparation of the teachers; and non existence of the subject at the primary school level.

Most of the teachers and other staff acknowledged that students perceived design and technology to be a difficult subject, because of the amount of work involved, as implied in the following comments.

> Generally the students‟ perception about D&T is that is a very very tough subject. As a result they end up not choosing it. We end up just putting it there as an option for students to take it and because we want to fill the gap so that at the end of the day somebody must be doing it. That is why we have some students doing it, but generally they don‟t like it, they perceive it as a tough subject. (**Senior teacher 4 / School 1**)
>
> They think it‟s a lot of job[19] which require a lot of time. (**Teacher 11 / School 3)**
>
> Well they take it to be a difficult subject where most of the time you got to struggle through the processes and other things, hence they feel that it is really demanding and it‟s taking their time. (**Teacher 12 / School 5)**

The teachers themselves agreed that there was too much work involved in the subject, as one teacher observed that for students to finish:

[19] In Setswana, a local language in Botswana, job and work is considered to be the same thing, referred to as „tiro‟. So by saying „they think it‟s a lot of job‟ this teacher meant that „they thought it was a lot of work‟.

> . . . you will need to come in the afternoons, you will need to come here Saturdays, Sundays so that those who are behind catch up. (**Teacher 3 / School 2)**
> . . . but it needs a lot of effort on the side of the teacher extra times, afternoons, so that we can cover up. (**Teacher 3 / School 2)**

The problem of too much work is a result of the amalgamation of specialist areas embraced in the subject of design and technology, such areas as woodwork, metalwork, technical drawing, that were traditionally separate subjects. Also included in the new subject of design and technology were areas such mechanisms, structures, electronics, and design. Hendley and Lyle (1996) reported similar managerial and educational issues arising from the same problem in design and technology in Wales during the early years of its introduction. Toft in Barlex (2007) also observed that the combination of different aspects made design and technology more complex to learn. According to him:

> In a class of twenty students, each wanting to make something different yet each needing to learn new making techniques and technological knowledge before they do so, it is easy to lose of sight of the value pre-planned class teaching to cover knowledge and skills efficiently and to make the most efficient use of scarce time (Barlex, 2007, p. 284).

One teacher acknowledged that design and technology:

> . . . has got a lot of information which to some students it‟s not easy to remember and as it is, it makes students to believe that DT is difficult. (**Teacher 1 / School 1)**

According to this teacher, they have to rush through the syllabus to finish it because:

> If they do not finish the syllabus they have to account why they were not able to cover certain topics and some of this certain topics what they normally do is they teach theory. And theory without practical in DT (Pause) you are really not doing the students any good. (**Teacher 1 / School 1)**

During the focus group interviews with students there was mention of deficiency in coverage of knowledge and skills by teachers, as Joseph commented:

> . . . they don't teach us about these tools we have to learn them ourselves so when they come out in the test we don't know their names and stuff like that, so we end up writing the wrong names and end up failing. **(Joseph / School 2)**

> *Nna* [me] I think D&T is really an easy subject the people are really making it difficult, they make us do folios, sketching, doing things rather than practical work you see. **(Joseph / School 2)**

Other comments by teachers implied that they were not adequately prepared to handle the subject, and also that the subject was new to the students since it was not offered in primary schools. For example, this teacher observed that:

> . . . there is no in-servicing to the teachers who are already out there in the field. So in that case the interpretation of the syllabus and the presentation of the material is not as adequate as it should be. Perhaps if that was a regular thing, maybe teachers would be getting to understand how best to approach the syllabus, the shortest time around and be in a position to accommodate the students, all of them because in principle it's a new subject to students. New terms, every time you are introducing a topic you are introducing new terms to them unlike with Maths and other subjects which they came from primary. (**Teacher 3 / School 2)**

Another teacher also said that:

> Basically I think its lack of knowledge about the subject itself. They don't know about the subject from their background so therefore, what is the use of going for a subject you don't know about. (**Teacher 5 / School 5)**

This perception has negatively impacted on the views of many about design and technology, resulting in a widespread dislike of the subject.

3) Resource constraints

As discussed in chapter two, section 2.7, design and technology has suffered from resource constraints more than most if not all subjects. As a resource based subject, in terms of materials, tools, equipment and machinery, design and technology is vulnerable to poor management of available resources, inadequacies and inconsistencies in resource supplies and other support agents. The impact of resources constraints upon the uptake and performance of design and technology was also confirmed by the semi-structured interviews. Staff were asked if they agreed that there was shortage of tools and other facilities in their schools, as reported by the majority of the students during the focus groups. Teachers and other staff unanimously agreed that there was shortage of tools, equipment and machinery in their schools. Out of the twenty two interviewees, not a single one of them denied that this was a big problem. There was evidence that some of these junior secondary schools were not adequately resourced since they were established. The problem got worse as the years went by because of: funding issues, government procurement procedure issues, security and accountability issues, and staffing issues.

Inadequate resourcing at the time when the schools were established came as a result of shortage of trained staff such as supplies officers and senior teachers in design and technology. According to the official from the Ministry of Education and Skills Development, at the time when the junior schools were distributed with equipment for design and technology, because of shortage of trained staff, proper records were not created; inventories or equipment log books were not created and kept. In some cases because of lack of knowledge, any equipment that looked scientific would be given to the science departments even though it belonged to design and technology. At that time Botswana relied on „expatriate teachers from the neighbouring countries and people kept coming in and going out so during the process most of the equipment went missing", said the official. He also indicated that even now, some schools did not have senior teachers in design and technology and that this led to mismanagement of equipment. Inadequate resourcing of the schools was confirmed by the following comments made during the interviews.

> I think this has been a long term problem because when these schools started they were not equipped sufficiently. Apparently some of the equipment that we are using is very old and we are just operating under those conditions. (**Senior teacher 4 / School 1**)

> . . . you will realise that most of the tools, especially power tools which have been supplied, they were supplied when the school started. (**Senior teacher 5 / School 2**)

> When we come to the work benches since the school was built the work benches have never been replaced nor have they ever been maintained, they are in a state of disrepair they should just be written off and new ones brought in. **(Teacher 1 / School 1**)

The situation described above is not conducive for design and technology, and it is obvious that students" learning in the subject would be hampered by such facilities, which are described as very old and in a state of disrepair. Definitely no student will enjoy learning design and technology under such conditions, taking that basic equipment such as workbenches are fundamental to most practical processes in design and technology.

The problem of resource constraints is compounded by, among other things, funding issues. In fact, funding turned out to be the most problematic of all the issues discussed during the interviews. The majority of comments made during the interviews regarding shortage of resources referred not only to shortage of funding but also to inconsistencies as to how the funding is allocated and managed in design and technology. There was evidence that information held by teachers from different schools was different. In some schools, teachers said it was possible to buy tools and other equipment, while in others it was not possible because schools did not have funds allocated for this. These comments below were made during the interviews.

> The problem is caused by the votes we are given, they are too little and the votes are just for the materials only, not for purchasing of tools. **(Teacher 11 / School 3**)
>
> For you to acquire the tools you still need to steal if I may say money from the vote for materials when you check through with the bursars there is nothing which is put aside for purchasing of the tools. **(Teacher 3 / School 2**)
>
> *So there is no vote for tools?* **(Researcher)**
>
> **N**ot at all at the moment, I checked, I confirmed there is nothing like that. **(Teacher 3 / School 2**)

According to these comments above, these teachers implied that funding was only allocated for buying materials used by students and not for purchasing of tools. It must be noted that tools, equipment and other machinery is not only purchased, but there is maintenance and replacements costs to it. So if there is no funding for purchasing of tools, what about maintenance and replacements costs? As indicated by the comments below from school three and school five, there are cases of break-ins and stealing, which means that replacements costs are inevitable. If there is no funding for replacing stolen tools and equipment as some teachers indicated in the comments above, then the situation is serious, given that these schools were established two decades ago.

> People have been breaking in and they have stolen a lot of material from our students from our D&T department so right at the moment we don‟t have enough material because of that. **(Deputy School head 3 / School 3)**

> So during these practicals you will find that tools are missing even if we replace them they are very small tools *tse e leng gore* [of which] the child can just get and put in their pocket. **(Teacher 5 / School 5**)

There were inconsistencies in what teachers reported, as some teachers indicated that it was possible to buy tools and equipment. These comments below seemed to suggest that there were funds for purchasing of tools and other equipment, which contradicts the ones above.

> What we normally do is we normally buy even (pause) whatever we buy it will never be enough because some tools are so small that students are able to steal them so even if the tools are many but still the shortage will always be there. **(Deputy School head 3 / School 3)**

> It is possible to buy new tools and equipment and we do buy them every annual year. When we start our annual year we buy some tools here and there but you know what is the main problem is some of the facilities particularly the benches, those are the old one and even some of the machineries but the small tools, those ones we buy them every year. (**Senior teacher 4 / School 1**)

However, there was evidence that, even in cases where teachers indicated that it was possible to buy tools and equipment, the bureaucratic government procurement procedures made it difficult for schools to do so. For example, the comments below indicated that the process was either too long or too cumbersome, particularly in schools further away from urban centres.

> Sometimes it‟s the procedure of getting the tools „you know‟ when the teachers want to buy, purchase tools they will be told to get five quotations whereas the suppliers are not even five and then where do they get the quotations? It‟s a hassle really to buy. (**Senior teacher 1 / School 5**)

> . . . others, they are damaged or destroyed then to maintain them it takes a very long time or to ask to be provided with other tools it takes time. **(Teacher 10 / School 4**)

> . . . another problem is that there is this tendency *ya gore* [that] we have to tender, there is this tender board, for buying any electrical equipment, they should be tendered. So this takes a lot of time. **(Teacher 11 / School 3**)

> To find tools we have to apply to our region and to the ministry, it surprises that we have tried that so many times but nothing is coming up. **(Teacher 9 / School 4**)

Another problem that brought about the inconsistencies was the fact that some design and technology departments were under a senior teacher whose background had nothing to do with the subject. In such cases the senior teacher may lack comprehension of the subject to sufficiently coordinate and manage its resources. Inconsistencies also arose due to the fact that some decisions were left to the discretion of the school managers as the comment below suggested.

> I think it depends on the School Head, one School Head and his Bursar[20] will say no this is especially for the materials while the other School Head will be flexible to say no some power tools you can buy them as long as you make estimations and as you do you don"t exhaust the money for materials. So with the others they say no, like the previous Head, she would tell you „no" this is for materials. (**Senior teacher 5 / School 2**)

This means that if the subject fell under a senior teacher or school head who had no interest in the subject, his decisions may not be favourable to the subject.

It appeared that the problem of shortage of tools, materials and other facilities in the three low performing schools was more severe than in the two high performing schools, as revealed by the general linear model reported in chapter five. Exemplar comments of staff from the three low performing schools (school one, two and five) regarding shortage of resources included the following:

[20] A professional financial administrator in a school.

> Yes we have this problem. For us its more severe, initially the labs were not taken care of as such, they were used as base rooms and „you know" desks were so damaged and now we are even running short of some of them so indeed we are experiencing the same problem. (**Deputy School Head 1 / School 5**)

> Yah we do have the same problem here. I think this has been a long term problem because when these schools started they were not equipped sufficiently. So the same tools that were used during then are the same tools we are using right now. Apparently some of the equipment that we are using is very old and we are just operating under those conditions. (**Senior Teacher 4 / School 1**)

> Yes! I do agree. (**Senior Teacher 5 / School 2**)
> Why is it so? **(Researcher)**
> Problem of finance. So the funds that we are using seems to be allocated especially for materials so you will realise that most of the tools, especially power tools which have been supplied, they were supplied when the school started. So problem of finance. We are told there is no money. (**Senior Teacher 5 / School 2**)

Although staff from the two high performing schools three and four also agreed that there was shortage of tools and other resources in their schools, their comments suggested that the situation in their schools was not as bad as in the other schools. Here is what they said:

> Yes, but I think this problem we only heard about it recently. In the past when I said the department was manned by our foreign brothers everything was intact, everything was intact. . . these tools will be displayed somewhere but because there was close monitoring, even at the beginning of the lesson they made sure they distributed the tools then they will even give themselves time to collect tools, take stock of that to say no we have distributed so many, so many have been returned but it has just now because of lack of closer supervision, tools (pause) students will be left alone with some tools and these tools are so expensive and also they are so valuable, they can be used outside. (**Deputy School Head 2 / School 4)**

> It"s not that severe, it is only that we have recently undergone *problemo ya* [problem of] stealing. People have been breaking in and they have stolen a lot of material from our students from our D&T department so right at the moment we don"t have enough material because of that. They normally ask (pause) do that from other schools, *ee* there are certain things that they don"t do it here they do it from other schools. **(School Head 3 / School 3)**

From these later comments from high performing schools three and four, the problem of shortage of resources was recent and buying tools was possible, though the process was slow. With low performing schools one, two and five, the former comments indicated that since the schools were supplied with tools and equipment when they started, they have never been restocked.

6.3.2 Tackling declining enrolment in design and technology: teachers and other staff‟s views.

Teachers and other staff raised three issues that should be addressed in tackling the problem of declining enrolments in design and technology. Besides the issue of resources, which has been discussed earlier, teachers also raised concerns about teacher training and management, and subject content as issues that need to be addressed.

Teacher training and management

Teachers expressed the view that, they were not adequately prepared to sufficiently handle the subject. For example, teacher three from school two, was quoted earlier on having observed that there was no in-servicing of teachers and that the interpretation of the syllabus and its presentation was not adequate. This teacher observed that regular in-service would help them to:

> . . . to understand how best to approach the syllabus, the shortest time around and be in a position to accommodate the students, all of them because in principle it‟s a new subject to students. (**Teacher 3 / School 2)**

He also indicated that teaching design and technology was a challenge to them because students were not exposed to it at primary school level. The official from the Ministry of Education and Skills Development indicated that teacher training institutions do not impart in teachers enough practical skills to be able to teach them to students. According to him:

> The only problem with the training that we are getting . . . the teachers are not doing enough practical, you go to the school and you look at the scheming its only theory. You observe lessons the classroom activities is only theory there are no practicals. That is hitting us hard.

According to him, junior secondary school students do not perform very well in the practical aspects of the subject, because they do not do enough practical work. Most students in the focus group interviews raised the same concern about not doing enough practical work. Considering that, about three quarters of the syllabus is based on the practical aspect of design and technology, insufficient coverage of this aspect would certainly result in poor performance in the subject. Oh the other hand, resource constraints reported by teachers and students show that doing practical work in these schools is a challenge to both the teachers and the students.

The official from the Ministry of Education and Skills Development also observed that schools are coordinated from different departments in the ministry. For example, there is one department that is responsible for employment and deployment of teachers; there is another department responsible for teacher training and development; and another for management and inspection of schools, as such, coordination and communication between these departments is a challenge. The officer indicated that the establishment register (see appendix

7), from the department responsible for employment and deployment of teachers recommends two teachers for design and technology in an 18 stream school, which according to his statement below, was impossible.

> Look at this (*referring to the establishment register*) number of teachers, design and technology, two point one. Now, telling me we have wood technology; metal technology; graphics; control technology; plastics. Two teachers are supposed to teach this subject? And this has got an impact in the students again, the reason why they don‟t like the subject. Because if you don‟t deliver accordingly in each area they are going to hate it.

One school head also commented that:

> . . . there are no teachers who are to teach the subject and then if you are to make it core like for the 1174 students all of them doing D&T, it‟s impossible. **(School Head 1 / School 5)**

Subject content

Besides the fact that most teachers observed that the design and technology syllabus content was too much, one teacher indicated that the content was outdated and that the way it is delivered needs changing. In his comment below, he specifically suggested that wood and metal work skills were outdated and should give way to electronics.

> I think this thing of making (Pause) let us say woodwork, metalwork. I think it has been long taught and nowadays we are talking about electronics. (**Teacher 2 / School 2)**

Considering the imbalance in the syllabus between craft skills knowledge, and knowledge and skills in other areas such as technologies and communication (see appendix 11), if teachers thought that craft skills are outdated, then the observation by the official from the Ministry of Education and Skills Development, above, that teachers are not doing enough practical, is not surprising.

The problem of declining enrolment in the subject cannot be tackled, unless these issues are resolved. Students may not necessarily articulate some of these issues that impact upon their attitudes to and perceptions of design and technology, but their response to the subject shows that all is not well with the subject.

6.4 Summary of the qualitative results

The results of focus group interviews with students and the one-on-one interviews with teachers and other staff were consistent. According to the two sets of results, attitudes and perceptions of students towards design and technology were generally negative. The negative attitudes and perceptions of students towards design and technology had in turn, negatively impacted on the views of teachers and other staff. As far as the teachers and other staff were concerned, students did not appreciate the subject, but they could only speculate on why students felt that way towards the subject. Level of difficulty coupled with the amount of work involved in design and technology were mentioned in the focus group interviews with students and the one-on-one interviews with teachers and other staff as a major obstacle in performance and enrolment in the subject.

Gender was highlighted in both the focus group interviews and the one-on-one interviews as impacting upon students" attitudes to and perceptions towards design and technology. These results suggested that girls tended to perceive design and technology as a difficult subject, involving too much homework and little enjoyment. It is thus highly likely that the low level of girl enrolment was linked to the nature of the curriculum subject and its style of delivery.

The teachers and other staff confirmed that resource availability was also a major drawback but unlike the students, teachers" interviews indicated that the situation was different between high performing schools and low performing schools, as was highlighted in the multivariate analysis. The multivariate analysis indicated that high performing schools were more associated with the attitude “There are enough DT tools in my school” than the low performing schools (Figure 5.5).

Teachers and students believe that exclusion of design and technology at primary school level is major drawback to the subject. According to teachers and other staff, tackling the problem of declining enrolment in design and technology will involve reviewing structures involved in the supervisory, management and development of teachers in junior secondary schools.

Although the quantitative and the qualitative results were discussed in chapters five and six, respectively, the two are brought together in chapter seven as a final synthesis of the finding.

CHAPTER 7: DISCUSSION OF RESULTS

7.1 Discussion

This chapter is organised around the primary research questions to provide a framework for discussion. Conclusions generated from the quantitative analyses of the students‟ attitudes and perceptions towards design and technology questionnaire and the qualitative analyses of the students‟ focus group interviews, as well as the teachers‟ semi-structured interviews are presented here. The findings from the mixed methodology and insights drawn from the literature converge in the discussion of results chapter. Finally, conclusions, implications and recommendations for future growth and development of design and technology are discussed in chapter eight.

7.1.2 Research question 1

- What factors influence students‟ attitudes and perceptions of design and technology?

The principle component analysis of student‟s responses to the attitudes towards and perceptions of design and technology questionnaire identified three components with a high cronbach‟s alpha of 0.94, indicating the reliability of the questionnaire in producing an idea of the pattern of attitudes and perceptions investigated. These components were identified as:

1. The perceived importance of design and technology;
2. The perceived level of difficulty of design and technology; and
3. Shortage of resources.

Perceived importance of design and technology

The perceived importance of design and technology was summarised by variables with strong weightings on the first axis of the principle component analyses, suggesting that this attitude or perception was a main factor which divided opinions between students. Two groups, group one and group three representing 49% of the population surveyed, clearly dismissed design and technology as an unimportant subject. 68% of the focus group interviews" participants indicated that design and technology was important but the majority of them perceived it as important in the area of craft skills. Attitude groups one and three were not linked to the three determinants investigated (gender, age or school), and could likely therefore be related to other factors reported in other studies; for example, socio-cultural background, socio-economic background, and parents" education level (Lyons, 2006; Kesamang and Taiwo, 2002; Volman and Dam, 2007; Bame and Dugger, 1989). As was the case in Europe two decades ago, technology education in Botswana is relatively new in the curriculum and has evolved from craft-based subjects aimed at academically weak boys (Moalosi, 1999; Moalosi and Molwane 2008; Mackay et al, 1991). In Europe and the USA, this was reported to be the main reason why students did not perceive the subject as an important one to choose (Stables and Kimbell, 2000; McCarthy and Moss, 1999; Raat and de Vries, 1985). In the UK, Turner (2003) found that design and technology did not feature in the top six subjects considered by students to be vocationally relevant. So this perception in the present study is consistent with perceptions in the UK.

Although attitude groups one and three were not linked to the three investigated determinants of gender, age or school, the general linear model and the focus group interviews indicated that gender significantly affected how students perceived the importance of design and technology. The focus group interviews suggested that girls were generally less positive about the importance of design and technology than boys and the general linear model suggested that this was only true in the two high performing schools. This discrepancy could be attributable to the small sample numbers and the unbalanced design (twice more boys than girls in both the questionnaire survey and the focus group interviews). Boys were more likely than girls to perceive design and technology to be important and useful if it was more craft based, but girls were less likely to be attracted to the craft skills, which they perceived to be more adapted to boys. For boys, the craft aspect of design and technology as observed by Volman and Dam (2007) represented a realistic perspective in relation to a social practice in which they already participated outside school. Design and technology has a strong reference to a valued social practice and through it boys acquire a technical identity. According to Turner (2003) girls were more likely not to opt to study the „workshop oriented‟ design and technology because they believed that they were not good at using workshop tools. Another challenge expressed by girls in the present study was the fact that they considered themselves not able to draw. Clearly, because of the emphasis on workshop craft skills and the portfolio in design and technology in Botswana, girls were likely to find themselves alienated from the subject.

Although females nowadays may perceive design and technology as representing a realistic perspective in relation to future employment, they associated it with boys and masculinity. This is reflected in many studies around the world and in the gender bias in the subject uptake in Botswana. Volman and ten Dam (2007, p. 858) observed that because of the liberal ideology that everyone could choose for themselves, and the emancipated norm that men and women were equal, students could feel discouraged from explicitly mentioning a relationship between the subject and gender. So it was not surprising that all attitudinal groups (69% -

91%) identified in this study, and 83 of the discounted respondents disagreed or strongly disagreed that design and technology was a boys‟ subject. Gaotlhobogwe (2004) found that girls in Botswana enrolled in design and technology for several reasons; including being forced to do it, being persuaded by teachers and friends, and to prove that they were capable to do whatever boys were capable to do.

As reported in the literature in chapter three, design and technology was developed in Botswana under the pre-vocational preparation approach in which there was no clarity between the subject‟s vocational purposes and general education purposes. As such, because of its history of having evolved from traditional craft subjects of woodwork and metalwork, the nature of delivery of design and technology has remained biased towards craft skills development. The dilemma was between design and technology as an old subject (craft based) and as a new subject that emphasized the importance of technological concepts and skills as part of today‟s education of technologically literate citizens. Mackay et al (1991) observed that technology was seen primarily in terms of its occupational relevance rather than its part in broadening general education and that it has taken on the characteristic features of other „vocationalizing‟ innovations such as work experience. Turner (2003) concluded that the perceived lack of gender inclusiveness in the subject content could well be the single most important factor in explaining the high proportion of students who appear to make their options choice on traditional, gender stereotypical lines. These conflicting philosophies of design and technology have been debated in many studies (Osnat and Mioduser, 2002) and continue to be debated today. On the one hand, design and technology as an old subject attracts „the not so academic boys‟, but does not attract girls and the „academic boys‟. On the other hand, design and technology as a new subject attracts girls and the „academic boys‟ but does not attract „the not so academic boys‟. As a result of this dilemma, it has not been easy to design a well developed design and technology curriculum that would serve the needs of all students.

Perceived level of difficulty of design and technology

The perceived level of difficulty of design and technology was also summarised by variables with strong weightings on the second axis of the principle component analyses, suggesting that this attitude or perception was the second factor which divided opinions between students. Two attitude groups (group one and group four) representing 42% of the population surveyed perceived design and technology to be difficult. 69 of the discounted respondents agreed or strongly agreed that the portfolio was difficult, as opposed to only 17 who disagreed or strongly disagreed that the portfolio was difficult. Perceptions about level of difficulty of design and technology were found to be in direct contrast to the attitude „In DT I enjoy problem-solving" (see table 6.1), meaning that the 42% and the 69 of the discounted respondents who perceived design and technology to be difficult, enjoyed the problem-solving aspect of it instead. The focus group interviews, supported by the results of the discounted respondents (50 in agreement and only 8 in disagreement to the statement „In DT I enjoy practical") revealed that the majority of students enjoyed design and technology because of its practical/craft aspect. This means that these 42% and the 69 of the discounted respondents who perceived it difficult, their attitude and perception is a result of the practical/craft aspect of design and technology. They perceived the practical/craft aspects of design and technology difficult but not the problem-solving aspect.

Axis 2	
In DT I enjoy problem solving	-0.513
DT involves too much work in poblem solving	0.425
DT involves too much work in practical work	0.461
In DT I find folio work difficult	0.491
In DT I find practical work difficult	0.590
In DT I find problem solving work difficult	0.578

Table 7.1: Weightings of the main variables for the second axis of the PCA describing trends in student attitudes to design and technology.

One group of students (group 1) representing 24% of the population surveyed, five students from the focus group interviews, and between three and four students from the discounted respondents, who dismissed design and technology as an unimportant subject, considered it insufficiently challenging with respect to „problem-solving". These results suggested that because the problem-solving aspect of design and technology was not sufficiently augmented, but instead there was too much of the practical/craft aspect, such students found design and technology difficult, narrow, and not important. In a research carried out in England, Mcllelan and Nicholl (2008, p. 5) found out that although overall students (aged 11 – 16 years) were positive about design and technology, a substantial number felt they were not being sufficiently challenged, and were being asked to do meaningless work.

The general linear model and the focus group interviews revealed that gender affected attitudes and perceptions about the level of difficulty of design and technology significantly. Girls tended to perceive design and technology as a difficult subject, involving too much work and with little enjoyment. It was thus clear that the low level of enrolment of girls in particular was linked to the nature of the curriculum subject. Although all attitude groups

(69%-91%) and 83 of the discounted respondents disagreed or strongly disagreed that design and technology was a boy"s subject, these results indicated that, because of its nature, some students particularly girls found themselves alienated from the subject. These results were consistent with results from other studies in Botswana and in Europe. Meide (1997) reported that girls" attitude towards technology was generally less positive that that of boys. The same observation was made in other research studies (Turner, 2003; Hannover, 1992; Brotman and Moore, 2008). Volman and ten Dam (2007) found that boys already identified themselves as technologically expert, whereas girls identified themselves as outsiders and that this identification either enhanced or inhibited learning.

Shortage of resources

Shortage of tools emerged in the multivariate analysis as a major drawback of design and technology in Botswana. This perception did not discriminate between attitude groups (i.e. these variables had little weight in the ordination), as all the attitude groups disagreed that there were enough resources. Majority of the discounted respondents also disagreed or strongly disagreed to questions eight and nine (see table 5.4). This perception was confirmed in the focus groups and the semi structured interviews. Lack of tools and other resources was found to be the third factor leading to the decline in uptake of design and technology. During the focus group interviews it emerged that „lack of tools and other resources" was not only a factor leading to the decline in uptake of the subject, but it also affected attitudes and perceptions in a number of ways. Lack of tools and other resources resulted in unfinished work or poorly finished work, leading to poor performance of the subject. Because of this, most students developed a distaste for the subject. Hendley et al (1996) pointed out that pupils valued the subject for its creative potential and so finishing work might be seen as a sign of fulfilling one‟s creative potential within it. Lack of resources also impacted on one of the important dimensions of classroom climate necessary for creativity in design and technology as was discussed by McLellan and Nicholl (2008). Affording students the necessary freedom to generate and realise creative solutions to problems is a motivational attribute in a design and technology classrooms, and lack of resources undermined this dimension

Evidence drawn from the semi structured interviews indicated that resources have decreased over the years, hence students increasingly perceived this lack of resources as a real drawback when it came to making subject choices. Lack of resources has been flagged-up as a major factor impacting student attitudes elsewhere in the world: In Britain (Dakers, 2006, 2007), in Spain (Font-Agusti, 2000), and in Australia (Gardner, 1994, 1995; Fritz, 1996). In Africa, technology education and applied science-based teaching as a whole was widely considered to be under-resourced (Weeks, 2002; Potgieter, 1999; Kumar, 2002).

The general linear model indicated that gender, school background and age explained little variation in students‟ attitudes and perceptions even though they all affected some attitudes and perceptions significantly.

Gender

Many research studies (Bame and Dugger, 1989; Volman and ten Dam, 2007) have found gender to have a major influence on students‟ attitudes and perceptions in technology education and design and technology in particular. This study has also highlighted gender as having a more influential effect on how students perceived design and technology in terms of importance, level of difficulty and enjoyment. It is thus confirmed through this study that general enrolment in design and technology and girls enrolment in particular is low because they perceived design and technology to be a male-oriented subject. Volman and ten Dam (2007) advised that research should focus on the extent to which social identities are being developed in learning, and ways found to avoid the reproduction of existing power relationships in such learning arrangements (p. 863); for example, a case where food technology would be studied by mostly girls, and resistant materials studied mostly by boys. Such arrangements reinforced the existing social identities between boys and girls.

School background

Case study schools‟ background was also highlighted as one of the factors that influenced students‟ attitudes and perceptions towards design and technology in this study. Interaction between School performance and gender indicated that school performance affected how boys and girls appreciated design and technology. Although the focus group interviews could not confirm the effect of the interaction between school performance and gender, it was clear that attitudes and perceptions from boys and girls in a village school were different from those of boys and girls in urban schools. However, Meide (1997) warned that students‟ school background, in terms of being urban or rural, involved a more complex factor structure than a simple location model could provide. The concept of rural and urban could be considered if it accounted for aspects such as proximity to urban environment, interaction with modern technologies, norms of behaviour in traditional and modern social structures, economic differences and other distinctions (Meide, 1997, p. 210).

Attitudes and perceptions of students concerning resources were different between high performing schools and low performing schools, indicating that availability of resources affected school performance, which in turn influenced attitudes and perceptions.

Age

Age was found to have a significant effect on students" attitudes and perceptions about the importance of design and technology, with younger students having a more positive view than older ones. The effect of age on students" attitudes and perceptions was not counter checked through focus group interviews because the age of the students was not established during the interviews. According to literature reviewed, the age factor has been found to affect students" attitudes and perceptions towards design and technology. According to their study, Hendley and Lyle (1996) reported important differences in attitudes towards gender in technology according to age. In this study more younger boys than older boys perceived being male to be an important characteristic of a good design and technology pupil. Bame and Dugger (1989) found that the general interest in technology of high school students was significantly greater than that of those in the lower grades. In speculation, it would seem that in the current study older students were more aware about their career prospects than younger students and their perception about the importance of the subject was influenced by employment opportunities available to them.

Further research is thus required to establish how much school background, age and other factors such as: proximity to urban environment, interaction with modern technologies, norms of behaviour in traditional and modern social structures, and economic differences were affecting students" attitudes and perceptions of the value of design and technology as a subject.

7.1.2 Research question 2

- How does examining the views of form three design and technology students help explain the problem of declining enrolments in the subject?

The views of form three design and technology students helped to explain in detail some of the issues surrounding the problem of declining enrolments in the subject. Although the statistical analysis of the questionnaire highlighted factors influencing students‟ attitudes toward and perceptions of design and technology, it was pertinent to seek the views of the students about these factors to get further insight into this issues. It was also important to check the views of students against those of the teachers and other staff.

The views of design and technology students are important in influencing other students and society at large about the subject. If their views are negative, that is how they will influence other students, their siblings and their parents towards the subject. During the interviews teachers clearly indicated that the general view of students is that they do not like design and technology. According to the official from the Ministry of Education and Skills Development, „the general view . . . from students, people, the public at large, even the parents, they don‟t like the subject, they say we don‟t like that subject‟. This general view also explains why there is a decline of enrolments in design and technology. However, most students indicated how much they believed in and expected from the subject and how much their expectations are quashed due to issues involved in the subject; issues such as too much content in the subject and shortage of resources, as discussed in chapter six.

The general view of design and technology students interviewed is also that design and technology is a valuable craft subject, most suitable for boys. This also could help to explain the problem of declining enrolments in design and technology in the sense that, in this century, as life becomes technology intensive, more and more people are becoming aware that craft skills are losing value and that general technological literacy is more valuable than craft skills. In this case many students, particularly those who perceive themselves not practically oriented, would not want to study a craft intensive design and technology. Many parents also would not encourage their children to study a craft intensive design and technology under circumstances described during the interviews. Gender stereotypical views have been part of technology education from a long time, but such views are bound to have a major influential impact when there is shortage or insufficient resources.

7.1.3 Research question 3

- How could the decrease of uptake in design and technology be tackled?

The results of the qualitative analysis indicated consistently that gender, student‟s performance in the subject, and resource constraints all affected attitudes of students towards design and technology, and they gave an in-depth understanding of the issues involved. Multivariate analysis (PCA-Factor analysis) provided information in ranking how different attitudes contributed to the overall perception of the subject, in assessing the relative and interacting effects of external determinants like age or gender; and in classifying students into attitude groups.

The findings show that design and technology enrolment could be improved by: targeting students, girls in particular, who deemed the subject to be too difficult or unimportant; by reviewing the curriculum; and by sufficiently providing the necessary resources for all aspects of the subject. Clearly, some aspects of the subject; for example, portfolio and craft-work, are an unnecessary burden for particular groups of students, and removal or reduction of such aspects for those particular groups would help tackle the problem of declining enrolments and reinforce perceptions of design and technology as an enjoyable life-skill. The mere fact that the junior secondary school curriculum is biased towards the resistant material"s craft skills is enough to drive most students away.

The majority of students, particularly those who perceive themselves as not academically strong indicated that they find portfolio work burdensome, too demanding, and not enjoyable, but such students enjoy the craft aspect of the subject and they perceive it as an important life skill. A case study of seven highly motivated and interested design and technology students in one comprehensive technology college in England reported the same finding about the views of students towards the portfolio (Welch et al, 2005). Although, the junior secondary school design and technology curriculum is biased towards the resistant material"s craft skills, results show that not much practical work goes on in schools, perhaps because of the dire shortage of resources. As a result, the subject fails to meet the expectation of the majority of students. On the other hand, some students, particularly those who do not perceive themselves as practically gifted, do not perceive design and technology as an important, enjoyable life-skill, and they find practical craft work burdensome. To these students, the problem-solving aspect of design and technology is underdeveloped, so their expectations are also not met by the curriculum.

Addressing the problem of shortage of resources would certainly help to tackle the problem of declining enrolments in design and technology. Both the quantitative and the qualitative results consistently indicated that shortage of resource negatively affected attitudes of students towards the subject at every level. Training of more teachers of design and technology and developing more of them to take up supervisory and management positions could help address the problem of shortage of resources. Also, strategic development and deployment of design and technology teachers coupled with in-service training on issues such as resource management and record keeping are important steps in dealing with the problem.

CHAPTER 8: CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

The results of the current study have several implications for curriculum and instructional strategies for design and technology education in Botswana. Because of its link with the past, the subject of design and technology has not been responsive enough to the challenges of the 21st century. As a result, the uptake and performance of the subject in comparison to other curriculum subjects have continued to decline, much to the amazement of many who had experienced remarkable achievements in the subject area in a very short space of time.

In my conclusions I examine the subject and its link to the past to determine the future that lies ahead for design and technology. Although there are several multifaceted hurdles that have to be overcome, as revealed through the present study, design and technology remains one of the most exciting areas of study that is in touch with every aspect of human nature. It is this responsibility that technology education carries that makes it an exciting area of study. While the future for design and technology demands radical changes, many in the field of design and technology have warned of possible unrealistic responsibilities being placed upon the subject.

Also, I discuss the future of design and technology in Botswana in line with current and future trends in the technological world we find ourselves in. I make recommendations, to suggest alternative approaches for curriculum change in the field of design and technology in Botswana to ensure continued growth and development. Finally, I discuss the benefits of using a mixed methods approach in appraising students‟ attitudes to and perceptions of curriculum subjects and possibilities of using this approach in future studies.

8.1.1 Design and technology and its link to the past in Botswana

Although this is not a design and technology curriculum evaluation study, it is imperative to note that the subject in Botswana has not managed to achieve the government‟s desired effect, hence the decline in enrolment and performance in the subject, and the failure to implement the recommendation to make it a core (mandatory) subject. The single major obstacle to this development has been the subject‟s link to the past. Although, there seemed to be something different between design and technology and its predecessors, namely craft subjects, this difference is just on the surface. The new subject that was introduced as design and technology was merely a conjunction of elements of woodwork, metalwork, plastics, technical drawing, and art, combined with light doses of structures, mechanisms, basic electricity and electronics, and „the design process‟.

While design and technology was viewed in Botswana as a subject that was in line with a philosophy of an education that would produce independent citizens who would cope resourcefully with the demands of the real world (Ndaba, 1994, p. 110), so far there has been only a small „cosmetic‟ difference between design and technology and its predecessors. This difference has been that:

1. While with the traditional craft subjects, the teacher planned and decided what „craft‟ students were going to make, out of what material, depending on whether they studied woodwork or metalwork, with design and technology the students themselves plan and decide what „craft / artefact‟ they are to make, out of one or a combination

of different materials.

2. While with the traditional craft subjects, the teacher provided the drawing of the „craft" to be made, with design and technology the students themselves go through the „design process" to decide and plan what „craft / artefact" they are to make out of one or a combination of materials.

In essence, design and technology in Botswana could be described as a „modern craft subject" in the sense that it offers a little more flexibility to students, in terms of material and „craft / artefact" choice than the „traditional craft subjects". The curriculum content and the way it is taught and learnt is highly overloaded and prescriptive. As could be seen from the list of topics in the syllabus in chapter two, teachers do not have time to teach them in depth, or for children to consolidate their learning. Problem-solving, design, and creativity is taught through an ordered learning of the stages of the „design process" which culminates in a design portfolio. Welch et al (2005) observed that while it was possible to use the portfolio to enhance students" learning and assess their progress;

> . . . the ritualisation of designing, the conversion of this record into a product (a design portfolio), the constraints imposed by examining bodies, and the inflexible, narrow interpretation of what constitutes design have become significant problems in technology education (Welch et al, 2005, p. 175).

This ritualisation of designing is what Dagan and Mioduser (2002, p. 39) described as having to meet the requirements of products-production processes, e.g. to be structured, to proceed in stages, to meet schedules, to be clearly product oriented. This ritualisation process is what led to design and technology to be craft-based or product-oriented. During a panel discussion at the PATT conference in 2008, one delegate observed that teacher capabilities and student needs were mismatched; that many teachers, trained as industrial arts / crafts teachers, were still teaching as they were taught and many technology education programmes were still rooted in crafts teaching.

As a „modern craft subject", design and technology in Botswana and elsewhere appeals to those students who are not academically gifted, but they still find the portfolio an unnecessary burden, which does not enhance their confidence and creativity (Welsh et al, 2005; McLellan and Nicholl, 2008). At the same time, it does not appeal to the academically gifted students and clearly is not in line with developments in the ways in which goods, services, and experiences of our worlds will be designed, manufactured, and distributed over the next decade (Steeg, 2008, p. 1). Therefore, it is time to examine the design of design and technology curriculum and find ways in which it can best meet the needs of the 21st century society. Keirl (2007) suggested five perspectives that could be used to examine the design of a relevant design and technology curriculum as:

The global perspective

Within „the global" perspective we should consider how the curriculum related to global trends. As it is now, design and technology does not serve its role of preparing children for the future they are likely to inhabit as adults. Global trends, as fabrication techniques of computer-aided manufacture (CAM) and computer-aided design (CAD), the internet, web social networks, and sustainability were some of the developments mentioned by Steeg (2008, p. 6) as not featuring significantly in the current design and technology curriculum in England, but which are likely to be available in homes in the near future. It would be naive to assume that these developments that Steeg talked about are only likely to affect western societies. Doing so would be tantamount to a situation in which Botswana‟s technology education would be following two decades behind and out of tune with the expectations of its citizens as is the case now.

The would-be stakeholders‟ perspective

Within this perspective we should consider who a curriculum is purported to serve. Among the list of these would-be stakeholders are students, their communities and societies at large, and a wide range of work place settings. The way in which these would-be stakeholders respond to design and technology curriculum explain who it does or does not serve. Clearly, from the findings of the present study, the current design and technology curriculum in Botswana does not serve the students, their communities and society at large. Steeg (2008) and Keirl (2003, 2007) have argued that current technology education practices encourage students to view their designing and making through the lens of designing products for mass consumption in the consumer market, which contradicts the spirit of sustainability.

The society perspective

Within this perspective we should consider the contribution of design and technology to the general education of all students as citizens of our individual nations, as well as of the world at large. We should consider the kind of society and quality of life we wish to have, and consider the values at every stage of intention, manifestation and use of a designed technology to critique the technologies we choose to live with (Keirl, 1999, p. 77). According to Steeg (2008) design and technology curricula should enlighten students about consequences of anti-democratic design approaches, such as „trends in manufacturing towards low-cost, short-life products supported by a mass-market and constrained by the ever-increasing of intellectual property (IP) laws." Until design and technology curricula make students aware of these issues and suggests alternative approaches that best represented them and their communities, then its contribution may not be appropriate for students as citizens.

The fulfilled person perspective

Within „the students as fulfilled person perspective" we should consider how design and technology meets the needs of individual students. The findings of this study and many other similar studies (Welch et al, 2005; Nicholl et al, 2008; McLellan and Nicholl, 2008) have revealed that the subject does not meet the needs of enough students. Many design and technology curricula are biased towards the technological knowledge goals of materials, systems, structures, and skills. There is very little in terms of technological issues, capabilities and general cognitive skills development. Without these aspects there is very little scope for students to make design decisions which, according to Barlex (2005) are central to good work in design and technology education.

The curriculum dynamics perspective

Within this perspective we should consider the appropriate curriculum setting for design and technology. Locating the appropriate curriculum setting for technology education is a political and ideological argument. While some technology education programmes around the world were historically located within STEM (Science, Technology, Engineering and Mathematics), current developments indicate a shift towards such areas as, Art & Design, Citizenship, ICT, Computer Science or the Social Sciences. Kierl (2007, p. 71) advises that this calls for our capacity to articulate comprehensive (not partial) educational arguments with all those with whom we interact and who have curriculum influence. At a PATT conference in Israel (2008) there was a unanimous agreement that this was a political issue and that there was need for both „smart classrooms‟ as well as „smart politics‟ in technology education. One of the founding members of PATT jokingly observed that perhaps the next PATT conference should be titled „Politicians Attitudes Towards Technology‟. Because of this observation one of the sub-themes at a recent PATT conference in the Netherlands (2009) was „seeking political support‟.

8.1.2 The future of design and technology in Botswana

Many studies have shown how a range of technological, legal and social developments in the ways in which products are designed and made presents a challenge to the current design and technology curriculum (Steeg, 2008; Keirl, 2003, 2007; Kumar, 2002). This challenge manifests itself in the way in which the society as a whole and the political decision-makers in particular, react to the curriculum subject. Technology education faces the constant challenge of defending its position in the school curriculum against threats of being absorbed by other school subjects or being abolished altogether, as boundaries between domains of knowledge increasingly become blurred. For example, in the case of: CAPA in Botswana primary technology education (Gaotlhobogwe, 2009); „areas of learning‟ in the case of England primary education (Rose, 2009); and „learning areas‟ in the case of Australia (William, 2008). General education as a whole and technology education in particular is expected to respond and manage the impact of such developments.

Rapid and continuing advances in information and communications technologies (ICT), coupled with complex environmental, social and economic pressures that extend beyond national borders need to be accommodated in the 21st century curriculum. The policy to make design and technology one of the core areas of study in the junior secondary school curriculum in Botswana will not be achievable until the curriculum responds to these developments in meaningful ways. According to Steeg (2008, p. 7), these challenges should be celebrated as a route to creating an ethically defensible curriculum that will allow design and technology (or its immediate successor) to contribute meaningfully to a broad education for a technological literacy that supports education for democracy.

Design and technology as a „modern craft subject‟ has no future in today‟s global society (Keirl, 2007, 2003; Steeg, 2008), hence Steeg signified the possibility of design and technology‟s immediate successor. In Botswana, this is not an exception, as already indicated in the way the subject has fared over the years in the school curriculum. There have been remarkable achievements in design and technology, but to avoid the tide of accelerating change is proving to be detrimental to the subject area. According to Spendlove (2008) there is much literature and evidence to support the claims that design and technology curriculum is lacking in aspects of creativity and designerly practices.

Advancing the case for technological education to respond to technological change and globalisation may not be appreciated by many in developing countries such Botswana, where resources are limited, or by those who see globalisation and technological advancement as synonymous with Western imperialism or Americanisation (Keirl, 2003). But the more developing nations resist change brought about by globalisation and technological advancement the more they remain consumers and not participating members in the global world. In fact, Grant, quoted in Keirl (1999, p. 78) views this as denying people the most basic freedom and can lead to alienation from and ignorance, or worse still, fear of technology.

The fundamental questions to ask are: Can our current design and technology education serve the role of preparing children for the future they are likely to inhabit as adults? In what way will the craft skills they are learning serve their technological needs? Referring back to section 2.6 in chapter two, one cannot help but see the mismatch between the content of the design and technology curriculum and technological literacy. The content is essentially technical and practical; it may just do for a functionally literate citizenry. However, because of the technologies we inhabit in our daily experiences and because of the position we find ourselves as a society in, we need a critically literate society capable of exploring the continued „technologisation" of our „selves" (Keirl, 1999).

8.1.3 Benefits of mixed methods approach to the study

Approaches combining ordination (PCA or factor Analysis) with Analysis of variance procedures like ANOVA or chi-square have been used with success in pupil attitude related studies (Ankiewicz et al, 2001; Van Rensburg et al, 1999, Boser et al, 1998, Meide, 1997; Bame et al, 1989; Turner, 2003). This study extended further the method by using General Linear model procedures which considered more than one determinand at a time. For example, ANOVA procedures would assess the impact of gender on students attitude to design and technology, while GLM procedures assessed the impact of many determinands at a time (here gender, age and school performance), while also taking in account the possible interaction between determinands. In this case study, the GLM identified that boys in high performing schools found design and technology to be an important subject, while simple ANOVA would not have identified boys or high performing schools to be significantly linked to this attitude.

Another interesting benefit of multivariate analysis methods was in the multivariate classification option. In education, managers often need more than general perceptions of what makes a subject a success with students. From an applied perspective, it is often important to identify which groups of students need what particular attention, and to tailor the needs of each group with adapted strategies. This study addresses this point and I believe that the quantitative methodology described here provides a practical way both to identify target groups of students with similar perceptions and identify what factors or combinations of factors affect these perceptions. This study addresses this limitation by moving a step further to suggest a model which identifies groups that have similar attitudes. Related attitudinal studies are limited to either quantitative or qualitative methodologies, the research presented here illustrates how quantitative and qualitative analysis can be used in a complementary way, to support each other in identifying students" attitudes. The quantitative procedures flagged up attitudes and guided the qualitative interviews to enrich the findings. As the main rationale for using mixed methods approach was both triangulation and complimentary treatment (Bryman, 2006), these methods were undertaken sequentially.

8.2 Recommendations

Issues facing design and technology educators world-wide, Botswana included, are multi-faceted and complex because they are not only educational, but technological and political as well. In making recommendations for the growth and development of design and technology education in Botswana, there are many questions in my mind, questions about the politics of education, the politics of technology, and implications of these on the design and technology curriculum.

Nevertheless, current debates indicate that design and technology curriculum reform is now overdue to address some of the issues that have been highlighted in this study and elsewhere. One of these is the „vocademic" nature of the subject (Spendlove (2008). According to the findings of this study, it is actually the „vocademic" nature of the subject that divided opinions or perceptions of students towards it. In most countries, the post-primary phase is one in which students make pivotal choices regarding their future careers. Many at this age, it seems have not discovered their dual capabilities, most of them are either practically orientated or academically orientated and they make their career choices based on that. This means therefore, that, „vocademic" design and technology does not serve the needs of either. As a result, the subject does not attract the practically orientated students nor the academically orientated students. There is evidence that in some instances, for example, New Zealand, the concern was that the pendulum had swung and seemed stuck too far away from the basics of instrumental or operational lines of skills and techniques towards an increasingly critical technological literacy. In the case of Botswana, the design and technology curriculum maintained the basic, essentially technical, aspect of technology, while at the same time there was an attempt to allow students to make meanings and understanding of their „made world" through designing and making products of their own. Circumstances surrounding the nature of the subject, for example, teacher training and deployment, assessment, resources in terms of curriculum time and facilities did not allow for adequate coverage of these aspects. My recommendations therefore, are informed by both future trends in the subject and circumstances on the ground.

The area of design and technology in general is a very broad one and it is imperative that priorities, choices, and decisions have to be made. Issues concerning what and what not to include in the curriculum have been problematic and have led to overloaded design and technology programmes. The recommendations I propose here will amount to cutting down on the content of design and technology curriculum so as to allow space for students to reflect on, critique, deconstruct and evaluate technologies in a way that would develop their critical technological literacy, while at the same time there would be opportunities for developing craft knowledge and skills, which most students interviewed enjoy.

Any review of the curriculum must however be preceded by establishing patterns of attitudes and perceptions among students to know what the major concerns are. This process is an important first step towards tackling the decrease in uptake of design and technology, or any curriculum subject. Establishing groups of students with similar attitudes provides a practical option for relevant, tailor-made interventions focussed towards particular groups to meet their specific technological needs. One of the interventions could be to target children who dislike design and technology because it was deemed unimportant by augmenting the problem-solving aspect of it and stressing the continuity between design and technology and other subjects such as Science, Mathematics, English and Business Studies, which seemed to be more popular. Popularising design and technology could also be matched in higher institutes of learning and in the workplace through policies made specifically for this purpose, as recommended by Meide (1997). According to Meide, simply providing design and technology, or some other technology course, to all students, without offering incentives that reshape attitudes, would not reverse years of social and educational oversight (Meide, 1997, p. 212).

Other strategies could be to target girls who thought design and technology demanded too much homework by enhancing the amount of work done at school, or to re-structure the subject such that it offered a choice of diversified areas of design and technology as is the case in the UK. Literature shows that in the UK, although design and technology is a single subject it has diversified areas such as food technology, textile technology, Resistant Materials, Graphics and Communications, and as such there is choice for students. As it has been reiterated earlier design and technology in Botswana is limited to craft skills development, other areas of the subject are not equally developed. Even the craft aspect which is more established than other areas has been negatively impacted by the shortage of resources. Boser et al (1998) recommended that the profession should strive to develop curriculum materials and activities that met the interest and technological needs of all students. In doing so care must be exercised to avoid developing social identities and the reproduction of existing power relationships in such learning arrangements as cautioned by Volman and ten Dam (2007). Although Volman and ten Dam concern was a valid one, in practice this was not going to be easy because these social identities were developed from outside the schools. However, school policy makers should try and counter social identities if they were found to be a hindrance to the development of future technologically literate citizens. Van Rensburg et al (1999) attributed the difference in attitudes of boys and girls towards Mathematics and Science subjects to cultural and societal influence. They advised that girls would rather study Food technology than electronics or structures, for example. Food technology could be used as the basis for developing technology among females (Van Rensburg et al, 1999, p 148)

Increasing the availability of tools and resources which also seemed to have a direct effect on school performance and other attitudes would bolster existing strengths in the current teaching of design and technology, which were the enjoyment of a hands-on life skill. In order for this to happen, I propose that:

There could be two pathways in the design and technology curriculum in Botswana. Instead of one „vocademic" design and technology curriculum trying to serve the different needs of students, I believe that two pathways, one serving the needs of the practically orientated students and one serving the needs of the academically orientated students is the way forward. The present study revealed that most students currently enjoying the study of the subject, did so because of its practical nature, but this enjoyment was interrupted by the burden of designing and having to make a portfolio, which to them was an unnecessary waste of time. Their enjoyment was also interrupted by having to share the limited resources with the group that did not enjoy or appreciate the practical aspects of having to make artefacts. I believe that if the burden of making artefacts could be removed in one pathway, and the burden of designing removed in the other, then students following either pathway would have more time to develop higher-order intellectual skills, of reflecting, critiquing and evaluation of technologies that affect their daily lives.

Another alternative would be to have in the curriculum, different areas of technology that students could choose to follow, as is the case in England and Wales. For example, students could choose to do food technology, textile technology, communications technology, systems and control, or resistant materials. The current design and technology in Botswana, is meant to cover all of these, with the exception of food technology, but fails to do so and the result has been a negative response from the students and the public.

In the light of the observations made with regard to the findings in this research and the conclusions drawn, specific recommendations are advanced under the following sub-headings: design and technology curriculum review, design and technology development and implementation, and suggestions for future research.

8.2.1 Design and technology curriculum review

Some of the areas of the curriculum that need urgent attention include the following:

a) Aligning the curriculum content with the goals of the programme

The design and technology curriculum should be reviewed with a view to align its content with the goals of the programme to ensure consistency. The discrepancy that currently exists between the goals of the programme and content seems to suggest that the two were not developed concurrently. For example, one of the goals stipulates that the programme seeks to enable students to incorporate indigenous materials and technologies into their design and technology activities. The content, on the other hand, does not mention anything about indigenous technologies and how these should be incorporated in design and technology activities. Another example of many inconsistencies is between the goal that stipulates that the programme seeks to provide flexibility to allow for varied interpretation of the syllabus according to the local context of each community. The over-prescribed specific objectives of the syllabus content, on the other hand, permit little flexibility for teachers, or students.

The Department of Curriculum Development and Evaluation should convene a meeting/workshop with stakeholders to review the curriculum and find means to harmonize the content and the programme goals. Stakeholders should include teachers of design and technology, academics in the field of technology education, design and technology education officers and representatives from design and technological industry. Moalosi, a design and technology academic from the University of Botswana, has done extensive research on the integration of culture in product design (Moalosi et al, 2004; Moalosi et al, 2007; Moalosi, 2009). This research should be used to facilitate ways of including in the curriculum local context indigenous materials and technologies.

Stimulation of creativity and imagination is another important goal which does not seem to be consistent with an over-prescribed, specific objectives-based syllabus content. This should be an important agenda item for a curriculum review meeting. Examples from around the world, for example, The Young Foresight initiatives in England (Barlex, 2007) could be used as a basis for discussions on how to meet the conditions of creativity in design and technology.

b) Reduction of repetition of topics in the curriculum

Although the syllabus content seems to be overloaded, much of the overload is a result of repeated topics that run from year one through to year three. While the level of complexity may be different between the same topic in year one and in year three for example, it is not clear how different would be, the level of complexity between the „*select appropriate saws when cutting material*" in year one, and the „*select appropriate saws when cutting material*" in year two, and in year three. The principle in selecting appropriate saws is what is important and is the same regardless of whether students are in year one or in year three.

Emphasis on principles, rather than specificities, would be an important strategy to deal with the problem of content overload. For example, if we take another topic which is repeated through year one, year two and year three, „*measuring and marking out tools*", there are hundreds of measuring and marking out tools. It would be unreasonable to expect students to be able to memorise them all by name, to be able to illustrate them, label them and to know how each of them is used. It is enough for students to learn the principles involved in classifications and usage of certain groups of tools, instead of expecting them to be able to illustrate and label each part of every tool, and to know how each marking tool is used. The repetitions are an unnecessary overload on the curriculum, denying learners the opportunity to develop in areas such as creativity and problem-solving, which are more important and spelt out in the list of the goals of the curriculum.

c) Reduction of over-prescribed specific objectives

Similarly the specific objectives in the syllabus should be revised with a view to reducing them. They are often repeated and make the curriculum over-prescriptive. One of the goals in the junior secondary design and technology programme is that: *the programme seeks to provide flexibility to allow for varied interpretation of the syllabus according to local context of each community.* The specific objectives dictate lesson activities that teachers should provide for students and, as such, flexibility cannot be achieved. Creativity is also stifled when there is so much prescription in the curriculum.

d) Integration of Information and Communications Technology (ICT)

ICT plays an important role in design and technology, and also appeals to most students regardless of whether they consider themselves academically gifted or practically oriented. ICT provides an opportunity to attract students into the subject if determined steps are taken to integrate it into design and technology activities. There is an isolated mention of ICT in the current design and technology curriculum, and no resources whatsoever in schools to support any initiatives to develop it in the school curriculum. It is recommended here that a task force should be set up to carry out investigations and make recommendations to the Ministry of Education and Skills Development regarding the development of ICT in design and technology in schools.

8.2.2 Design and technology development and implementation

As observed earlier, issues involved in design and technology are not only educational but technological and political as well. Therefore, the design and technology education community needs to co-op various stake-holders from other fields sympathetic to design and technology, such as politicians, technologists, engineers, craftsmen, and designers into task forces and associations to lobby for the development of the subject in Botswana.

There is an urgent need for the revival of such organisations as the defunct Design and

Technology Association of Botswana (DATAB) and the National Design and Technology Exhibition of Botswana (NDETEBO). It through such organisations that practical steps could be taken to advance the course of the subject. Design and technology teachers need such forums to meet other stake-holders and discuss specific pedagogic and implementation issues.

8.2.3 Future Research

With reference to the current study and other related studies, further research and evaluation studies that focus on specific aspects of future directions of policy and practice in design and technology education is needed. Possible aspects for further research include:

a) An audit of design and technology resources in junior secondary schools in Botswana. This investigation is important to discover the extent of the problem of shortage of resources and to determine what it would cost to remedy the situation. The audit could take the mode of a national report, utilizing resources available in education centres across the country. The outcome of such an investigation would provide feedback and make recommendations to the Ministry of Education and Skills Development.

b) Investigation of parents‟ attitude to and perceptions of design and technology and how this influence students in choosing the subject. Such a study would provide feedback to the design and technology community as to how much parents know about design and technology and therefore provide a basis for outreach programmes intended for community education purposes. This study could take the mode of regional report, or be conducted as a thesis or dissertation.

c) Investigation of non-design and technology students" attitude to and perceptions of the subject. This study will determine whether attitudes and perceptions of students are developed from within or outside the subject. This will also provide a basis for comparisons of attitudes and perceptions. This could take the mode of a conference or journal paper.

d) Collaborations with other subject areas facing the same problem of declining enrolments and performance. Two such subject areas are Home Economics and Geography. Such collaborations would provide a forum for exchange of ideas. These could take the mode of case studies culminating in comparative analysis. Collaborations with Home Economics for example could be a basis for possible merging of the two subject areas, as recommended earlier in this study.

The present study focused on a small selection of determinants affecting students" perceptions (gender, age, and school performance), but the methodology provided a structure to analyse concomitantly a much larger array of effects. This study contributes to a general trend in education research that suggests that the use of both qualitative and quantitative analysis is helpful (Niglas, 2004, Turner, 2003). The use of principal component analysis and general linear model provides an option for future studies to closely look at combinations of different variables affecting student perceptions. The present study suggests that complementary analysis offers a valid and rigorous option to assess both quantitatively and qualitatively the attitudes of students to diverse educational issues, a key tool to developing effective education policies.

This study has empowered me as a teacher educator and a researcher to be able to contribute to the future knowledge base in the area of general education and technology education in particular through research and publications.

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APPENDIX 1

STUDENT ATTITUDES AND PERCEPTIONS TOWARDS DESIGN AND

Questionnaire for students

SECTION A

Please place a tick in the appropriate box.

Gender: Female [ ] [ ] Indicate your Age [ ]

Studying Design and Technology at this school is by:

Requirement [ ] Choice [ ]

If other, please specify ____

____

SECTION B

Please make a tick in the box that most matches your chosen response to the various statements made.

N.B. SA = Strongly Agree A = Agree D = Disagree SD = Strongly Disagree

1. D&T is important for my
   a) Future career

SA	A	D	SD

2. All students at junior school should study D&T.

SA	A	D	SD

3. D&T at junior school involve too much work in
   a) Folio work
   b) Practical work
   c) Problem-solving

SA	A	D	SD

4. Home work and or after school work in D&T take too much of my time.

SA	A	D	SD

5. There are enough D&T tools in my school for everyone.

SA	A	D	SD

N.B. SA = Strongly Agree A = Agree D = Disagree SD = Strongly Disagree

6. There are enough D&T workbenches in my school for everyone.

SA	A	D	SD

7. In D&T in general there is too much to do in too little time.

SA	A	D	SD

8. It is just as important that all students study D&T at junior school as it is for them to study
   a) Mathematics
   b) Science
   c) English

SA	A	D	SD

9. In D&T, I find the following areas difficult
   a) Folio work
   b) Practical work
   c) Problem-solving

SA	A	D	SD

10. In D&T, I enjoy
    a) Folio work
    b) Practical work
    c) Problem-solving

SA	A	D	SD

11. I enjoy the design aspect of D&T (painting, drawing, colouring etc).

SA	A	D	SD

12. I find satisfaction in designing and making artefacts with my own hands.

SA	A	D	SD

13. D&T is a boys subject

SA	A	D	SD

14. D&T prepares me for
    a) Work
    b) Life

SA	A	D	SD

APPENDIX 2

FOCUS GROUP DISCUSSION GUIDE

Focus group discussion guide

Number of Discussants (maximum: 10)

Facilitator

Introduced myself, told them who I am and where I come from. Introduced the research study and told them what is expected of them during this discussion. All the ethics considerations, about confidentiality, anonymity and the voluntary nature of the discussion were outlined. I told the discussants what I am going to be doing, which is to facilitate.

1. How do you like DT? Do you enjoy it?

2. Do you think it is important for your future career and your life when you finish school

3. Is DT a difficult subject?

4. How about tools and equipment, do have enough in your school?

5. When you compare DT to subjects like Maths, Science, and English do you see DT as important as these subjects?

6. Which part of DT do you enjoy most, the practical or the folio work?

APPENDIX 3

SEMI – STRUCTURED INTERVIEW GUIDE

Semi structured Interview Guide for teachers

1. How do students perceive D&T in your school? Do they take it as an important subject? Do they like it? Do they enjoy it, in your opinion?

2. There is an outcry of shortage of tools and equipment among students across schools. Do you agree that there is shortage of tools and equipment in your school?

3. How often does audit of tools and equipment or inventory take place?

4. Is there any part of D&T that in your opinion students enjoy most, for example practical work or folio work or research, is there any part that you think NO! This area the students enjoy most?

5. Do you believe that DT prepares students for work and for life in general?

6. Are you aware of the general poor examination performance of DT students at JC? What do you think causes this poor performance?

APPENDIX 4

INFORMATION AND CONSENT FORMS

Dear Participant

<u>RE: Agreement to take part in a research project.</u>

My name is Michael Gaotlhobogwe, I am trying to learn about what you think about Design and Technology as a subject at Junior Secondary School.

I would like you to take part in answering written questions on the subject of Design and Technology as you have experienced it in your school. You might also be asked, If you so wish to join with some of your school mates in discussing issues concerning Design and Technology as a subject at Junior Secondary School. The information you give will be treated with strict confidence and you will not be required to mention your names. The sole use of the information will be in the context of my doctoral study, the content of which might be later published in academic or professional journals.

You will be free to ask questions or to withdraw from taking part at any stage during your participation.

Do you want to do this? If you want to take part kindly fill in the tear-off slip below to show your agreement to take part, and take it back to school.

Thank you,

Michael Gaotlhobogwe

I -- agree to take part in the

research project explained above.

Signed -- Date ------------------------

Dear Parent/Guardian

RE: Consent for your child to participate in a research project.

I wish to request your permission to allow your child to participate in a research project to be conducted during the period of December 2007 to Sept 2008. This research project is to fulfil the requirements of my PhD studies at the University of Wales Institute, Cardiff in the United Kingdom. The sole use of the data will be in the context of the doctoral study, the content of which might be later published in academic or professional journals.

The title of my research study is, **Perceptions of students towards Design and Technology in Botswana junior secondary schools: A case study of four junior secondary schools.**

The study will involve the use of a questionnaire based survey on Design and Technology to be completed by students plus focus group discussions with a selected number of Design and Technology students in four selected junior secondary schools. I intend to use a voice recorder during the interviews and the focus group discussions for purposes of recording information for transcribing at a later stage. All responses will be treated in strict accordance with research ethics and the School of Education Ethics committee (UWIC).

Kindly fill in the tear-off slip below to give your permission and give it back to your child to take it back to school.

Thank you,

Michael Gaotlhobogwe

I give permission for my child---to take part in the research project explained above.

Signed --------------------------------------- Parent/Guardian

Signed --------------------------------------- Participant

Dear Participant

RE: Consent for your participation in a research project.

I wish to request your consent to participate in a research project to be conducted during the period of December 2007 to Sept 2008. This research project is to fulfil the requirements of my PhD studies at the University of Wales Institute, Cardiff in the United Kingdom. The sole use of the data will be in the context of the doctoral study, the content of which might be later published in academic or professional journals.

The title of my research study is, **Perceptions of students towards Design and Technology in Botswana junior secondary schools: A case study of four junior secondary schools.**

The study will involve the use of one-on-one interviews with teachers, School Heads, Heads of Department, and D&T Department coordinators at the selected junior secondary schools and the D&T Principal Education Officer. I intend to use a voice recorder during the interviews for purposes of recording information for transcribing at a later stage. All responses will be treated in strict accordance with research ethics and the School of Education Ethics committee (UWIC).

Kindly fill in the tear-off slip below to give your consent.

Thank you,

Michael Gaotlhobogwe

I -- consent to take part in the research project explained above.

Signed -- Date -----------------------

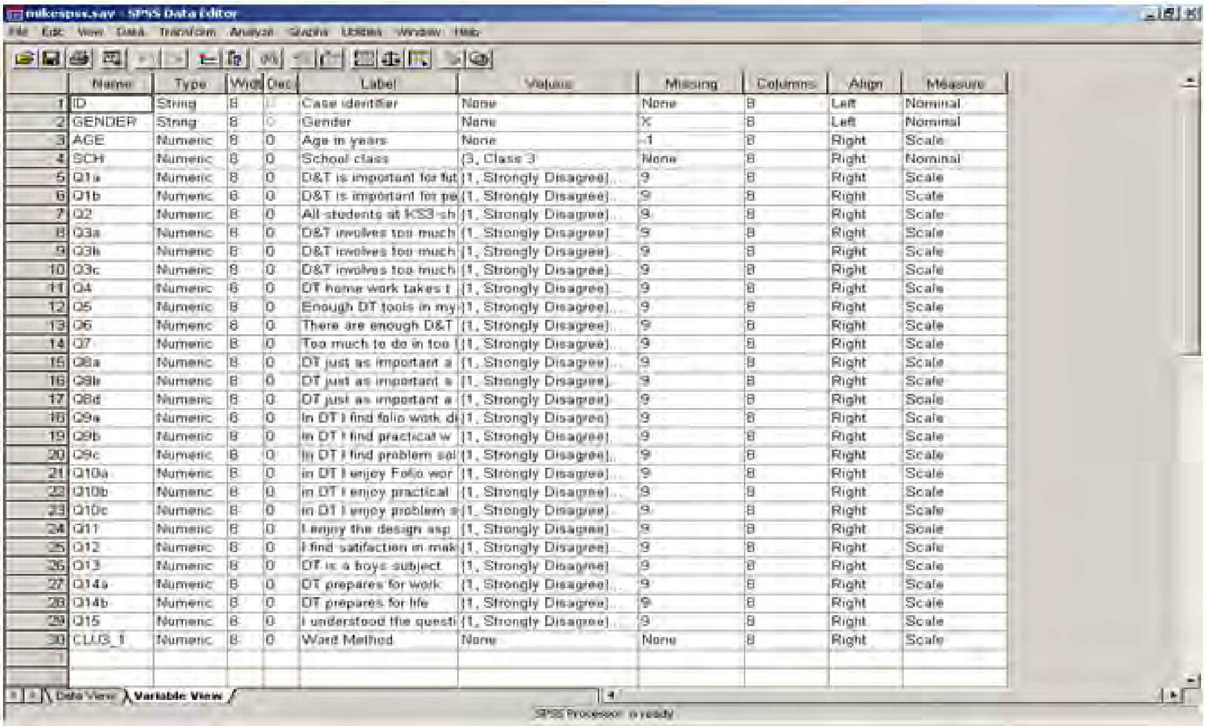
APPENDIX 5

SPSS DATA CODE BOOK

Variable Name	Description	Coding	Missing
ID	case identifier		
GENDER	Gender	M=Male F=Female	X
AGE	Age in years		-1
SCH	School reference	3=Class 3 4=Class 4	-1
Q1a	D&T is important for future career		9
Q1b	D&T is important for personal benefit		9
Q2	All students at KS3 should study DT		9
Q3a	D&T involves too much work in folio work		9
Q3b	D&T involves too much work in practical work		9
Q3c	D&T involves too much work in problem-solving		9
Q4	DT home work takes too much time		9
Q5	Enough DT tools in my school		9
Q6	There are enough D&T workbenches		9
Q7	Too much to do in too little time		9
Q8a	DT just as important as maths		9
Q8b	DT just as important as science		9
Q8d	DT just as important as English		9
Q9a	In DT I find folio work difficult		9
Q9b	In DT I find practical work difficult		9
Q9c	In DT I find problem-solving work difficult		9
Q10a	in DT I enjoy Folio work		9
Q10b	in DT I enjoy practical		9
Q10c	in DT I enjoy problem-solving		9
Q11	I enjoy the design aspect of DT		9
Q12	I find satisfaction in making with my hands		9
Q13	DT is a boys subject		9
Q14a	DT prepares for work		9
Q14b	DT prepares for life		9
Q15	I understood the questionnaire		9
	Coding is the same for all questions		1=strongly Disagree 2= Disagree 3=Agree 4=strongly Agree

APPENDIX 6

SPSS 12.0 DATA EDITOR SCREEN



	Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure
1	ID	String	8	0	Case identifier	None	None	8	Left	Nominal
2	GENDER	String	8	0	Gender	None	X	8	Left	Nominal
3	AGE	Numeric	8	0	Age in years	None	-1	8	Right	Scale
4	SCH	Numeric	8	0	School class	{3, Class 3	None	8	Right	Nominal
5	Q1a	Numeric	8	0	D&T is important for fut	{1, Strongly Disagree}...	9	8	Right	Scale
6	Q1b	Numeric	8	0	D&T is important for pe	{1, Strongly Disagree}...	9	8	Right	Scale
7	Q2	Numeric	8	0	All students at KS3 sh	{1, Strongly Disagree}...	9	8	Right	Scale
8	Q3a	Numeric	8	0	D&T involves too much	{1, Strongly Disagree}...	9	8	Right	Scale
9	Q3b	Numeric	8	0	D&T involves too much	{1, Strongly Disagree}...	9	8	Right	Scale
10	Q3c	Numeric	8	0	D&T involves too much	{1, Strongly Disagree}...	9	8	Right	Scale
11	Q4	Numeric	8	0	DT home work takes t	{1, Strongly Disagree}...	9	8	Right	Scale
12	Q5	Numeric	8	0	Enough DT tools in my	{1, Strongly Disagree}...	9	8	Right	Scale
13	Q6	Numeric	8	0	There are enough D&T	{1, Strongly Disagree}...	9	8	Right	Scale
14	Q7	Numeric	8	0	Too much to do in too	{1, Strongly Disagree}...	9	8	Right	Scale
15	Q8a	Numeric	8	0	DT just as important a	{1, Strongly Disagree}...	9	8	Right	Scale
16	Q8b	Numeric	8	0	DT just as important a	{1, Strongly Disagree}...	9	8	Right	Scale
17	Q8d	Numeric	8	0	DT just as important a	{1, Strongly Disagree}...	9	8	Right	Scale
18	Q9a	Numeric	8	0	In DT I find folio work di	{1, Strongly Disagree}...	9	8	Right	Scale
19	Q9b	Numeric	8	0	in DT I find practical w	{1, Strongly Disagree}...	9	8	Right	Scale
20	Q9c	Numeric	8	0	In DT I find problem sol	{1, Strongly Disagree}...	9	8	Right	Scale
21	Q10a	Numeric	8	0	in DT I enjoy Folio wor	{1, Strongly Disagree}...	9	8	Right	Scale
22	Q10b	Numeric	8	0	in DT I enjoy practical	{1, Strongly Disagree}...	9	8	Right	Scale
23	Q10c	Numeric	8	0	in DT I enjoy problem s	{1, Strongly Disagree}...	9	8	Right	Scale
24	Q11	Numeric	8	0	I enjoy the design asp	{1, Strongly Disagree}...	9	8	Right	Scale
25	Q12	Numeric	8	0	I find satisfaction in mak	{1, Strongly Disagree}...	9	8	Right	Scale
26	Q13	Numeric	8	0	DT is a boys subject	{1, Strongly Disagree}...	9	8	Right	Scale
27	Q14a	Numeric	8	0	DT prepares for work	{1, Strongly Disagree}...	9	8	Right	Scale
28	Q14b	Numeric	8	0	DT prepares for life	{1, Strongly Disagree}...	9	8	Right	Scale
29	Q15	Numeric	8	0	I understood the questi	{1, Strongly Disagree}...	9	8	Right	Scale
30	CLU3_1	Numeric	8	0	Ward Method	None	None	8	Right	Scale

APPENDIX 7

ESTABLISHMENT REGISTER IN THE CASE STUDY SCHOOLS (2006/7)

Establishment Register - Secondary 2006/7

Twenty-four (24) School: 1

Scale	Number	Position	Position Number
D3	1.00	School Head	103242
D4	1.00	Deputy School Head	103243
D4	3.00	Head of Department - Pastoral Care	103244
C1	1.00	Senior Teacher 1 - Computer Awareness	103246
C1	1.00	Senior Teacher 1 - General Studies	123807
C1	1.00	Senior Teacher 1 - Guidance & Counselling	103245
C1	1.00	Senior Teacher 1 - Humanities Subjects	123806
C1	1.00	Senior Teacher 1 - Library Studies	122966
C1	1.00	Senior Teacher 1 - Practical Subjects	122594
C1	1.00	Senior Teacher 1 - Science Subjects	123805
C1	1.00	Senior Teacher 1 - Sports	123808
C1	1.00	Senior Teacher 1 - Staff Development	103247
C4-C2	3.90	Assistant/Teacher/Sr Teacher 2 - Agriculture	103260
C4-C2	3.30	Assistant/Teacher/Sr Teacher 2 - Art	120834
C4-C2	3.30	Assistant/Teacher/Sr.Teacher 2 - Business Studies	120833
C4-C2	2.90	Assistant/Teacher/Sr.Teacher 2 - Design & Technology	103261
C4-C2	3.90	Assistant/Teacher/Sr.Teacher 2 - English	103255
C4-C2	0.80	Assistant/Teacher/Sr.Teacher 2 - Guidance & Counselling	120835
C4-C2	2.90	Assistant/Teacher/Sr.Teacher 2 - Mathematics	103257
C4-C2	2.00	Assistant/Teacher/Sr.Teacher 2 - Moral Education	120831
C4-C2	1.70	Assistant/Teacher/Sr.Teacher 2 - Music	120832
C4-C2	1.70	Assistant/Teacher/Sr.Teacher 2 - Physical Education	123269
C4-C2	1.70	Assistant/Teacher/Sr.Teacher 2 - Religious Education	103263
C4-C2	2.30	Assistant/Teacher/Sr.Teacher 2 - Science	103258
C4-C2	3.90	Assistant/Teacher/Sr.Teacher 2 - Setswana	103256
C4-C2	3.90	Assistant/Teacher/Sr.Teacher 2 - Social Studies	103259
Total	52.20		

Establishment Register - Secondary 2006/7

18 Stream + D-Shift School: 2

Scale	Number	Position	Position Number
D3	1.00	School Head	103418
D4	1.00	Deputy School Head	103419
D4	3.00	Head of Department - Pastoral Care	103420
C1	1.00	Senior Teacher 1 - Computer Awarenesa	111325
C1	1.00	Senior Teacher 1 - General Studies	124002
C1	1.00	Senior Teacher 1 - Guidance & Counselling	103421
C1	1.00	Senior Teacher 1 - Humanities Subjects	124001
C1	1.00	Senior Teacher 1 - Library Studies	122794
C1	1.00	Senior Teacher 1 - Practical Subjects	122592
C1	1.00	Senior Teacher 1 - Science Subjects	124000
C1	1.00	Senior Teacher 1 - Sports	124003
C1	1.00	Senior Teacher 1 - Staff Development	124595
C3	1.00	Teacher - Agriculture	DS08SC
C3	2.00	Teacher - Business Studies	DS06SC
C3	1.00	Teacher - Moral Education	DS07SC
C3	1.00	Teacher - Science	DS09SC
C4	1.00	Assistant Teacher - Art	DS05SC
C4	1.00	Assistant Teacher - English	DS01SC
C4	1.00	Assistant Teacher - Mathematics	DS03SC
C4	1.00	Assistant Teacher - Physical Education	DS04SC
C4	1.00	Assistant Teacher - Setswana	DS02SC
C4-C2	1.90	Assistant/Teacher/Sr.Teacher 2 - Business Studies	120218
C4-C2	1.10	Assistant/Teacher/Sr.Teacher 2 - Religious Education	103439
C4-C2	2.80	Assistant/Teacher/Sr.Teacher 2 - Agriculture	103436
C4-C2	1.90	Assistant/Teacher/Sr.Teacher 2 - Art	120220
C4-C2	1.80	Assistant/Teacher/Sr.Teacher 2 - Design & Technology	103437
C4-C2	2.80	Assistant/Teacher/Sr.Teacher 2 - English	103431
C4-C2	0.60	Assistant/Teacher/Sr.Teacher 2 - Guidance & Counselling	120219
C4-C2	1.90	Assistant/Teacher/Sr.Teacher 2 - Home Economics	103438
C4-C2	1.80	Assistant/Teacher/Sr.Teacher 2 - Mathematics	103433
C4-C2	1.10	Assistant/Teacher/Sr.Teacher 2 - Moral Education	121100
C4-C2	0.10	Assistant/Teacher/Sr.Teacher 2 - Music	120217
C4-C2	1.10	Assistant/Teacher/Sr.Teacher 2 - Physical Education	123293
C4-C2	1.80	Assistant/Teacher/Sr.Teacher 2 - Science	103434
C4-C2	2.80	Assistant/Teacher/Sr.Teacher 2 - Setswana	103432
C4-C2	2.80	Assistant/Teacher/Sr.Teacher 2 - Social Studies	103435
Total	**50.30**		

Establishment Register - Secondary 2006/7

Eighteen (18) **School: 3**

Scale	Number	Position	Position Number
D3	1.00	School Head	103726
D4	1.00	Deputy School Head	103727
D4	3.00	Head of Department - Pastoral Care	103728
C1	1.00	Senior Teacher 1 - Computer Awareness	103730
C1	1.00	Senior Teacher 1 - General Studies	124281
C1	1.00	Senior Teacher 1 - Guidance & Counselling	103729
C1	1.00	Senior Teacher 1 - Humanities Subjects	124280
C1	1.00	Senior Teacher 1 - Library Studies	122806
C1	1.00	Senior Teacher 1 - Practical Subjects	122664
C1	1.00	Senior Teacher 1 - Science Subjects	124279
C1	1.00	Senior Teacher 1 - Sports	124282
C1	1.00	Senior Teacher 1 - Staff Development	103731
C4-C2	2.80	Assistant/Teacher/Sr.Teacher 2 - Agriculture	103744
C4-C2	1.90	Assistant/Teacher/Sr.Teacher 2 - Art	120414
C4-C2	1.90	Assistant/Teacher/Sr.Teacher 2 - Business Studies	120413
C4-C2	1.80	Assistant/Teacher/Sr.Teacher 2 - Design & Technology	103745
C4-C2	2.80	Assistant/Teacher/Sr.Teacher 2 - English	103739
C4-C2	0.60	Assistant/Teacher/Sr.Teacher 2 - Guidance & Counselling	120415
C4-C2	1.90	Assistant/Teacher/Sr.Teacher 2 - Home Economics	103746
C4-C2	1.80	Assistant/Teacher/Sr.Teacher 2 - Mathematics	103741
C4-C2	1.10	Assistant/Teacher/Sr.Teacher 2 - Moral Education	120995
C4-C2	0.10	Assistant/Teacher/Sr.Teacher 2 - Music	120412
C4-C2	1.10	Assistant/Teacher/Sr.Teacher 2 - Physical Education	122229
C4-C2	1.10	Assistant/Teacher/Sr.Teacher 2 - Religious Education	103747
C4-C2	1.80	Assistant/Teacher/Sr.Teacher 2 - Science	103742
C4-C2	2.80	Assistant/Teacher/Sr.Teacher 2 - Setswana	103740
C4-C2	2.80	Assistant/Teacher/Sr.Teacher 2 - Social Studies	103743
Total	**40.30**		

Establishment Register - Secondary 2006/7

Eighteen (18) **School: 4**

Scale	Number	Position	Position Number
D3	1.00	School Head	102670
D4	1.00	Deputy School Head	102671
D4	3.00	Head of Department - Pastoral Care	102672
C1	1.00	Senior Teacher 1 - Computer Awareness	102675
C1	1.00	Senior Teacher 1 - General Studies	124300
C1	1.00	Senior Teacher 1 - Guidance & Counselling	102673
C1	1.00	Senior Teacher 1 - Humanities Subjects	124299
C1	1.00	Senior Teacher 1 - Library Studies	122810
C1	1.00	Senior Teacher 1 - Practical Subjects	122668
C1	1.00	Senior Teacher 1 - Science Subjects	124298
C1	1.00	Senior Teacher 1 - Sports	124301
C1	1.00	Senior Teacher 1 - Staff Development	102676
C4-C2	1.10	Assistant/Teacher/Snr Tchr-2 - Moral Education	102674
C4-C2	2.80	Assistant/Teacher/Sr Teacher 2 - Agriculture	102688
C4-C2	1.90	Assistant/Teacher/Sr.Teacher 2 - Art	120442
C4-C2	1.90	Assistant/Teacher/Sr Teacher 2 - Business Studies	120441
C4-C2	1.80	Assistant/Teacher/Sr.Teacher 2 - Design & Technology	102689
C4-C2	2.80	Assistant/Teacher/Sr.Teacher 2 - English	102683
C4-C2	0.60	Assistant/Teacher/Sr Teacher 2 - Guidance & Counselling	120443
C4-C2	1.90	Assistant/Teacher/Sr.Teacher 2 - Home Economics	102690
C4-C2	1.80	Assistant/Teacher/Sr.Teacher 2 - Mathematics	102685
C4-C2	1.10	Assistant/Teacher/Sr.Teacher 2 - Music	120440
C4-C2	1.10	Assistant/Teacher/Sr.Teacher 2 - Physical Education	123303
C4-C2	1.10	Assistant/Teacher/Sr.Teacher 2 - Religious Education	102691
C4-C2	1.80	Assistant/Teacher/Sr Teacher 2 - Science	102686
C4-C2	2.80	Assistant/Teacher/Sr Teacher 2 - Setswana	102684
C4-C2	2.80	Assistant/Teacher/Sr.Teacher 2 - Social Studies	102687
Total	41.30		

Establishment Register - Secondary 2006/7

Eighteen (18) School: 5

Scale	Number	Position	Position Number
D3	1.00	School Head	104012
D4	1.00	Deputy School Head	104013
D4	3.00	Head of Department - Pastoral Care	104014
C1	1.00	Senior Teacher 1 - Computer Awareness	104016
C1	1.00	Senior Teacher 1 - General Studies	123477
C1	1.00	Senior Teacher 1 - Guidance & Counselling	104015
C1	1.00	Senior Teacher 1 - Humanities Subjects	123475
C1	1.00	Senior Teacher 1 - Library Studies	122853
C1	1.00	Senior Teacher 1 - Practical Subjects	104018
C1	1.00	Senior Teacher 1 - Science Subjects	123474
C1	1.00	Senior Teacher 1 - Sports	123478
C1	1.00	Senior Teacher 1 - Staff Development	104017
C4-C2	1.10	Assistant/Teacher/Sr.Teacher 2 - Religious Education	104033
C4-C2	2.80	Assistant/Teacher/Sr.Teacher 2 - Agriculture	104030
C4-C2	1.90	Assistant/Teacher/Sr.Teacher 2 - Art	120701
C4-C2	1.90	Assistant/Teacher/Sr.Teacher 2 - Business Studies	120700
C4-C2	1.80	Assistant/Teacher/Sr.Teacher 2 - Design & Technology	104031
C4-C2	2.80	Assistant/Teacher/Sr.Teacher 2 - English	104025
C4-C2	0.60	Assistant/Teacher/Sr.Teacher 2 - Guidance & Counselling	120702
C4-C2	1.90	Assistant/Teacher/Sr.Teacher 2 - Home Economics	104032
C4-C2	1.80	Assistant/Teacher/Sr.Teacher 2 - Mathematics	104027
C4-C2	1.10	Assistant/Teacher/Sr.Teacher 2 - Moral Education	121075
C4-C2	1.10	Assistant/Teacher/Sr.Teacher 2 - Music	120699
C4-C2	1.10	Assistant/Teacher/Sr.Teacher 2 - Physical Education	123323
C4-C2	1.80	Assistant/Teacher/Sr.Teacher 2 - Science	104028
C4-C2	2.80	Assistant/Teacher/Sr.Teacher 2 - Setswana	104026
C4-C2	2.80	Assistant/Teacher/Sr.Teacher 2 - Social Studies	104029
Total	41.30		

APPENDIX 8

LETTER REQUESTING PERMISSION TO CONDUCT STUDY

172 Coed Edeyrn
Llanedeyrn
Cardiff
CF 23 9JY
United Kingdom

13 Nov. 07

The Permanent Secretary
Ministry of Education
Department of Secondary Education
Private Bag 00297
Gaborone

Dear Sir/Madam

RE: Request to conduct a study on Design and Technology in Junior Secondary Schools.

I wish to request your permission to conduct a study in Junior Secondary schools in the South Central Region Inspectoral area. This study is to fulfil the requirements of my PhD studies at the University of Wales Institute, Cardiff in the United Kingdom. The sole use of the data will be in the context of the doctoral study, the content of which might be later published in academic or professional journals.

The title of my research study is: **Error! Not a valid bookmark self-reference.**

The study is intended to be piloted in one junior secondary school, followed by the main research in 4 junior secondary schools in South Central Inspectoral Region. The study will involve the use of a questionnaire based survey on Design and Technology to be completed by teachers and students: interviews with School Heads, Heads of Department, Design and Technology department coordinators and Principal Education Officers (D&T) plus focus group discussions with a selected number of Design and Technology students in the four schools. I intend to use a voice recorder during the interviews and the focus group discussions for purposes of recording information for transcribing at a later stage. All responses will be treated in strict accordance with research ethics and the School of Education Ethics committee (UWIC). Piloting is intended to be carried out between the months of October and December, 2007, while the study is intended to be carried out between May and Sept, 2008.

Please find enclosed the research proposal and my Curriculum Vitae.

I thank you in anticipation.

Michael Gaotlhobogwe

CC: The Director, Secondary Department

APPENDIX 9

LETTER GRANTING PERMISSION TO CONDUCT STUDY

TELEPHONE: 3655400
MINISTRY OF EDUCATION
TELEX: 2944 THUTO BD PRIVATE BAG 005
FAX: 351624/3655408
GABORONE
REFERENCE: E11/17 XXXXII (17)
BOTSWANA

REPUBLIC OF BOTSWANA

15th February 2008

To: Mr. Michael Gaotlhobogwe

RE: PERMISSION TO CONDUCT RESEARCH ON "*PERCEPTIONS OF STUDENTS TOWARDS DESIGN AND TECHNOLOGY IN BOTSWANA*"

We acknowledge receipt of your application to conduct research on "Perceptions of Students towards Design and Technology in Botswana"

Therefore this serves to grant you a permit to conduct your study focusing on why are enrolment numbers in design and technology going down, what factors influence students" attitudes and perceptions towards design and technology. The permit is valid for a period of one year effective from 15th February 2008 to 5th February 2009.

You are furthermore requested to submit a copy of your final report of the study to the Division of Planning, Statistics and Research, Ministry of Education, Botswana.

Thank you.

Yours Faithfully

Boikhutso Monyaku
For /Permanent Secretary

APPENDIX 10

RESEARCH PERMIT APPLICATION FORM

REPUBLIC OF BOTSWANA

Research Permit Application Form

Two copies of this form should be completed and signed by the applicant who wishes to obtain a permit for conducting research in the Republic of Botswana, and sent to the Permanent Secretary of the relevant Ministry (See guidelines for addresses). These forms should not be submitted unless the Guidelines for the Research have been carefully studied. A copy of any project proposal submitted to funding agencies must accompany this application. Please refer to annexure I attached to this application form. **Fill this form in full.**

Description of the Proposal

4. Title of Research

Perceptions of students towards Design and Technology in Botswana: A case of four Junior Secondary Schools

5. Name and Address of Applicant

Title: Mr. ~~/ Mrs. / Miss/ Dr. / Prof:~~

Michael Gaotlhobogwe
172 Coed Edeyrn
Llanedeyrn
Cardiff, CF 23 9JY

Telephone: 0044 2920 734046

Fax: …………………………………………………………………………

E-mail M.Gaotlhobogwe@uwic.ac.uk.

6. Name and address of home institutions (if any) which you are affiliated
University of Botswana
Private Bag 0022
Gaborone

4. **Name and address of supervisor of research in home country or responsible referee:**
Dr Janet Laugharne
Cardiff School of Education
University of Wales Institute Cardiff

Cyncoed Road
Cardiff
CF23 6XD
Research plans

5. a) Main aims (general)
To investigate perceptions of junior secondary school students towards design and technology.

Objective: detailed description of issues/problems and/or topics to be investigated, relevance of the research; hypothesis etc. (Attach a separate sheet if necessary).

My objective is to address the following research questions:

- Why are enrolment numbers in design and technology going down?
- What factors influence student's attitudes and perceptions towards design and technology?
- What can be done to address the problem of falling enrolment?

c) **Methods of techniques**

Methods will involve the use of questionnaires to be completed by students, focus group discussions with groups of students and one-on-one interviews with teachers, Head of Department, Subject Coordinators and Principal Education Officers.

6. Budget for the costs in Botswana (give detailed breakdown of research costs such as subsistence, travelling, local staff, secretarial service, seminar, printing etc). Please state the amount in Pula

Subsistence	P0000.00
Travelling	P3000.00 (estimate)
Secretarial service	P3000.00 (estimate)
Printing	P1500.00 (estimate)
Telephone and fax	P 500.00 (estimate)

7. Name and address of financial sponsor(s) of the research (if appropriate)

See (3) above…

- **Has funding already been obtained? ~~(yes~~/No)**

a) If yes, please state the total amount granted, and the name and address of the funding agency:

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

1. **If no, what steps are being taken to ensure sufficient funding?**

The University of Botswana as the sponsor provides full financial support as per a budget compiled by researcher and approved by the university.

- **If you have previously done research in Botswana please give details of the research**.

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

- **Name and address of institution in Botswana to which the researcher is to be affiliated**

See (3) above…

- **Details of Botswana – based personnel that will be involved (names, functions, qualifications).**

……Beauty Gaotlhobogwe will distribute the questionnaire to the school that will have been identified for piloting purposes. She holds a Masters Degree in Special Education (Visual Impairment).

- **Places in Botswana where the research is to be undertaken**

Gaborone, Mochudi, Molepolole and Ramotswa.

- **Proposed time – schedule for the research**

Activity	Duration	Calender	Where
Proposal writing & presentation	10 months	Oct 06 – July 07	UWIC
Intruments piloting	3 months	Dec 07 – Mar 08	Botswana
Data collection	7 months	April 08 – Oct 08	Botswana
Data Analysis	7 months	Jan09 – Aug 09	UWIC
Writing up	9 months	Sep 09 – June 10	UWIC
Submission		September 10	UWIC

- **Plans for dissemination of research findings**

Not yet decided.

- **How are the research findings going to be used in the home country?**

Findings will be discussed with the relevant officers in the ministry of education for possible incorporation into policy and practice...

- **Any other information**

NO.

- **Signature of applicant:** ....

18. Date 23 November 2007.

APPENDIX 11

JUNIOR SECONDARY SCHOOL DESIGN AND TECHNOLOGY SYLLABUS

TOPIC	GENERAL OBJECTIVES	SPECIFIC OBJECTIVES
FOCUS- YEAR 1: SKILLS AND KNOWLEDGE ORIENTATION		
UNIT 1: SAFETY AND FIRST AID		
	Learners should be able to:	Learners should be able to:
1. Safety Precautions	1.1 apply safety precautions in the workshop	1.1.1. use protective clothing in the workshop. 1.1.2. use tools and equipment safely applying universal safety precautions that prevent transmission of infections e.g. HIV etc. 1.1.3. store tools and equipment safely. 1.1.4. keep the workshop clean. 1.1.5. dispose waste safely. 1.1.6. use sockets and switches safely. 1.1.7. respond to the warning signs.
	1.2 understand and appreciate workshop hazards.	1.2.1 Discuss different forms of hazards. 1.2.2 identify area with common hazards.
2. First Aid	2.1 apply simple First Aid in the workshop.	2.1.1 treat cuts safely 2.1.2. treat bruises safely 2.1.3. treat burns safely 2.1.4. handle and treat shocks. 2.1.5. control bleeding 2.1.6 dispose clinical waste safely 2.1.7 discuss ways of handling contagious infections such as HIV and AIDS.

UNIT 2: MATERIALS

TOPIC	GENERAL OBJECTIVES Learners should be able to:	SPECIFIC OBJECTIVES Learners should be able to:
1. Timber	1.1 acquire knowledge and skills in the use of Timber.	1.1.1. classify timber 1.1.2 illustrate methods of seasoning 1.1.3 illustrate methods of conversion 1.1.4 select timber according to physical properties. 1.1.5 dispose timber waste safely 1.1.6 work with timber safely 1.1.6 re-use timber.
2. Manufactured Boards	2.1. develop skills in the use of Manufactured Boards.	2.1.1 identify manufactured boards. 2.1.2 select manufactured boards according to physical properties. 2.1.3 use manufactured board safely. 2.1.4 dispose manufactured boards waste safely.
3. Metals	3.1 use of Metals appropriately.	3.1.1 classify metals. 3.1.2 select metals according to their physical properties. 3.1.3 work with metals safely. 3.1.4 dispose metal waste safely.
4. Plastics	4.1 use plastics appropriately.	4.1.1 classify plastics. 4.1.2 select plastics according to their physical properties. 4.1.3 work with plastics safely. 4.1.4 dispose plastics waste safely.
5. Adhesives	5.1 apply knowledge and skills of Adhesives.	5.1.1 state the characteristics of each of the adhesives. 5.1.2 select the appropriate adhesives when joining materials. 5.1.3 demonstrate safe measures when applying adhesives. 5.1.4 store adhesives appropriately. 5.1.5 dispose adhesives waste safely.

6. Abrasives	6.1 acquire and apply knowledge and skills of Abrasives.	6.1.1 select appropriate abrasives when abrading materials. 6.1.2 state the different grades of abrasives. 6.1.3 demonstrate the correct order of abrading. 6.1.4 work safely with abrasives. 6.1.5 dispose abrasives waste safely.
7. Fixings	7.1 acquire and apply knowledge and skills of Fixings.	7.1.1 illustrate fixings. 7.1.2 label parts of fixings. 7.1.3 select appropriate fixings when joining material. 7.1.4 work safely with fixings to prevent spreading contagious infections.
8. Fittings	8.1 acquire and apply knowledge and skills of Fittings.	8.1.1 illustrate fittings. 8.1.2 label parts of fittings. 8.1.3 select appropriate fittings when joining material. 8.1.4 work safely with fittings.
9. Finishes and Finishing	9.1 acquire and apply knowledge and skills on Finishes and Finishing.	9.1.1 classify finishes. 9.1.2 state the characteristics of finishes. 9.1.3 select appropriate finishes and solvents. 9.1.5 store finishes and solvents appropriately. 9.1.6 prepare surface of materials for appropriate finish. 9.1.7 demonstrate the correct order of applying finishes. 9.1.7 work safely with finishes and solvents. 9.1.8 demonstrate care for finishing equipment. 9.1.9 demonstrate the safe disposal of finishes and solvents.

UNIT 3: COMMUNICATION

TOPIC	GENERAL OBJECTIVES	SPECIFIC OBJECTIVES
	Learners should be able to:	Learners should be able to:
1. Graphics	1.1 use conversional methods in graphical communication.	1.1.1 construct lines. 1.1.2 bisect a line 1.1.3 divide a line into equal parts. 1.1.4 construct a perpendicular line. 1.1.5 construct and bisect angles. 1.1.6 construct quadrilaterals. 1.1.7 construct a circle and a tangencies 1.1.8 construct polygons 1.1.9 enhance drawings using different presentation techniques. 1.1.10 draw simple solids and blocks in orthographic using 1^{st} angle projection
2. Marketing	2.1 develop skills in marketing	2.1.1 select appropriate advertising strategies. 2.1.2 identify a target market for their product. 2.1.3 identify ways of packaging their product. 2.1.4 determine the cost of their product.
3. Design Process	3.1 design and make products using own initiative.	3.1.1 conduct basic research 3.1.2 generate possible solutions. 3.1.3 produce production plan 3.1.4 produce a quality product. 3.1.5 evaluate a product.

UNIT 4: TECHNOLOGIES		
TOPIC	GENERAL OBJECTIVES	SPECIFIC OBJECTIVES
	Learners should be able to:	Learners should be able to:
1. Structures	1.1 apply knowledge and skills of Structures in problem solving	1.1.1 define a structure. 1.1.2 identify types of structures. 1.1.3 classify structures. 1.1.4 differentiate between types of structures. 1.1.5 use simple materials to produce a model structure
2.Mechanisms	2.1 apply knowledge and skills of Mechanisms.	2.1.1 define mechanisms. 2.1.2 identify different types of mechanisms. 2.1.3 explain forms of motion. 2.1.4 describe ways of recycling metals 2.1.5 use simple materials to produce a working model
3.Electricity and Electronics	3.1 acquire and apply knowledge of electricity and electronics.	3.1.1 define electricity. 3.1.2 define electronics. 3.1.3 state the uses of electricity. 3.1.4 identify electronic components. 3.1.5 Illustrate electronic component symbols using conventional methods. 3.1.6 construct a simple circuit.

UNIT 5: TOOLS AND PROCESSES		
TOPIC	GENERAL OBJECTIVES Learners should be able to:	SPECIFIC OBJECTIVES Learners should be able to:
1. Measuring and Marking out tools.	1.1 acquires and apply techniques of Measuring and Marking out.	1.1 1 illustrate measuring and marking out tools 1.1.2 label the parts of measuring and marking out tools 1.1.3 select appropriate measuring and marking out tools 1 1.4 use measuring and marking out tools correctly 1.1.5 use measuring and marking out tools safely 1.1.6 check for squareness and flatness. 1.1.7 describe principles of marking out materials
2. Saws and Sawing	2.1 acquire and apply knowledge and skills of saws and sawing	2.1.1 classify saws 2.1.2 illustrate saws 2.1.3 state the specific use of saws 2.1.4 explain the function of parts of saws 2.1.5 demonstrate correct ways of sawing 2.1.6 select appropriate saws when cutting materials 2.1.7 work with saws safely 2.1.8 demonstrate care and maintenance of saws.
3.Planes and Planing	3.1. acquire and apply knowledge and skills of planes and planing	3.1.1 identify planes 3.1.2 state specific use of planes 3.1.3 explain functions of parts of planes 3.1.4 select appropriate planes for the correct job 3.1.5 handle planes safely 3.1.6 demonstrate care and maintenance for planes 3.1.7 demonstrate the correct ways of Planing.

4.Files and Filing	4.1 acquire and apply knowledge and skills of Files and Filing.	4.1.1 classify files 4.1.2 illustrate files. 4.1.3 state the specific use of files 4.1.4 explain the function of parts of files 4.1.5 demonstrate correct ways of filing 4.1.6 select appropriate files when filing materials 4.1.7 work with files safely 4.1.8 demonstrate care and maintenance of files
5.Drills, Drilling and Boring tools	5.1 apply skills of Drills, Drilling and Boring.	5.1.1 identify drill bits and boring bits 5.1.2 illustrate drill bits and boring bits 5.1.3 label parts of drill bits and boring bits 5.1.4 state specific use of drill bits and boring bits 5.1.5 identify types of holes 5.1.6 select appropriate drill bits and boring bits for the correct job 5.1.7 handle drill bits and boring bits safely 5.1.8 drill and bore holes in wood, metals and plastics accurately. 5.1.9 demonstrate correct ways of drilling and boring
6.Chisels and Chiseling	6.1 develop skills of Chiseling	6.1.1 classify chisels 6.1.2 illustrate chisels 6.1.3 demonstrate correct ways of chiseling 6.1.4 select appropriate chisels when chiseling 6.1.5 work with chisels safely 6.1.6 demonstrate care and maintenance of chisels.
7.Shears and Shearing	7.1 acquire and apply knowledge and skills of Shears and Shearing.	7.1.1 label parts of shears 7.1.2 demonstrate correct ways of shearing 7.1.3 select appropriate shears when shearing 7.1.4 work with shears safely 7.1.5 demonstrate care of shears

8 Holding and Cramping tools	8.1 apply skills of Holding and Cramping	8.1.1 identify holding and cramping tools 8.1.2 state uses of holding and cramping tools 8.1.3 use appropriate holding and cramping tools when working on material and assembling 8.1.4 handle holding and cramping tools safely 8.1.5 demonstrate care and maintenance for holding and cramping tools
9.Driving/ Impelling/Percussion Tools	9.1 acquire and apply knowledge and skills of Driving, Impelling, Percussion tools	9.1.1 identify driving and percussion tools. 9.1.2 demonstrate the correct use of driving and percussion tools 9.1.3 select appropriate driving and percussion tools 9.1.4 work with driving and percussion tools safely 9.1.5 demonstrate care of driving and percussion tools
10. Deforming	10.1 acquire and apply knowledge and skills of Deforming	10.1.1 define deforming. 10.1.2 discuss deforming processes. 10.1.3 identify materials and equipment used in deforming processes. 10.1.4 label equipment used in deforming 10.1.5 select appropriate deforming processes 10.1.6 work safely with deforming equipment 10.1.7 demonstrate care for deforming equipment.
11. Joining and Fabrication	11.1 acquire and apply knowledge and skills of Joining and Fabricating materials.	11.1.1 identify methods of joining and fabricating materials. 11.1.2 state specific use of joints. 11.1.3 select the appropriate methods of joining and fabricating materials. 11.1.4 make an appropriate joint for the job.
	11.2 acquire and apply knowledge and skills of Joining and Fabricating equipment.	11.2.1 identify joining and fabricating tools and equipment. 11.2.2 select appropriate tools and equipment when constructing joints 11.2.3 handle joining and fabricating tools and equipment safely. 11.2.4 demonstrate care of joining and fabricating tools and equipment.

FOCUS- YEAR 2: DESIGN TASKS AND PROJECT ORIENTATION

UNIT 2: MATERIALS

TOPIC	GENERAL OBJECTIVES	SPECIFIC OBJECTIVES
	Learners should be able to:	Learners should be able to:
1. Timber	1.1 acquire knowledge and skills in the use of Timber.	1.1.1 select timber according to working properties. 1.1.2 illustrate methods of storing timber. 1.1.3 identify commercially available sections of timber. 1.1.4 work with timber safely. 1.1.5 dispose timber waste safely 1.1 6 .identify timber defects. 1.1.7 re-use timber.
2. Manufactured Boards	2.1 apply skills in the use of Manufactured Boards.	2.1.1 select manufactured boards according to properties. 2.1.2 illustrate methods of storing manufactured boards. 2.1.3 use manufactured board safely. 2.1.4 dispose manufactured boards waste safely.
3. Metals	3.1 acquire and apply knowledge and skills in the use of metals	3.1.1 select metals according to their working properties. 3.1.2 illustrate methods of storing metals. 3.1.3 identify commercially available sections of metals. 3.1.4 work with metals safely. 3.1.5 dispose metal waste safely. 3.1.6 re-use metals. 3.1.7 describe ways of recycling metals 3.1.8 demonstrate perseverance when working with metals
4. Plastics	4.1 acquire knowledge and skills in the use of plastics.	4.1.1 select plastics according to their working properties. 4.1.2 illustrate methods of storing plastics. 4.1.3 identify commercially available sections of plastics. 4.1.4 work with plastics safely. 4.1.5 dispose plastics waste safely. 4.1.6 re-use plastics.

		4.1.7 describe ways of recycling plastics
5. Additional Materials	5.1 acquire and use the knowledge of locally available materials appropriately	5.1.1 identify the materials and their sources. 5.1.2 incorporate locally available materials in projects. 5.1.3 work safely with additional materials. 5.1.4 dispose material waste safely
6. Adhesives	6.1 apply knowledge and skills in the use of Adhesives.	6.1.1 state the characteristics of each of the adhesives. 6.1.2 select the appropriate adhesives when joining materials. 6.1.3 demonstrate safe measures when applying adhesives. 6.1.4 dispose adhesives waste safely.
7. Abrasives	7.1 apply knowledge and skills in the use of Abrasives.	7.1.1 select appropriate abrasives when abrading materials. 7.1.2 state the different grades of abrasives. 7.1.3 demonstrate the correct order of abrading. 7.1.4 work safely with abrasives. 7.1.5 dispose abrasives waste safely.
8. Fixings	8.1 develop knowledge and skills in the use of Fixings.	8.1.1 illustrate fixings. 8.1.2 label parts of fixings. 8.1.3 select appropriate fixings when joining material. 8.1.4 differentiate fixings into temporary and permanent. 8.1.5 work safely with fixings
9. Fittings	9.1 acquire knowledge and skills in the use of fittings.	9.1.1 illustrate fittings. 9.1.2 label parts of fittings. 9.1.3 select appropriate fittings when joining material. 9.1.4 work safely with fittings.
10. Finishes and Finishing	10.1 apply knowledge and skills on Finishes and Finishing.	10.1.1 prepare surface of materials for appropriate finish. 10.1.2 demonstrate different methods of finishing. 12.1.3 demonstrate safe measures when using finishes and solvents. 10.1.4 demonstrate the correct order of applying finishes. 10.1.5 work safely with finishes and solvents. 10.1.6 select appropriate finishes and solvents.

		10.1.7 demonstrate care for finishing equipment. 10.1.8 Demonstrate the safe disposal of finishes and solvents waste.

UNIT 3: COMMUNICATION

TOPIC	GENERAL OBJECTIVES Learners should be able to:	SPECIFIC OBJECTIVES Learners should be able to:
1. Graphics	1.1 use IT and conventional methods in graphical communication.	1.1.1 construct a circle and tangencies using IT. 1.1.2 construct polygons using IT. 1.1.3 produce 2-dimensional and 3-dimensional sketches using both IT and Conventional methods. 1.1.4 draw objects in 1 - point and 2 - point perspective using both IT and Conventional methods. 1.1.5 enhance drawings using different presentation techniques using both IT and Conventional methods. 1.1.6 draw complex solids and blocks in orthographic using 1st angle projection using both IT and Conventional methods. 1.1.7 produce annotations using IT 1.1.8 convert Isometric projection drawing into orthographic projection 1.1.9 convert orthographic projection drawing into Isometric projection
2. Marketing	2.1 acquire and apply knowledge and skills in Marketing	2.1.1 select appropriate advertising strategies. 2.1.2 identify a target market for a product. 2.1.3 design a package for product 2.1.4 determine the cost of a product. 2.1.5 use IT in advertising
3. Design Process	3.1 develop the ability to design and make products using own initiative.	3.1.1 analyse a given theme. 3.1.2 derive a situation from the theme. 3.1.3 identify a problem from a situation. 3.1.4 formulate a design brief. 3.1.5 formulate relevant specifications. 3.1.6 explore a variety of possible solutions. 3.1.7 select a solution to the problem 3.1.8 show logical progression of all aspects of development

		3.1.9 produce a working drawing. 3.1.10 produce a detailed production plan 3.1.11 produce a quality product. 3.1.12 evaluate their product.

UNIT 4: TECHNOLOGIES

TOPIC	GENERAL OBJECTIVES Learners should be able to:	SPECIFIC OBJECTIVES Learners should be able to:
1. Structures	1.1 apply knowledge and skills of Structures in problem solving	1.1.1 differentiate between static and dynamic forms of forces. 1.1.2 describe types of forces. 1.1.3 describe the principle of triangulation. 1.1.4 apply the principle of triangulation. 1.1.5 discuss causes of structural failure. 1.1.6 select an appropriate structure to meet the demands of a design situation.
2.Mechanisms	2.1 develop knowledge and skills of Mechanisms.	2.1.1 illustrate various forms of motion. 2.1.2 classify levers. 2.1.3 describe different types of linkages. 2.1.4 describe different types of pulleys. 2.1.5 calculate the speed of the driver and driven pulleys. 2.1.6 demonstrate various motions performed by mechanisms. 2.1.7 select and use appropriate mechanisms in a design situation.
3. Energy	3.1 acquire and apply knowledge and skills of Energy in problem solving.	3.1.1 define energy. 3.1.2 describe the different forms of energy. 3.1.3 identify different sources of energy.
4. Electricity And Electronics	4.1 acquire and apply knowledge and skills of electricity and electronics	4.1.1 illustrate electronic components symbols 4.1.2 state uses of electronic components. 4.1.3 interpret a circuit diagram. 4.1.4 draw a circuit diagram using IT. 4.1.5 design simple electronic circuits using IT 4.1.6 use Ohm's law to determine voltage, current and resistance. 4.1.7 work safely with electronic equipment. 4.1.8 construct an electronic product in response to a design situation.

UNIT 5: TOOLS AND PROCESSES

TOPIC	GENERAL OBJECTIVES	SPECIFIC OBJECTIVES
	Learners should be able to:	Learners should be able to:
1. Measuring And Marking out tools.	1.1 acquire and apply techniques of Measuring and Marking out.	1.1.1 illustrate measuring and marking out tools 1.1.2 label the parts of measuring and marking out tools 1.1.3 select appropriate measuring and marking out tools 1 1.4 use measuring and marking out tools correctly 1.1.5 use measuring and marking out tools safely 1.1.6 check for squareness and flatness.
2. Saws and Sawing	2.1 apply knowledge and skills of Saws and Sawing	2.1.1 illustrate saws 2.1.2 state the specific use of saws 2.1.3 explain the function of parts of saws 2.1.4 demonstrate correct ways of sawing 2.1.5 select appropriate saws when cutting materials 2.1.6 work safely with saws 2.1.7 demonstrate care and maintenance of saws.
3. Planes and Planing	3.1 demonstrate knowledge and understanding of Planes and Planing processes.	3.1.1 identify planes 3.1.2 state specific use of planes 3.1.3 explain functions of parts of planes 3.1.4 identify different processes of planing materials 3.1.5 select appropriate planes for the correct job 3.1.6 handle planes safely 3.1.7 demonstrate care and maintenance for planes 3.1.8 demonstrate the correct ways of Planing.
4. Files and Filing	4.1 demonstrate knowledge and understanding of files and filing processes..	4.1.1 classify files 4.1.2 illustrate files. 4.1.3 state the specific use of files 4.1.4 explain the function of parts of files 4.1.5 demonstrate correct ways of filing

		4.1.6 select appropriate files when filing materials 4.1.7 work with files safely 4.1.8 demonstrate care and maintenance of files
5. Drills, Drilling and Boring tools	5.1 apply knowledge and skills of Drills, Drilling and Boring.	5.1.1 identify drill bits and boring bits 5.1.2 illustrate drill bits and boring bits 5.1.3 label parts of drill bits and boring bits 5.1.4 state specific use of drill bits and boring bits 5.1.5 select appropriate drill bits and boring bits for the correct job 5.1.6 handle drill bits and boring bits safely 5.1.7 drill holes in wood, metals and plastics accurately 5.1.8 bore holes in wood accurately 5.1.9 demonstrate correct ways of drilling and boring
6. Chisels and Chiseling	6.1 acquire and apply knowledge and skills of Chisels and Chiseling	6.1.1 classify chisels 6.1.2 illustrate chisels 6.1.3 demonstrate correct ways of chiseling 6.1.4 select appropriate chisels when chiseling 6.1.5 work with chisels safely 6.1.6 demonstrate care and maintenance of chisels.
7. Shears and Shearing	7.1 acquire and apply knowledge and skills of Shears and Shearing.	7.1.1 label parts of shears 7.1.2 demonstrate correct ways of shearing 7.1.3 select appropriate shears when shearing 7.1.4 work safely with shears 7.1.4 demonstrate care of shears
8. Holding and cramping tools	8.1 acquire and apply knowledge and skills of holding and cramping tools	8.1.1 identify holding and cramping tools 8.1.2 state uses of holding and cramping tools 8.1.3 use appropriate holding and cramping tools when working on material and assembling 8.1.4 handle holding and cramping tools safely 8.1.5 demonstrate care and maintenance for holding and cramping tools

9.Driving,Impelling and Percussion tools	9.1 demonstrate knowledge and understanding of driving, impelling and percussion tools	9.1.1 demonstrate the correct use of driving and percussion tools 9.1.2 select appropriate driving and percussion tools 9.1.3 work with driving and percussion tools safely 9.1.4 demonstrate care of driving and percussion tools
10. Forming Plastics	10.1 acquire and apply knowledge and skills of forming tools	10.1.1 define forming. 10.1.2 discuss forming processes 10.1.3 identify materials and equipment used in forming processes 10.1.4 label parts of equipment used in forming 10.1.5 select appropriate forming processes 10.1.6 work safely with forming equipment 10.1.7 demonstrate care for forming equipment
11. Deforming	11. acquire and apply knowledge and skills of deforming	11.1.1 define deforming 11.1.2 discuss deforming processes 11.1.3 identify materials and equipment used in deforming processes 11.1.4 label parts of equipment used in deforming 11.1.5 select appropriate deforming processes 11.1.6 work safely with deforming equipment 11.1.7 demonstrate care for deforming equipment
12. Joining and Fabrication	12.1 demonstrate knowledge and understanding of joining and fabricating materials	12.1.1 identify methods of joining and fabricating 12.1.2 illustrate joints. 12.1.3 classify joints as temporary and permanent 12.1.4 state specific use of joints 12.1.5 select the appropriate methods of joining and fabricating materials 12.1.6 make an appropriate joint for the job.
	12.2 demonstrate knowledge and understanding of joining and fabricating materials	12.2.1 identify joining and fabricating tools and equipment 12.2.2 select appropriate tools and equipment when constructing joints 12.2.3 handle joining and fabricating tools and equipment safely. 12.2.4 demonstrate care of joining and fabricating tools and equipment.
12. Screen	13.1 acquire working	13.1.1. use screen printing frame

printing	knowledge of screen printing.	13.1 2 design and cut a stencil for screen printing 13.1 3 make a screen printing 13.1.4 care for screen printing 13.1.5 incorporate screen-printing where appropriate in practical activities.

FOCUS-YEAR 3: SKILLS, PRODUCT DESIGN AND MANUFACTURING		
UNIT 3: COMMUNICATION		
TOPIC	**GENERAL OBJECTIVES** Learners should be able to:	**SPECIFIC OBJECTIVES** Learners should be able to:
1. Graphics	1.1 use IT in graphical communication.	1.1.1 enhance drawings using different presentation techniques. 1.1.2 draw design solutions in orthographic using 1st angle projection. 1.1.3 construct design solutions using CAD
2. Marketing	2.1 apply knowledge and skills of Marketing	2.1.1 select appropriate advertising strategies. 2.1.2 identify a target market for a product. 2.1.3 design a package for product. 2.1.4 use IT in advertising 2.1.5 determine the cost of a product.
3. Design Process	3.1 develop the ability to design and make products using own initiative.	3.1.1 analyse a given theme 3.1.2 derive a situation from the theme. 3.1.3 identify a problem from a situation. 3.1.4 formulate a design brief. 3.1.5 formulate relevant specifications. 3.1.6 explore a variety of possible solutions. 3.1.7 select a solution to the problem 3.1.8 show logical progression of all aspects of development 3.1.9 produce a working drawing. 3.1.10 produce a detailed production plan 3.1.11 produce a quality product. 3.1.12. evaluate their product.

UNIT 4: TECHNOLOGIES		
TOPIC	**GENERAL OBJECTIVES** Learners should be able to:	**SPECIFIC OBJECTIVES** Learners should be able to:
2. Mechanisms	2.1 develop knowledge and skills of Mechanisms.	2.1.1 calculate the speed of the driver and driven pulleys. 2.1.2 discuss gears. 2.1.3 demonstrate various motions performed by mechanisms. 2.1.4 calculate gear ratio to determine speed. 2.1.5 illustrate the direction of movement of mechanisms. 2.1.6 illustrate cams and followers. 2.1.7 select and use appropriate mechanisms in a design situation.
3. Energy	3.1 acquire and apply knowledge of Energy in problem solving	3.1.1 discuss ways of conserving energy. 3.1.2 demonstrate ways of conserving energy. 3.1.3 select an appropriate energy source in response to a design situation. 3.1.4 describe energy conservation
4. Electricity and Electronics	4.1 acquire and apply knowledge of Electricity and Electronics.	4.1.1 use Ohm's law to determine voltage, current and resistance. 4.1.2 work safely with electrical and electronic equipment. 4.1.3 construct an electronic product in response to a design situation. 4.1.4 carry out minor repairs and maintenance in electrical appliances

UNIT 5: TOOLS AND PROCESSES		
TOPIC	GENERAL OBJECTIVES Learners should be able to:	SPECIFIC OBJECTIVES Learners should be able to:
1. Measuring and Marking out tools.	1.1 apply techniques of Measuring and Marking out.	1.1.1 select appropriate measuring and marking out tools 1.1.2 use measuring and marking out tools correctly 1.1.3 use measuring and marking out tools safely 1.1.4 Check for squareness and flatness.
2. Saws and Sawing	2.1 apply knowledge and skills of Saws and Sawing	2.1.1 demonstrate correct ways of sawing 2.1.2 select appropriate saws when cutting materials 2.1.3 work with saws safely 2.1.4 demonstrate care and maintenance of saws.
3. Planes and Planing	2.1 apply knowledge and skills of planes and planing	3.1.1 identify different processes of planing materials 3.1.2 select appropriate planes for the correct job 3.1.3 handle planes safely 3.1.4 demonstrate care and maintenance for planes 3.1.5 demonstrate the correct ways of Planing.
4. Files and Filing	4.1 apply knowledge and skills of Files and Filing.	4.1.1 demonstrate correct ways of filing 4.1.2 select appropriate files when filing materials 4.1.3 work with files safely 4.1.4 demonstrate care and maintenance of files
5. Drills, Drilling and Boring tools	5.1 know and apply skills of Drills, Drilling and Boring.	5.1.1 select appropriate drill bits and boring bits for the correct job 5.1.2 handle drill bits and boring 5.1.3 drill and bore holes in wood, metals and plastics accurately 5.1.4 set drill speeds to suit different materials and drill bit sizes. 5.1.6 demonstrate correct ways of drilling and boring
6. Chisels and Chiseling	6.1 apply knowledge and skills of Chisels and Chiseling	6.1.1 demonstrate correct ways of chiseling 6.1.2 select appropriate chisels when chiseling 6.1.3 work with chisels safely 6.1.4 demonstrate care and maintenance of chisels.

7. Shears and Shearing	7.1 apply knowledge and skills of Shears and Shearing.	7.1.1 demonstrate correct ways of shearing 7.1.2 select appropriate shears when shearing 7.1.3 work with shears safely 7.1.4 demonstrate care of shears
8. Holding and Cramping Tools	8.1 use knowledge and skills of Holding and Cramping tools	8.1.1 use appropriate holding and cramping tools when working on material and assembling 8.1.2 handle holding and cramping tools safely 8.1.3 demonstrate care and maintenance for holding and cramping tools
9. Driving/ Impelling/ Percussion Tools	9.1 apply knowledge and skills of Driving, Impelling, Percussion tools	9.1.1 demonstrate the correct use of driving and percussion tools 9.1.2 select appropriate driving and percussion tools 9.1.3 work with driving and percussion tools safely 9.1.4 demonstrate care of driving and percussion tools
10. Forming Plastics	10.1 apply knowledge and skills of Forming plastics	10.1.1 identify materials and equipment used in forming processes. 10.1.2 select appropriate forming processes 10.13 work safely with forming equipment 10.1.4 demonstrate care for forming equipment
11. Deforming	11.1 acquire and apply knowledge and skills of Deforming	11.1.1 identify materials and equipment used in deforming processes. 11.1.2 select appropriate deforming processes 11.1.3 work safely with deforming equipment 11.1.4 demonstrate care for deforming equipment.
12. Joining and Fabrication	12.1 apply knowledge and skills of Joining and Fabricating materials.	12.1.1 select the appropriate methods of joining and fabricating materials. 12.1.2 make an appropriate joint for the job. 12.2.1 identify joining and fabricating tools and equipment.
	12.2 apply knowledge and skills of Joining and Fabricating equipment.	12.2.2 Select appropriate tools and equipment when constructing joints 12.2.3 handle joining and fabricating tools and equipment safely. 12.2.4 demonstrate care of joining and fabricating tools and equipment.