A DIDACTIC STUDY TO IDENTIFY CRITERIA FOR PROJECT SELECTION IN TECHNOLOGY

by

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DEDICATION

This work is dedicated to my parents who have been a constant inspiration to me throughout my life. To my wife Arlene and children Crystal, Candy and Dewan. May this work be a source of inspiration throughout your lifetime.

G.A.CHAPMAN

DURBAN

DECLARATION

I, GAVIN ASHLEY CHAPMAN, hereby declare that this dissertation represents my own work in conception and execution.

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SUMMARY

Due to a rather weak performance of the economy and rising unemployment in South Africa a serious need of upgrading the South African education system was deemed necessary. The introduction of technology education into the general school curriculum was considered to be a possible means of improving the content and developing skills required by industry. As technology education is project driven, this study set about the investigation of identifiable criteria which may be applied by teachers to the selection of suitable projects in technology education courses. These criteria were considered to be essential to ensure equality between urban, rural and culturally diversified learners with special emphasis on previously disadvantaged pupils in a post-apartheid educational system.

This study is concluded with a check-list (table 34) consisting of five main criteria and twenty sub-criteria for teachers to apply when making choices of technology projects based upon sound didactic principles.

Chapter one orientates the reader into the background of the study, the problems and hypotheses.

Chapter two provides a detailed empirical overview of five main criteria: *SOCIO-ECONOMIC BACKGROUND, DEVELOPMENTAL LEVEL, PROBLEM SOLVING, MOTIVATION, and MEANINGFUL TRANSFER OF KNOWLEDGE.* These criteria were derived from a literary study of didactic sources which provided a sound basis for their foundation.

Chapter 3 investigates the possibility of using the principles of general and strategic management planning to facilitate a technology education programme and project theme. There is also an overview of the methodology required for the lorry project tested in this study and the conditions at the pilot schools.

Chapter 4 provides the quantitative results gathered via a questionnaire to 380 pupils (205 pupils from "disadvantaged" urban schools and 175 pupils from "disadvantaged" rural schools) at the eight pilot schools described by this study. There is also an overview of the findings related to these results presented in tabular form.

Chapter 5 analyses the findings presented in chapter 4 and forms the qualitative results of the study. The reader is directed specifically to the detailed criteria (classified as sub-criteria which support the five main criteria) required by technology education teachers when projects are to be selected.

Chapter 6 concludes the study with logical conclusions, guidelines and recommendations to teachers, education planners, curriculum developers and administrators who are the agents to promote educational change in Kwazulu Natal. A check-list with a simple yes/no response (table 34) is presented for the convenience and application by teachers when selecting technology education projects.

OPSOMMING

In die lig van die swak vertoning van die ekonomie en stygende werkloosheid in Suid Afrika word dit noodsaaklik vir die opgradering van sekere aspekte van die Suid Afrikaanse onderwys sisteem. Die insluiting van tegnologie onderrig blyk 'n moontlikke antwoord te wees vir die verbetering van die huidige inhoud, asook ontwikkeling van vaardighede wat deur die nywerheid benodig word. Omdat tegnologie onderwys deur projek werk gedryf word, was die doel met hierdie studie om kriteria te identifiseer wat deur onderwysers aangepas kan word vir die seleksie van paslike projekte in tegnologie kursese. Hiedie kriteria word as essentieel beskou om gelykheid tussen stedelike, buitestedelike en die kulturele verskillende diversiteit van leerlinge in 'n na-apartheid onderwys sisteem aan te spreek. Die bevinding van hierdie studie het 'n kriteria lys van vyf hoof kriteria en twintig sub-kriteria geidentifiseer (tabel 34) vir die gebruik van onderwysers as hulle tegnologie projekte kies wat gebaseer is op 'n vaste didaktise basis.

Hoofstuk een is 'n oriënteering vir die leser van die studie se agtergrond, die probleme en die hipotese.

Hoofstuk twee voorsien 'n empiriese oorsig van die vyf hoof kriteria: *SOSIO-EKONOMIESE AGTERGROND, ONTWIKKELINGSVLAK, PROBLEEM OPLOSSING, MOTIVEERING, en BETEKENISVOLLE OORDRAG VAN KENNIS.* Dié kriteria word gebaseer op 'n literatuur studie van didaktiese bronne vir die opstel van verantwoordbare beginsels.

Hoofstuk drie ondersoek die moonlikhede vir die aanpassing van beginsels van algemene bestuur en ook strategiese beplanning om tegnologie onderwys projekte te vergemaklik. Daar is ook 'n

uiteensetting van die metodologie om die vragmotor-projek wat deur die studie getoets is, asook die huidige omstandighede by die loods projek skole.

Hoofstuk vier maak voorsiening vir die kwantitatiewe resultate wat ingesamel was van 380 leerlinge (205 leerlinge van "benadeelde" stedelike skole en 175 leerlinge van "benadeelde" plattelandse skole) by die agt loodsprojek skole wat deur dié studie getoets is. Daarna volg 'n kort opsomming van die bevindings en die verbandskap van die resultate wat in tabelle uiteengesit is.

Hoofstuk vyf ontleed die bevindings wat in hoofsuk vier voorgelê is en vorm 'n deel van die kwalitatiewe uitslae van die studie. Die leser word gelei na die spesifieke kriteria (geklasifiseer as sub-kriteria wat die vyf hoof kriteria ondersteun) wat deur tegnologie-onderwysers benodig word om hulle projekte te selekteer.

Hoofstuk ses beëindig die studie met logiese opsommings, riglyne en aanbevelings vir onderwysers, onderwys beplanners, kurrikulum ontwikkelaars and administrateurs wie die agente is om veranderinge aan die onderwys sisteem in Kwazulu Natal te bewerkstellig, aanbeveel. 'n Lys wat 'n ja/nee antwoord vereis (tabel 34) word voorgestel vir die gerief van toepassing deur die onderwyser wanneer projek seleksie plaasvind.

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CHAPTER 1: STATEMENT OF PROBLEM

INTRODUCTION

The word *technology* is derived from the Greek "tekhnologia"; this word is derived from two roots viz.'tekhne'....meaning an art or skill and 'logia'....meaning an area of knowledge or study (Myerson, 1990:8). It is necessary to understand why technology is important to the world. Man continually seeks to better available Technology in an attempt to improve living standards, to try and control environmental pollution, to reduce overpopulation, and to provide jobs for the unemployed, to mention but a few (Jacobs, 1991:65). This study focusses in particular on technology education which forms part of the broad technology learning area.

1.1 STATEMENT OF THE PROBLEM

1.1.1 The world of work for future employment opportunities

In introducing this new topic to the school curriculum it is useful to obtain an overview of the world of work for which pupils are being prepared. When analysing future employment opportunities several areas of activity are revealed such as commerce, agriculture, the building industry, the engineering industry, etc. Thousands of young South African school pupils have to be prepared to enter into an occupation which will help them to provide for their families and place them securely in society. The question which needs to be answered is: "Is our present school system able to cope with the demand?"

1.1.2 Bridging the gap

Taking cognisance of the South African scenario where we obviously have to take into account that there are socio-economic and socio-political factors, which complicate the progress that is necessary to bridge the gap from third world to first world technological systems. If South Africa is to compete internationally it is most important for South African industries to develop international trade links in order to attract foreign investments. As the competition in the international arena is extremely competitive, it is of the utmost importance that the youth at school be adequately trained to compete effectively (Reconstruction and Development Programme, White paper, 1994:10).

1.1.3 Expertise required

A high level of expertise in a variety of industrial activities, needs to be encouraged and developed within the country in order to keep up with other rapidly developing countries. One way of developing the South African youth in a positive way to achieve this objective, would be to introduce all learners to technology education.

The Reconstruction and Development Programme, White paper (1994:54) makes the following statement:-

> "The responsibility for the renewal and transformation of our nation is, however, not the responsibility of the Government nor of particular elected officials. It is a joint responsibility of all sections of our Nation, and calls on all to put their energy and creativity into finding ways of doing things better and differently".

A strategic plan is desirable to re-direct the nation's thoughts towards optimal use of resources and the application of skills, techniques and methods to solve problems. Within these parameters technology may be effectively practised. Myerson (1990:7) states that:-

> " technology is about knowing what is wanted and why it is wanted and then working out how to achieve it with what is available ".

1.1.4 The HEDCOM 2005 project

A proposal was made by the Heads of Education Departments Committee to address the dilemma facing educationists in South Africa due to the shortage of adequately trained manpower. The project launched in 1995 was termed the HEDCOM 2005 technology project. This project currently being planned and implemented in each of the eight regions in South Africa, seeks to develop a new technology curriculum for all South African pupils. The first phase of implementation is aimed at the pupils from Grade 1 (Class 1) level to Grade 9 (Std. 7). It is to be implemented into the general curriculum after a three year trial period during which time the content will be developed. The long term objective is to ensure that all South African scholars become technologically literate by the year 2005.

1.1.5 Possible problem areas

Within each country there are education systems established to educate the nation's children. Within the South African context there are numerous problem areas (Department of National Education, Education Renewal Strategy, 1992:9) such as problems associated with the introduction of church schools and the abandoning of the apartheid system in 1994. Administration of the new Departments of Education have looked at unique ways to phase out inequalities of the past and to concentrate on developing latent talent within the different cultural groups.

1.1.6 Rationale for this study

This study is directed at generating acceptance for the idea of including technology as a new school subject in the general curricula. A didactic perspective is proposed as this is considered to be the most reasonable point of departure in order to view the phenomenon of teaching as a whole rather than as a combination of fragments. Special attention will be directed to the criteria of project selection in an attempt to look at didactic aspects such as the teacher, the pupil and the acquisition of knowledge in detail from a technology educational perspective.

This study is supported by the fact that the education authorities at the Department of National Education in our newly formed dispensation, having put aside differences, provided the following quote from the Draft White Paper on Education and Training:-

> "The curriculum and teaching methods should encourage independent and critical thought, the capacity to question enquire and reason, to weigh evidence and form judgements, to achieve understanding, and to recognise the provisional and incomplete nature of most human knowledge" (Department of Education, 1994:12).

This study also proposes that the technology education may be facilitated by the management method. Ideally, technology as a subject seeks to 'unlock' reality to the pupil. This aim may be possible by the method of integrating technology and management which can best be described as a bridging effect due to the fact that both factors are dependent upon one another.

1.2 FORMULATION OF THE PROBLEM

1.2.1 The initiation of technology in Kwazulu Natal

Rapid advancement in the development of new technology has meant that educationists needed to make changes to teaching and learning programmes. The relatively new subject named *Technology* was introduced to the province of Natal (now called Kwazulu Natal) at around 1992, after pilot work was conducted by the ex-Natal Education Department. Much of the proposed syllabus content was obtained from similar work programmes introduced into the general school curricula of British, Australian and New Zealand schools.

1.2.2 The Kwazulu Department of Education project

The ex-Kwazulu Department of Education and Culture (Technical Education section) initiative was launched in November 1993. This study is based on part of the pilot programme introduced to eight Grade 7 (Standard 5) classes in eight different schools during 1995 to identify strengths and weaknesses of the proposed course in technology which would be presented to pupils studying at this level. Time was taken during the interim period to train teachers (crash courses) and supply resources in kit form.

1.2.3 Technology's place in the curriculum

Technology, as a broad area of learning, can be associated with many subjects in the school curriculum eg. Mathematics, Science, Technical Drawing and even subjects like Home Economics etc. In an attempt to address the problems noted in technical education, technology education was proposed as a possible solution. The problems noted included an alarmingly high failure and consequent drop-off rate in subjects like Mathematics, Science and Technical Drawing which are essential for further engineering course studies at higher education institutions (Universities, Technikons and Technical Colleges). The overall statistics for 1993 revealed that only 38,6% of black matriculants managed to pass. (Kwazulu Department of Education and Culture Annual Report, 1993:62). The technical candidates formed an extremely small proportion of this number.

1.2.4 The lorry project approach to learning technology

Once the proposal for a technology education pilot programme in technology education was passed by the head-office authorities at Ulundi, a technology education programme developer (Mr.Z.J.Van Den Heever) was commissioned to supply a course for the pilot programme which he had designed. The lorry project was purchased (in kit form) for the pilot programme, and included back-up training and support. The use of a project (in kit form) was considered more suitable for the circumstances at ex-Kwazulu Department of Education schools compared to the other ex-Departments of Education like the Natal Education

Department and to a lesser extent the House of Delegates, who allowed the teacher a great deal of flexibility to choose whatever project they desired. It was evident from these initiatives that the teachers did not have a sound knowledge of whether or not a technology education project, which they selected, would be successful or not. This factor prompted this investigation to find possible criteria for project selection in technology education.

The majority of schools controlled by the Kwazulu Department of Education were predominantly classified as "disadvantaged" school environments. Teachers at such disadvantaged community schools had limited access to resources if a kit was not supplied, and did not receive enough training (due to time and financial constraints) to enable them to develop their own projects. They therefore had only a limited amount of knowledge of technology education presented to them. The eight selected pilot schools all completed the same project in a systematic manner and this study is partly aimed at evaluating the effectiveness of the initiative.

1.3 RESEARCH PROBLEM

The study centred upon the following four problems:-

(a) Which didactic criteria should be used by South African teachers teaching the subject *Technology* in primary and secondary schools when they select practical projects to be included in the curricula?

(b) How effective was a proposed set of criteria for project selection when a pilot study was conducted among 480 disadvantaged pupils in Grade 7 (Standard 5)?

(c) To which extent were 205 pupils in an experimental group, who completed a technology education project, better prepared for technical education than 175 pupils in a control group who did not participate in the project?

(d) Which guidelines based on empirical evidence from this study can be suggested for the implementation of Technology curricula in South African schools?

1.4 THE HYPOTHESES

Only two of the four problems stated above lend themselves to hypotheses: problems (b) and (c). The other two problems (a) and (d) were exploratory in nature and therefore were treated as hypothesis generating focal points. The following two hypotheses guided the search for solutions to problems (b) and (c) respectively:

HYPOTHESIS (1)

The following set of broad criteria will prove to be didactically sound, relevant and profitable when they are utilised to select a technology project for 480 disadvantaged pupils in Grade 7 (Standard 5):

(a) Socio-economic background.

(b) Developmental level of the student.

(c) Problem solving.

(d) Motivation.

(e) Meaningful transfer of knowledge.

These broad criteria will lead to the identification of a series of detailed criteria which can be used by teachers from various subject fields to select technology projects for pupils at all school levels.

HYPOTHESIS (2)

In a post-test evaluating children's perceptions of a few basic technological concepts the average marks obtained by pupils in the experimental group will be significantly higher than that of pupils in the control group, where "significant" is taken to mean that the average marks obtained by the experimental group in each section of the post-test will be at least double the average marks obtained by the control group.

1.5 DEMARCATION OF STUDY FIELD

1.5.1 Technology education

The study concentrates almost entirely on technology education although other subjects may be referred to here and there. The approach adopted is inclined to follow a technical perspective because the problems addressed by this study were identified within this field. Furthermore, the study does not adopt the approach that everything is technology and therefore one may decide to plan a birthday party and call the project technology. The study addresses the problem areas from the point of view of developing the whole child - holistically.

1.5.2 Criteria

The main target of the study is to identify criteria which may be used by teachers to evaluate the merits of selecting any particular technology education project. Other didactic concepts such as teaching methods and teacher competencies may be explored as well, but the main aim is to formulate criteria.

1.5.3 Project selection

The study revolves around technical projects considered suitable to be implemented into ordinary schools although special reference is made to disadvantaged schools throughout the study.

(a) "Project" in the text refers to:- a task selected by the teacher for pupils to complete. The task should include the application of knowledge and skills combined with the correct use of available resources to solve a problem situation or satisfy a need.

(b) "Selection" refers to:- making a choice from a number of possible technology education projects.

1.6 METHODOLOGY

1.6.1 Introduction

The methods considered relevant to the study consisted of a pilot project which was tested at eight selected schools at Grade 7 (Standard 5) level. All eight schools were classified as being disadvantaged community schools in Kwazulu Natal. It was necessary to use an instrument to evaluate the project. The experimental research method was chosen to complete this task.

1.6.2 Justification of methods used

Ary et al. (1972:229) comment on the experimental research method and state the following:-

> ".....two groups of subjects are required; these are called the experimental and control groups. Each group is subjected to a different treatment".

The methodology required to provide insight into identified problems and hypotheses, was based upon the above experimental research method. Other writers like Borg (1981:182), Leedy (1989:223) and Cohen & Manion (1989:196) term the experimental method the pretest-posttest control group design. This study neglected to include a pretest and therefore only supplied data (see chapter 4) extracted from a posttest. The study attempted to prevent threats to internal validity like history, maturation and statistical regression (Cohen & Manion, 1989:200) which could influence the outcome of the research.

The study also observed the possibility of interference of the independent variable which Dyer (1979) reflects as being included by the investigator into the experiment. Dyer (1979:226) states that:- " researchers determine whether in fact they did create or change that which they intended ". This factor is true of this study. The project initiated in Kwazulu Natal was incorporated into the research methodology for the purpose of this study.

1.6.3 Methods used for this study

The study applied the experimental research methodology through the initiation of a pilot project (designed by an independent course developer) to eight schools in Kwazulu Natal. The project consisted of pupils who were introduced for the first time to technology education. The experimental research was then derived from this project by selecting two representative groups of pupils. These independent groups were termed the experimental group (those pupils who completed a technology education project) and compared their performance with a control group (those pupils from the same school and same grade level who had not participated in the technology education project). The independent variable was in this way determined by the researcher and kept as consistent as possible for the duration of the study. A post-test was used to evaluate the experiment.

1.7 TERMINOLOGY

pilot project : the first course of it's kind being tested and run on a trial basis within the ex-Kwazulu Department of Education in technology education.

ex-Kwazulu Department of Education : the previous Kwazulu Department of Education and Culture, now amalgamated (one of five ex-Departments of Education within the province) into the Kwazulu Natal Department of Education and Culture.

white paper : a common term used to indicate the draft proposal of National Education and Training Policy which is approved by parliament and endorsed by the Minister of Education [eg Government Gazette Vol. 351(15974) : 1-59].

criteria : the plural form of criterion meaning:- a standard by which something may be judged or decided on.

project : a task set by a teacher for the pupil to complete. This should also include the application of a skill or a number of skills for the completion of the project. In the text it refers to technology educational projects.

resources : a supply or source of aid necessary to complete a project (human, financial, physical, non-human).

traditionally disadvantaged : schools and pupils from the black South African community disadvantaged in terms of the apartheid legislation promulgated by the National Party government prior to 1994.

management principles : the fundamentals or essence of management namely planning, organising, leading and controlling.

curriculum : the full range of learning material which a pupil must learn in one year at a particular grade or level eg. Grade 7 (Standard 5). In other words the content of all subject courses to be studied.

Didactics : a science which deals with the phenomenon of teaching as a whole. It is mainly concerned with what, why and how we teach.

kit : the resource material required to construct a project including the instruction manual. The kit referred to in the text includes two kits utilised in the experiment:-

(a) The lorry project kit consisted of the necessary resource material to make one lorry.

(b) The back-up kit (described in chapter 3) consisted of the resource equipment to assemble the lorry project and complete the technical drawing section eg. glue, drawing instrument set, file, crayons, scissors etc.

optimising : to make best or most effective use of. The term is generally used with specific reference to the effective use of resources.

cognitive : a type of behavioural objective described by Benjamin Bloom and other psychologists. It can be broadly defined as the domain of knowledge, comprehension or synthesis.

affective : a type of behavioural objective described by psychologists to broadly define the domain of feeling and emotion, values or responding.

psychomotor : a type of behavioural objective used by psychologists. It can be broadly defined as the domain of physical skills or reflex movements.

CHED : an abbreviation meaning Committee of Heads of Education. A committee established to attend to curricula and policy matters prior to HEDCOM.

HEDCOM : an abbreviation for Heads of Education Departments Committee. This committee is currently fulfilling the roles previously played by CHED.

ex-departments : this refers to other education departments within the province of Kwazulu Natal, who prior to the amalgamated education department, acted alone as independent entities, eg. Natal Education Department, The Education Department of the House of Delegates, Department of Education and Training, etc.

state of the art technology : refers to the use of very sophisticated resources for the teaching and learning of technology eg. computers, measuring instruments, etc.

RDP: Reconstruction and Development Programme commissioned by the new African National Congress Government in 1994 to address issues of under-development and equality especially to advance black South Africans (RDP White paper, discussion document, September 1994).

structured programme : this refers to the content of the learning material being set up in such a way, that all teachers do the same work eg. the lorry project.

developmental level : refers to the perceived level of learning ability of a particular group of pupils in the same standard, eg. Standard 5 (Grade 7).

effective education : teaching can be classified as effective if the objective of the course or lesson has been attained.

conceptualised management learning system : (C.M.L.S.) : an integrated systems approach directed by structured, strategic planning. This concept is discussed in detail in chapter 3.

intulogical structure model : a structure of reality, evaluated as **meaning**, from **contents - form** and **function**. These concepts form part of the conceptualised management learning system.

comprehensive high school :- a school within the Kwazulu Natal Region, managed by the advisory services of technical education, and funded by the Kwazulu Government ie. an ex- Kwazulu Department of Education school. It is equipped to offer technical education as an option in the school curriculum and has four to five different practical trade workshop facilities.

pedagogics :- the science dealing with education and practised by the pedagogician derived from *pedagogy* meaning " to lead the child ".

1.8 CONCLUSION

The study consists of a literary study in chapter 2 followed by a description of methodology used in the research and the management method proposed in chapter 3. The results of the experiment are outlined in chapter 4 and the analysis of the results in chapter 5. The final recommendations and suggestions are provided in chapter 6.

CHAPTER 2

GENERAL DIDACTIC CRITERIA

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CHAPTER 2 : GENERAL DIDACTIC CRITERIA

INTRODUCTION

The introduction of the technology education concept into education systems of overseas countries, did not identify criteria which can be applied when deciding on any particular project or topic. This empirical study intends formulating general categories to analyse the empirical research results. The questions which need to be answered are firstly, whether or not such criteria are of value and secondly, whether criteria tested through this study could be applied to the situation in South Africa.

The criteria discussed in this chapter are viewed as being important precautionary measures for each teacher to apply, before choosing a project or topic for pupils to complete. Without the application of these criteria, the teacher may easily choose something which is didactically unsound. The project may, for instance, be too difficult for the pupils to comprehend or conversely, too easy for that particular level of child. The idea of pupils solving problems on their own needs careful attention, and this study, through the medium of criteria for project selection, intends highlighting this. Suffice to say that these are pertinent points which must be considered when technology education is introduced into the South African education system.

There have been complaints from educators at higher education institutions who believe that school educators have been producing mediocre students who are of questionable 'value' for further study programmes. To be eligible for employment in a technologically progressive society, pupils at schools must have a 'value-added' type of education. Technology education at schools is one avenue through which such requirements could become a reality.

The criteria which are discussed in detail in this chapter are:

criterion one - Socio-economic background

criterion two - Developmental level of the student

criterion three - Problem solving

criterion four - Motivation

criterion five - Meaningful transfer of knowledge.

The study will endeavour to present justification for each criterion in order to form a categorical structure which links relevant and important concepts.

2.1 CRITERION ONE - SOCIO-ECONOMIC BACKGROUND

FOR A TECHNOLOGY PROJECT TO BE DIDACTICALLY JUSTIFIABLE, IT SHOULD CORRESPOND WITH THE SOCIO-ECONOMIC BACKGROUND OF THE PUPILS AT WHICH IT IS TARGETED.

2.1.1 Introduction

This criterion consists of information which is associated with the broad criterion of socio-economic background. Initially a comparison between the situation in the United States of America the United Kingdom and South Africa directs the reader to take a closer look at the history of South African education. The physical facilities at schools, resources for projects, the apparent "phobia" for technically related subjects displayed by black pupils and the school system are discussed.

The need for equality and a closer look at family relationships amongst black pupils round off the discussion.

2.1.2 The situation in the United States of America

Dennis Carlson comments about economic functionalism in the curriculum, where most attention is focussed on subject content areas that offer a 'high return' on investment. (Carlson as quoted by Altbach et al.,1985:174). Carlson refers in particular to subjects like mathematics, science and foreign languages. Certain schools in the USA are encouraged to identify their meritous students; the 'bright and best', who may then receive advanced coursework in what is referred to as *special educational programmes.*

Carlson also makes reference of the teachers who are presenting these subjects. Special salary packages are arranged which are competitive with those received in industry within the USA.

This strategy is aimed at trying to attract or hold the most competent in teaching careers (*Ibid.*,1985:175). These teachers would perform the task of educating the select students would probably end up as trained specialists, technicians, scientists, engineers, etc. Carlson thinks that they would constitute a new order of 'middle class' people, and perform an important role in an increasingly knowledge-intensive re-industrialisation process (*Ibid.*,1985:176).

However, within the USA education system, there are also problems at some state urban schools. These schools are also trying to attract adequately trained teachers and to keep class numbers as low as possible, but without much success. Further problems are also being experienced through the lack of special curricula materials necessary for the desired small groups of pupils. Carlson reports that at these USA schools where special educational programmes and specialist teachers are not available, the problem is one of affordability. Such schools are providing education for students whose school lives are greatly influenced by their socio-economic backgrounds. These students are therefore not expected to benefit from a rigorous knowledge-intensive curriculum. (Carlson as quoted by Altbach et al. 1985:175)

Carlson concludes that there is thus a great 'wastage' of potential talent among disadvantaged youth in the USA (*Ibid.*,1985:177). John Carter (1989b:3) writes that all youth need to learn how to prepare for the world of work. Carter therefore suggests a "Collaborative Programme" in which students may be prepared for the workforce through business/education partnerships.

2.1.3 The situation in the United Kingdom

A case to highlight class distinction was described in a study conducted by Paul Willis (1977), in the United Kingdom, of delinquent working-class youth called 'the lads'. Willis concluded that the group refused to advance themselves in life, despised any authority system and believed that most people could not succeed in the school hierarchy. This action ensured 'the lads', and others like them, of a place in working-class type jobs and lifestyles after school. Teachers in this particular instance were forced to settle for less and mediocrity became the most appropriate course of action (Willis as quoted by Altbach et al.,1985:178). This situation is not indicative of a poor UK education system, but rather describes the prevailing social milieu.

2.1.4 The situation in South Africa

In the South African situation, much class distinction exists due to the past apartheid era. However, even though this policy is no longer enforced, the aftermath can easily be viewed within many township schools in Kwazulu Natal. If in South Africa there is a tremendous range of social distinction, then surely future planning of education programmes needs to take cognisance of this reality. Fuller(1991:38) states:-

> " empirical evidence shows that schools do little to alter the reproduction of a society's (unequal) class structure. This may be due

to lower levels of instructional quality in schools attended by low-income kids ".

The education system therefore has to address all inequalities regardless of the socio-economic backgrounds of the pupils who attend the provincial schools. In this way the differences can be eliminated, and over-looked potentials of pupils attending township schools, can be addressed. This study proposes that through a technology education programme, the criterion *socio-economic background* could be addressed in a logical manner, and so attempt to uplift traditionally disadvantaged children. Schools in South Africa therefore face the acute problem of how to provide appropriate training for **all** pupils. Industry requires schools to adequately train all pupils and society expects it, yet our schools cannot provide such a service which is proportional to the demand (Haasbroek, 1995:3). The problems related to lack of good facilities, funding, lack of adequate equipment, etc., are all factors which compound the socio-economic dilemma in South Africa.

The criterion socio-economic background may be linked to the didactic requirements at school, where it is necessary to develop and assist the child to organise and realise his/her life world. If children happen to come from a disadvantaged socio-economic background, then surely the school should contribute to bringing about change to their lives. Disadvantaged pupils should not be denied access to technology education programmes, regardless of their socio-economic background. Through careful and inspired planning, links between the different social barriers can be bridged via the introduction of technology education which can offer relevant content to address the educational needs of the current time.

2.1.5 South African history of education

2.1.5.1 The slave schools at the Cape

Van Riebeeck opened the first slave schools at the Cape in 1658 (Steyn, 1992:79). His justification was that the local people had to learn the language of Dutch and to also be Christianised. There were problems with the Christening ceremony of young slave children which led to separate schools being established in 1667 (*Ibid.*,1992:80).

Later, between 1743-1792, the Moravian mission society worked at setting up a mission school at Genadendal, which became a model for others to follow (*Ibid.*,1992:81). However, cultural background differences led to various problems being experienced from this initiative (*Ibid.*,1992:81).

2.1.5.2 The first missionary societies among the black people

The London Mission Society established a mission school in 1801, under leaders Edwards and Kok, which displayed more success than their predecessors Kemp and Edmond. This work was amongst the Xhosa people (*Ibid.*,1992:82). Nearly all the mission societies (1799 - 1839) instructed their people to become self-supporting in respect of food, stock-breeding, accommodation etc. (*Ibid*.,1992:84). The mission schools were initially funded by the Colonies, then by the Republics, and later by the Provinces. These were the only existing black schools at the time. The curriculum was always decided upon by the mission personnel, and included mainly reading, writing in the native language, and sometimes also offering mathematics and science as an option (*Ibid*.,1992:86).

2.1.5.3 Struggle for central control in education (1900 - 1953)

In 1907 the first legislation relating to black schools in the ex-Transvaal was passed. Section 29 stipulated that no 'coloured' person (in Transvaal) was allowed to be educated in a white school. The idea of separate education between the predominant mission schools for blacks and separate schools for whites was established as law (*Ibid*.,1992,87). This was not a new idea as even during the time of Van Riebeeck the struggle for separate schools for the slave and colonist children had emerged.

In 1910 the statutes of the Union of South Africa stipulated that all teachers be Christian-National and that provinces fund education for all races (*Ibid*.,1992:86/87). This issue was amended in 1917 by Dr Loram (Natal Inspector of Education) who declared 'education has become a state function in all civilised countries', thus attempting to address the need for education to fall under state control (*Ibid*.,1992:87).

The Phelps-Stoke Commission investigated education in Africa from 1920 - 1922, and concluded that black families be taxed for black schools (Hartshorne,1992:27). Hartshorne suggests that this principle was the cornerstone of the later apartheid policy and was only seriously challenged during the period 1945 -1955. The Eiselen report (1951), regarding the condition of black education, concluded that education for the Bantu was not an integral part of the socio-economic development plan for South Africa, but was a result of missionary education initiatives, and was managed without any active participation of the Bantu. Eiselen recommended that "education must be of the Bantu, by the Bantu and for the Bantu" (*Ibid.*,1992:89).

In 1953, law 47 was passed in parliament which legislated that Education would fall under central government from 1 January 1954. This action ushered in decentralisation of black schools into six regions and local control by communities of their own schools (*Ibid.*,1992:89). Dr Verwoerd ensured that the apartheid structure was administered right down to curriculum level. He maintained that blacks had to be prepared for service within their own community. He also criticised the mission schools for 'blindly' basing black education on European principles (Verwoerd, 1954:7).

2.1.5.4 The development of black education in South Africa (1953 - 1991)

By 1961 the state of education did improve for black people in South Africa. The government objective was basic education for the masses to enable as many as possible to achieve literacy (Steyn, 1992:91). Law 45 of 1959 made allowance for separate universities to be established hence the establishment of the University College of Ngoye later to be renamed the University of Zululand (*Ibid.*,1992:91).

By 1971, a bottle-neck had developed in primary education with 76% of school-going pupils caught up in this phase (*Ibid.*,1992:91). The funding of education remained a problem, with black and white pupils not receiving the same total monetary allocation.

TABLE 1 - The 1971 total educational expenditure per race group

RANDS (Millions)	RACE GROUP
461	WHITE
124	INDIAN
94	COLOURED
21	BLACK

Source:- Steyn,1992:93

In 1976, the reaction to separate provisioning for education of blacks reached a climax. Riots began in Soweto and soon spread across South Africa. To try and improve the situation in 1977, the Department of Bantu Education was replaced by the Department of Education and Training, and the expenditure increased dramatically.

TABLE 2 - The comparative per capita expenditure for black education

YEAR	RANDS per pupil
1972	20
1980	70
1990	500

Source:- Hartshorne,1992:42

During 1983 the De Lange report was completed and the 'white paper' on education was published. This report actually had only a limited effect on the radical policy changes which were necessary to address the problems of black education. However, Law 76 of 1984, provided general legislation for all education and included the movement towards equal opportunities for all South African citizens (Steyn, 1992:95). It was only in 1991 that schools were gradually opened up to all races especially in the urban areas although only on a voluntary basis (*Ibid.*,1992:96). Some of the historical problems experienced by black pupils, can be solved through the introduction of a Technology Education programme.

2.1.6 Physical facilities

2.1.6.1 **Overview of current situation**

It is generally accepted, that due to the apartheid policy in South Africa, pupils are disadvantaged if they come from the black communities. This factor is of particular significance with respect to equipping schools. I have observed a number of township schools during the course of this study, and have come to the conclusion that many of the schools are in a state of disrepair and therefore do not create a suitable environment for good teaching and learning. Furthermore, many schools are not locked after normal school hours, but remain with doors and windows permanently open without any security measures. This provides planners with a problem of how to equip schools for technology education courses.

The 1993 Kwazulu Department of Education Annual report (1993:64), indicates that 115 740 pupils were enrolled at Standard 5 level out of a total of 1 171 966 in the primary phase (Class 1 - Std.5). This represents about 10% of primary school pupils who were spread across 25 circuit areas in Kwazulu Natal.

During the 1993/94 financial year, the expenditure for primary education of the Kwazulu Department of Education schools was R1 367 705 100 out of a total Kwazulu education budget of R2 533 125 000 (Kwazulu Department of Education and Culture, 1993:63). This represents 54% of the total spending on

Kwazulu education for the 1993/94 financial year. This may seem to be a great expense, yet this amount is only utilised to maintain the present system of education amongst black people in Kwazulu Natal. Technology education would seek to go beyond the 'normal' school curriculum, and therefore could further impact on the overall education expenditure due to the nature of some of the equipment required to set up such a programme. Within some of the so-called advantaged schools, the parents tend to contribute significantly towards the support of similar programmes.

2.1.6.2 Schooling in Africa

Schools in Africa vary considerably if one considers the physical facilities, resourcing, etc. This same trend also holds true for South African schooling.

In 1982, Hawes conducted a study of schools in the greater part of Africa, and made the following suggestions:-

> "...it is therefore necessary for those who plan a curriculum to make suggestions for the type of building and furniture needed to implement it, but it is also necessary to think in terms of alternative styles and costings to suit different communities, and most essential that these requirements be presented in such a way that they are understood and used "
> (Hawes,1982:145).

Hawes provides a list of what he considers to be the most important aspects of planning for the benefit of good teaching and learning. The following is a list of the most important points:-

(a) Adequate space.

(b) Classrooms that can be locked.

(c) Large flat working surfaces.

(d) Storage space.

(e) Adequate blackboard and display space.

(f) Staffroom facilities.

(Hawes,1982:146).

A study conducted in the USA revealed that the single most important variable leading to the retardation of disadvantaged children was the poor environment in which they matured (Biehler and Snowman,1990:240). While it may be difficult to compare South Africa with the USA, there are certain similarities eg. the present situation amongst the disadvantaged schools in the USA, seems to be negatively influenced by the socio-economic background of the pupils currently attending such schools.

2.1.6.3 The school system in South Africa

The apartheid legacy of neglect, inferiority, inequality and discrimination, has cost South Africa dearly, both in human terms (frustration, bitterness, anger) and in economic terms (Hartshorne, 1992:23). Consequently the quality of education in some areas is questionable and lack of physical facilities compounds the issue. This 'failed' system of education has been unproductive, as children have not been held in the school long enough for schooling to benefit them. Hartshorne writes the following about the state involvement:-

> "the State again resorts to the numbers game, quoting enrolment statistics, growth figures and increases in expenditure without any serious attempt to assess the quality and relevance of what is being learned, or it's value to the children, the community from which they come, or to the development of South Africa as a whole ".
>
> (Hartshorne, 1992:24)

Hartshorne, citing the work of Kane-Berman(1978), provides a useful argument regarding the education system which pre-empted the uprising in Soweto (1976);

> " pupils resorted to rote-learning of what was contained in text-books which senior pupils found unacceptable and frustrating. This frustration was not only against 'the system' but against teachers, whose limited qualifications were regarded as the cause of their inability to cope with pupils learning needs ".
>
> (Kane-Berman 1978 as quoted by Hartshorne, 1992:244)

Having visited a large number of schools within the province of Kwazulu Natal, I was constantly reminded of the urgent need for the school system to be upgraded. The most noteworthy difference is between the previous 'Model C' schools and schools in Kwamashu, for instance. One could say that two different standards are being applied in what is supposed to be a common 'new' school education system. To clarify the type of problems currently being experienced; the following points need to be noted:-

(a) Teachers at disadvantaged schools are not all punctual. The usual excuse is transport problems.

(b) Teachers are not always in attendance of their class groups. Their own personal problems often receive priority.

(c) The final bell causes teachers to leave immediately. They do not conduct sport or extramural activities at most township schools. Most teachers appear to be inflexible towards the idea of putting in extra hours for the benefit of their pupils.

There are obviously other distressing factors which one could list but the main point is that the present system of education, especially for the disadvantaged pupil, apparently continues to 'condone' this unsatisfactory behaviour of teachers. Such problems do not seem to be so noticeable at previous "Model C" schools.

2.1.6.4 The need for equality in education

Hartshorne(1992:254) advocates that teachers should be trained for a *democratic system*, which is the direction in which South Africa has tended to follow after the election of a new government party in 1994.

> " future teachers need to be educated and prepared for a democratic society and an education system consistent with this ".

This seems to be a tall order for new teachers but there is no doubt that teachers who are not properly trained to handle the wide variety of content which technology education demands, will lead to an unsatisfactory result, even though the course may be well designed. Due to unequal budgets in each of the ex-Departments of Education, widely contrasting situations exist at the different schools within the province which will negatively impact on the technology education proposal.

Hartshorne further comments that society has a right to expect of teachers that they be committed to a democratic, open, just and equitable future for all South Africans, and that their education be imbued with these ideas (Hartshorne,1992:254). Antonouris and Wilson (1989:101), focus on the school as being an equal opportunities zone, maintaining and reinforcing equal chances in life for all. The new democracy in South Africa has ushered in this frame of reference for all educators to build on. However, we must be aware that, from a didactic point of view, not all institutions are able to perform at the same level, partly because of the inequalities still existing at schools, and a system of education which is at present undergoing some changes, albeit at an extremely slow pace.

Statistics reveal that 115 740 pupils at Std.5 level were enrolled at schools throughout the province of Kwazulu Natal during 1993 (Kwazulu Department of Education and Culture, 1993:64). Further statistics in this source show that the vast majority of these pupils attend community based schools which are

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Statistics reveal that 115 740 pupils at Std.5 level were enrolled at schools throughout the province of Kwazulu Natal during 1993 (Kwazulu Department of Education and Culture, 1993:64). Further statistics in this source show that the vast majority of these pupils attend community based schools which are grossly unequal compared to many of the historically white schools. The inequality of education would therefore have to be addressed, especially when choosing projects for technology education programmes. A uniform standard would have the added advantage of pupils being able to move freely around the province without being disadvantaged.

Hartshorne (1992:338) gives sound advice to provincial administrators, as he suggests that more power be given to regional and local authorities to achieve greater equality and a better distribution of resources. This makes sense as the inequality of the present education system would require close co-operation from education and political administrators at all levels, in an attempt to redress the problems of the apartheid era.

Tierney (1982:113), comments on the finer details of inequality related to society and provides the following quote:-

> " rather than schooling a population to accept a lower status in social terms, the real issue is how to educate a society that no longer requires a disadvantaged class of people ".

There do not seem any 'quick fixes' to the huge inequality problem at schools in the Kwazulu Natal region . The introduction of technology education may only be considered feasible if these discrepancies are eliminated. Norms and standards, set via education policy, must take into account the financial implications and time constraints that compound the problem, regardless of the perceived advantages which are being proposed. Without the removal of inequalities and the establishment of a transparent democratic society, technology education would have very little chance of impacting positively on the national economy.

2.1.7 Resources for projects

2.1.7.1 Introduction to the Kwazulu-Natal situation

When considering the physical facilities at schools in the township areas, it is necessary to think not only in terms of the buildings, but also about the individual items necessary to implement a technology education project. Educational planners have in the past tended to just leave certain schools alone to 'fend for themselves'. This problem arose during the apartheid era when black communities were required to provide for their own educational needs. These schools commonly termed 'community schools', are plentiful in the Kwazulu Natal region. The question arises: How would one equip such schools with enough materials to introduce technology projects?

2.1.7.2 Technology course resourcing

The concept of technology education is in itself rather unique to black communities, but this study is focussing on the probability that technology education will be introduced into such schools within the next few years.

Jacquier and Blanc (1984:88) describe the benefits of technology in the general sense viz. the more sparing use of resources, the relatively lower cost to make a product of high potential for employment and lower capital investment per unit output. This would infer that technology education programmes are more efficient than general educational courses which do not necessarily lead to employment opportunities, and are very costly.

Hawes (1982:147), commenting on the purchasing of educational materials, suggests that the starting point is the securing of a realistic allocation of funds. During the historical development of black education (see Tables 1 and 2), black students were allocated the least amount of funding to run their courses. Hawes' comment on a realistic allocation would ensure that funding would be available to ensure adequate purchasing of equipment and resources for courses.

The realities of the situation and the conditions attached to the implementation of new courses, will necessitate prioritisation of the funds. Hawes warns against indiscriminate spending as an excuse for not having enough funds (*Ibid.*,1882:). The concerns of Hawes are feasible and the following questions may be posed in the light of his comments:-

(a) Which concepts and skills do we wish to develop?

(b) Which educational materials (including natural resources in the environment) are available?

(c) How shall we plan and modify content so as to make the best use of what we have?

These questions may be linked to the socio-economic status of the pupils for which projects need to be selected. Hawes does provide a number of possible ideas when he describes the situation noted during a study of Nigerian education. Teachers collected waste materials like paper, cloth, wood, etc. from factories, and then established a teaching-aid production centre. The idea of semi-manufactured materials in 'kit' form emanated from this initiative (Hawes,1982:182).

Ndlela (1993:90) agrees with the idea of the possible use of locally available materials. Ndlela also suggests that technology should not be seen as an end in itself, but as part of real development, owned and controlled by the community. It is necessary for curriculum planners of a future technology education programme to be aware of the inequalities which still exist at black schools. This situation is not conducive to a healthy learning environment. A careful look at the problem globally, yet within the limits of the criterion of socio-economic background, could assist developers to find possible solutions.

2.1.8 "Phobia" for technically related subjects

2.1.8.1 **The current trend in black education**

There is a tendency for pupils at black schools to follow the trend of a general education curriculum instead of a more technical-oriented field of study. This situation which has been inherited by the youth of today can be traced back to the attitude generated by the apartheid era amongst the parents of the pupils.

The 1993 statistics for the Kwazulu Natal region indicates that only *1318* pupils attended a technical school out of a total of 344179, who enrolled at senior secondary level (Grade 10 - 12) and 88976 enrolled at junior secondary level (Grade 6 - 9) (Kwazulu Department of Education, 1993:68). Furthermore, the Education Renewal Strategy Document (Department of National Education, 1992:5) quoted the following:-

> " it can be shown that learners in all population groups tend to choose mainly general or 'academically oriented' study programmes".

Due to the extremely low numbers of pupils taking technical subjects in the Kwazulu Natal region, we may deduce that this situation is most prevalent amongst black learners. The obvious question to pose is:- 'Why is this the case'?

2.1.8.2 Possible explanation for the reasons of a 'phobia' towards technical subjects in black education

Van Der Walt (1991), carried out a study to try and find answers to the problem of why so few black pupils enter technical education courses. His findings were primarily linked to the historical events of black education. Black pupils have tended towards being wary of technical and occupational training. Van Der Walt concluded that this perceived perspective can be attributed to the school system for blacks, which has not only been associated with inferior education, but also an education which was conceived with the purpose of perpetuating the apartheid policy (Van Der Walt, 1991:171). The same viewpoint is also expressed by Kahn and Rollnick (1993), who noted that students tend to view education with distrust rather than as offering opportunity. Kahn and Rollnick are of the opinion that it has to do with attitude possibly due to the Verwoerdian doctrine (see Section 2.1.5.3) expressed in the education system (Kahn and Rollnick,1993:267).

Luthuli (1982) comments on how education in the broadest sense satisfies human needs other than purely economic ones. Luthuli eludes to the black philosophy of life and states the following:-

> "...yet in an industrialised country such as South Africa, education needs to be re-orientated to meet the technical and material needs of the people" (Luthuli,1982:117).

A modification to the philosophy of life could assist the black people in determining what should be taught to their children at school. Luthuli identified the misguided path which the black child was following. The point may be linked to the general criterion of socio-economic background as the disadvantaged pupil has inherited some of the current problems from the past. De Beer provides a logical conclusion in the HSRC report-(vol 3):

" A fresh approach to the field of technical education through amendments of Government policy, could provide a diverse range of actions to counter the problem " (De Beer,1991:49).

2.1.9 Family relationships

Family relationships are a further problematic area which influences the didactic situation of the black school child. Black families tend to be fragmented, with grandparents often fulfilling the role of parent. The parent may work great distances from the home. The people often expect the teacher to educate children without parental support. The lack of involvement, by many parents, could in this way be described as being problematic. Teachers are expected to continue educating regardless of this anomaly.

Luthuli (1982:116) suggests that in most cases home conditions and pre-school life will determine what the child will become at school and also later on in life. It is essential that contact be established and maintained between parent and school. Du Preez and Duminy (1980) highlight the factors relating to the parental home which have an influence on the intelligence of children. Cultural interests and activities in the home, radio, TV, attitude and beliefs and the amount of time spent with children are all contributing factors. Factors and environmental issues such as the kind of school attended, quality of teaching, etc., prompted the following noteworthy points:-

(a) Children from orphanages and broken homes show lower IQ ratings than those from normal homes.

(b) Children whose fathers are professional men had a higher IQ than those whose fathers were unskilled labourers.

(c) IQ's of children whose parents had received good formal education were higher than those children whose parents had not (Du Preez and Duminy, 1980:62).

Tierney (1982) investigated the situation in the UK, where he worked amongst the lower classes and disadvantaged communities in which black pupils had to compete with middle class white counterparts. He found that lower class black and white pupils shared certain common problems within their education system. However, studies revealed that the black child also carried a black working class culture, derived from the family and neighbourhood. This caused severe problems with adjustment (Tierney,1982:35). In a study on the early home environment and educational performance, Jubber (1994) concluded that those pupils who had a beneficent home environment benefited incrementally through the school years, while those less fortunate progressed at a relative disadvantage (Jubber,1994:140).

Curzon (1985) provides a commentary on the work of Bruner (1966), and sums up this situation aptly by stating :-

> " cultural variations produce variations in modes of thinking so that a student's cognitive growth will be influenced directly by social patterns" (Curzon,1985:57).

To date not much research is available on the impact of black students into white schools within the South African context. The problems facing the introduction of technology education into all schools, is greatly influenced by the differences in cultural and family relationships that exist at present among black people.

2.1.10 Summary of the criterion socio-economic background

The criterion of socio-economic background in South Africa may, up to a point, be compared with similar situations in the USA and UK An overview of how the South African education system has evolved provides the reader with necessary background to explain why certain problems still exist. The physical facilities at disadvantaged schools as well as the resources required for projects necessitates that all potential planners take a closer look at current and past trends in black education to address the problem of equality. The criterion was also linked to black pupils' apparent 'phobia' towards technical courses, and why the family unit and support is necessary for complete development of the whole child in education. The selection of technology education projects require the application of the above criterion so as to justify their meaningful contribution to future educational needs within South Africa.

2.2 CRITERION TWO - DEVELOPMENTAL LEVEL OF THE STUDENT

FOR A TECHNOLOGY PROJECT TO BE DIDACTICALLY JUSTIFIABLE, IT SHOULD CORRESPOND WITH THE DEVELOPMENTAL LEVEL OF THE PUPILS AT WHICH IT IS TARGETED.

2.2.1 Introduction

Technology projects should be rooted in developmental theories. A closer look at the cognitive and affective development of children, provides us with background information which may be then be related to technology education. This criterion is considered to be an important link between general education as it is practised in schools at present, and the anticipated introduction of a new technology education programme for South African schools.

2.2.2 Introduction to developmental theories

Children, at different stages of their lives, develop different ways of thinking and will therefore also develop different behavioural patterns. Du Preez and Duminy(1980:94) define thinking as the function through which one seeks to understand the world and to adjust to it. This may be possible by acquiring knowledge and making deductions. If, therefore, teachers are faced with possible differences among pupils' learning, because of their different levels of development, then surely allowances must be made when selecting project content for technology education programmes.

Biehler and Snowman (1990:39) discuss possible reasons for behavioural differences among learners. they call this concept 'Entering Behaviour'. The term is used to describe the characteristics and knowledge a pupil *should* possess at the beginning of a sequence of instruction. This pre-knowledge varies according to a number of factors, like socio-economic background, family relationships, prior school experience, etc. Teachers must take cognisance of the fact that the child's academic ability, physical development and value judgements change with age within a 'dynamic continuum' (Unisa, Didactics study guide for Higher Education Diploma, 1985:26).

Project task selection will be influenced by the pupil's developmental stages. It is therefore necessary to briefly discuss some development theories which reflect the learning ability and expected behavioural outcomes of pupils who may participate in a technology education programme.

A child develops mainly on three inseparable levels:

(1) PHYSICAL LEVEL:- development which establishes physical differences.

(2) PSYCHIC LEVEL:- cognitive, affective and conative development.

(3) SPIRITUAL LEVEL:- the development of religious belief, meaning to life, values (Unisa, Empirical Education study guide for Higher Education Diploma, 1985:26).

2.2.2.1 **Cognitive development - an overview**

Cognitive development primarily involves, the intellect ie. that aspect of the child which helps with knowledge and reasoning. The child is always dealing with things, conceiving images of objects, seeing similarities, noticing differences and relationships and giving names to things in his/her environment. The current study is mainly focussing on the 12 - 14 year old child (standard 5 level or grade 7); at this age children should be able to detach themselves from the perceptual (the here and now) in their representations, yet this does not enable them to move with ease to the abstract or symbolic. The emphasis is thus still on the factual knowledge as the relationship with reality is still highly emotional at this age (Unisa, Empirical Education study guide for Higher Education Diploma, 1985:36).

When a child encounters a problem, he/she is stimulated to think. The confrontation with reality involves taking certain actions, such as planning, comparing, arranging, all with a view to a possible solution. This is essentially a management function which will be discussed in greater detail in Chapter 3. When the child is stimulated to seek a solution and understanding of the given problem situation, then the acquisition of knowledge is a possibility

(Strauss,1963:167). Strauss further states that 'the act of questioning is the beginning and origin of thought'. This implies the language used by the teacher would also have to be considered, as this is the mechanism which drives the thought process. Without language there cannot be a didactic situation with a meaningful outcome, as no questions could be asked or answered.

Macdonald (1990b:41), led a comparative study between black and white standard 3 children on the issue of language and concluded that the white children who had proficiency in English possessed what she termed 'cognitive capacity'. The meant that these first language speaking pupils were free to attend to the formal learning demands of their tasks, which included concept and skills development. The black child by comparison in the state system, using English as a second language, was noted as having language learning constraints which interfered with their concept learning. Roos (1987:276) also confirmed the issue of language as being very problematic, especially in developing countries. It may then be logically concluded that this same problem could also be repeated in a technology education programme.

2.2.2.2 **Piaget's theory**

Jean Piaget (1896-1980) postulated that human beings inherit two basic tendencies viz. that of organisation (the tendency to systematise and combine processes into coherent general systems) and adaptation (the tendency to adjust to the environment). The intellectual process seeks a state of balance through the process of equilibrium, (a form of self regulation that all individuals use to bring coherence and stability to their conception of the world) (Biehler and Snowman, 1990:59).

The product of organising and adapting is the creation of new schemes that allow us to organise at a higher level and more effectively. Piaget concluded that schemes evolve through four stages which follow a continuous but often zig-zag pattern.

Piaget believes that the rate at which a child proceeds through the stages, may vary, but that the sequence is the same for all children. Piaget's approach, although having been hypothesised about a few decades ago, still contains some interesting developmental theories relevant for technology education.

TABLE 3 - Piaget's stages of cognitive development

STAGE	AGE RANGE	CHARACTERISTICS
(1) SENSORIMOTOR	0 - 2 years	Develops schemes primarily through sense and motor activities.
(2) PRE-OPERATIONAL	2 - 7 years	Gradually acquires ability to conserve and decenter, but not capable of operations and unable to mentally reverse actions.
(3) CONCRETE-OPERATIONAL	7 - 11 years	Capable of operations but solves problems by generalising from concrete experiences. Not able to manipulate conditions mentally unless they have been experienced.
(4) FORMAL - OPERATIONAL	11 years and older	Able to deal with abstractions from hypotheses, solves problems systematically, engages in mental manipulations.

Source: Biehler and Snowman (1990:63)

Jacob (1982:221-236) conducted a study of Piaget's work and commented on the following noteworthy points:

(1) The rate of intellectual development as proposed by Piaget, was influenced by factors of maturation, social transmission, physical experiences and equilibration. Jacob considers these to be general conditions that govern intellectual growth.

(2) Jacob also directs attention to Piaget's goals for education viz. " the principal goal of education is to create men who are capable of doing things, not simply repeating what other generations have done ".

(3) Furthermore, " to form minds which can be critical, can verify, and not accept everything they are offered ". Jacob suggests that thought processes or mental operations must interact with content. He states that Piaget recognises the need for teaching set bodies of information, and recommends that a balance be struck between content to be memorised, and free activity. This point is significant for the planning of technology education curricula in order for creativity and other related thinking skills to be exercised.

2.2.2.3 **Affective development - an overview**

This refers to the emotional side of the child's life. Emotion may be defined as:-

" a complex phenomenon comprising of at least three aspects:-

(a) experience of conscious feeling of emotion;

(b) processes that occur in the brain and nervous system;

(c) observable expressive patterns of emotion, especially on the face".

Izard (1977:29).

Rice (1978:194) also suggests that emotions are subjective feelings which an individual experiences in response to stimuli. If we examine the first aspect of

Izard's work, then special attention needs to be given to what transpires deep inside a person, hidden from the view of others. The child may feel frustration, dread, revulsion or affection of which he/she may not be able to identify the actual cause. He/she may also not be able to express the feeling in words; nevertheless the feeling does exist and it affects a child's responses to all situations which generate feeling (Husen et al.,1980:1656).

Secondly, there is the role of the brain and nervous system. When a person is under pressure or experiences stress, the limbic system becomes highly activated and learning is subsequently inhibited.

Pupils from disadvantaged backgrounds, may seek to compensate their inadequacies under certain conditions, whether real or imaginary, and consequently exhibit behaviours that bring about further pressure. Finally, the intimate connection between inward feelings and outward expression is observable. Bellak and Baker (1981:29) report on at least six identifiable emotions which can be reliably recognised on the human face viz. happiness, surprise, fear, sadness, anger and disgust.

2.2.2.4 Implications for technology education

Ward and Murphy (1966) cite the following:-

> " The quality of a child's emotional development at school is determined by the quality of his social relations.. ..The personality of

the child is developed in the process of interaction between the child and the group ".(Ward and Murphy, 1966:102).

They point out that from the time the child enters a school there is a strong desire to be accepted by the group with membership eliminating isolation, and ensuring a feeling of security (*Ibid.*,1966:103).

Steyn (1984:11) generalises this concept from a curriculum perspective as follows:-

> " dat kennis van die leerders of teikengroep noodsaaklik is vir die kurrikuleerder. Hierdie kennis sluit 'n verskeidenheid van veranderlikes in soos die 'mate' van heterogeniteit in die begin situasie en psigo-opvoedkundige feite oor kognitiewe, affektiewe en psigomotoriese ontwikkelingsvlakke in bepaalde skoolfases en standerds".

This essentially means that educators of a new technology education programme, in selecting projects, would have to consider the 'whole' child which includes their emotional development. The prevailing circumstances which could influence behaviour in this regard must be considered in order to prevent the possible negative effects of poor affective development.

Husen et al.(1980:1657) also mentions a few other factors which may influence emotional development. These include:- (a) maturation (b) socialisation (c) the child is developed in the process of interaction between the child and the group ".(Ward and Murphy, 1966:102).

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Husen et al.(1980:1657) also mentions a few other factors which may influence emotional development. These include:- (a) maturation (b) socialisation (c) personality (d) language and communication skills (e) environment and (f) temperament.

2.3 CRITERION THREE - PROBLEM SOLVING

FOR A TECHNOLOGY PROJECT TO BE DIDACTICALLY JUSTIFIABLE, IT SHOULD PROMOTE THE PROBLEM-SOLVING ABILITY OF THE PUPILS.

2.3.1 Introduction

The possibility of introducing a new subject into the curriculum which promotes problem solving abilities amongst all learners is obviously a positive development. The fundamentals of problem-solving as a criterion will be highlighted and linked to subsections of discovery learning, heuristics of discovery, critical thinking and other forms of thinking ability. Finally the important aspects of creativity will be discussed to provide a logical argument for the inclusion of technology education into the school curriculum.

2.3.1 Problem solving

Firstly, it is necessary to examine the concept "problem-solving". Gates et al. indicate that problem-solving occurs when there is some or other obstruction to the attainment of an objective. If the path to the goal is straight and open there is no problem. It is when one has to discover a means of circumventing an obstacle that the stage is set for reasoning to be applied (Gates et al.,1963:449). Behr (1988) eludes that problem solving can be regarded as the chaining of a series of principles. To solve a problem the learner must have an understanding of the nature of the solution (Behr, 1988:51). Problem-solving seems closely related to heuristics.

A model was developed by Gallagher (1981:136) for the learning of problem solving skills which was linked to the heuristic skills approach. The model aimed at encouraging unique solutions to problems which overarch large bodies of information, and which involve long range planning. The management approach which will be described in Chapter 3 is similar to the aims of Gallagher's model, as it implements strategic planning as it's foundation.

Gagné (1985:178) views problem solving as :

> " a process by which the learner discovers a combination of previously learned rules and plans their application so as to achieve a solution for a novel problem situation ".

Gagné contends that for the process to occur efficiently, students will need to master two general kinds of capabilities viz. intellectual skills and cognitive strategies. To complete the process Gagné recommends a learning hierarchy. This is the ability to take a skill learned in one situation and use it to master a similar task in another; the concept is known as transfer of learning (Gagné,1985:178).

Macdonald (1990a:84), reporting on the work of Feuerstein (1979), identified deficient functions operational at three stages of the mental action. These impairments occurred at the input phase, elaboration phase and the output phase. Most problematic seems to be to identify **what** the problem is. Feuerstein's "cognitive map" which Macdonald (1990a:86) considers to be an *intervention programme*, had three sub-goals. These sub-goals emphasised affective motivational factors viz:-

(a) Promoting extrinsic motivation through the application of what was learnt elsewhere.

(b) Promoting task-intrinsic motivation.

(c) Possibly the most important, instilling in the learner a perception of him/herself as an active generator of knowledge, rather than a passive reproducer.

Arbitman-Smith (1984) state that:-

> " training in cognitive processes per se cannot make one immune to the need for knowledge that is necessary to do effective problem solving in a particular area " (Arbitman-Smith as quoted by Macdonald, 1990a:85).

The view of Ausubel et al. is that the only kinds of transfer that have been empirically demonstrated in problem-solving situations are the transfer of specific skills, general principles and orientation to a specified class of problem (Ausubel et al.,1978:544). Gates et al. (1963) focussed attention on the development of 'reasoning' which he called 'productive thinking'. Previous experiences are re-organised, or combined in new ways, to solve problems. This process is characterised by understanding or insight (Gates et al.,1963:446).

The concept of problem solving is very much a part of the Craft Design and Technology programme established in the UK. Problematic situations are created for pupils to solve - initially through their Design phase and then carried through to the Making and Evaluating phases, to test if a solution has been successful (Shepard,1989:28). This process has proved more difficult to implement into the UK education system than was initially thought by curriculum designers and has subsequently been revised (Dearing,1994).

From the foregoing arguments, it is evident that there is a tremendous difference of opinion, as to which characteristics should or should not be learnt first. South Africa seems at present to experience the effects of too few people being able to solve problem situations successfully. One wonders whether or not curriculum developers of technology education are themselves clear about possible methods to effectively teach and learn problem-solving. Whatever one's theoretical persuasions are regarding the precise nature of problem-solving, it is obvious that the teaching of problem-solving is essential for a programme to be didactically justifiable and that it should therefore be integrated into a new proposed curriculum for technology education.

The issue of problem solving is of particular interest to technology education initiatives, as there have been numerous meetings and discussions amongst members of the HEDCOM 2005 project committee, as well as the Kwazulu Natal provincial sub-committee for technology education, in which this characteristic was raised as being a desirable element for a new programme. This suggestion is supported by the work of Ndlela who writes:-

> " Technology education coupled with subjects such as science, would help develop problem-solving skills whilst encouraging independent thinking " (Ndlela, 1993:104).

2.3.3 Discovery learning

Bruner (1966) was a proponent of the discovery method of learning. Bruner's work, was influenced by Piaget's theory of developing thought processes (Curzon, 1985:57). The discovery learning theory as proposed by Bruner may be summarised as follows:-

> " The curriculum of a subject should be determined by the most fundamental understanding of the underlying principles that give structure to that subject " (Curzon, 1985:60).

Bruner suggests that teaching will be most productive when subject matter is reduced to the structural elements (like bare bones), to provide a foundation for the acquisition of principles (Bruner as quoted by Curzon, 1985:60). Through the discovery method, pupils may learn concepts and relationships. Bruner hypothesises that a student who knows the principles of a discipline, has the power to investigate and solve problems within its terms. Ausubel et al.(1978)

in their criticism of Bruner's theory concede that discovery learning is useful in the earlier stages of learning, prior to adolescence. They further agree that it is an indispensable method for testing the meaningfulness of acquired knowledge and problem solving skills (Ausubel et al.,1978:528).

Ausubel in fact challenges the possibility of solving problem situations through discovery alone, and forwards the suggestion that a minimal necessary amount of didactic exposition is required (Ausubel et al.,1978:524).

TABLE 4 - The advantages of discovery learning

(1)	DISCOVERY LEARNING PROMOTES THE ABILITY TO DEVELOP 'STRATEGIES' BY APPROACHING AND ANALYSING PATTERNS IN HIS/HER ENVIRONMENT, IN AN ORGANISED MANNER.
(2)	INTRINSIC MOTIVATION IS PROMOTED ABOVE EXTRINSIC MOTIVATION AS PUPILS DISCOVER SOLUTIONS ON THEIR OWN.
(3)	DISCOVERY TECHNIQUES WHICH ARE MASTERED MAY BE APPLIED TO REAL PROBLEMS OUTSIDE THE CLASSROOM.
(4)	THERE IS AN IMPROVEMENT IN MEMORY, AS THE PUPIL HAS ORGANISED KNOWLEDGE IN TERMS OF HIS/HER OWN SYSTEM.

Source:- Curzon(1985:60).

Ausubel et al. indicate the second disadvantage of discovery learning as the increased time which this method requires. Time obviously influences the budget expenditure for programmes. The use of discovery as a primary means of transmitting subject-matter is branded by Ausubel et al. as being unnecessary and unfeasible (Ausubel et al.,1978:538). A further problem area is that children tend to jump to conclusions, or to over-generalise on the basis of limited experience. This leads to them only considering one aspect of a problem at a time. Ausubel et al. suggests systematically organised content together with practice, linked to feedback variables from programmed presentations (*Ibid.*,1978:539).

Further criticism is recorded by Biehler and Snowman (1990:429), who agree with the points made by Ausubel and add the following: Students may become frustrated when teachers refuse to tell what they obviously know, especially when a project or discussion has been disorganised and unproductive. However, the brightest students tend to monopolise the discoveries, which may lead to jealousy, resentment and an inferior feeling by students who never come up with a discovery of their own. Finally, only one student may act as a lecturer when group discussion techniques are used to foster discovery. The balance of the group assume listeners' positions albeit only temporarily. As listeners, they tend to be less enlightened and less involved than if, for example, they were working independently on a computer.

The purpose of presenting these criticisms is not to remove the possibility of using discovery as a method of presentation of technology education courses, but rather to stress the need for teachers to think about the circumstances in which the discovery method is likely to be didactically most effective. Teachers need to be aware of the arguments against using the discovery method as the **only** method of presenting a technology lesson. However, if integrated with other methods, the discovery method is a most valuable learning experience in technology education programmes.

2.3.4 Heuristics of discovery: overview of literature

The word heuristics comes from the Greek *heuriskin* meaning " *serving to discover* " (Macdonald,1990a:91). Macdonald carried out a study on problem solving and made use of the word heuristics to connote inductive and analogical reasoning. From this approach plausible conclusions could be derived, rather than the deductive development of rigorous proofs as applied in the discovery process. Heuristics may therefore be referred to as a type of guided practice where a pupil is guided into the process of discovering. Bruner(1961a) advocates that once the heuristics of discovery are mastered, they serve as ' a style of problem solving suitable for any kind of task one may encounter '. Similarly, Suchman(1961), developed an Inquiry Training Programme as a means of teaching basic cognitive skills. This programme is claimed not only to be directed at science, but in every other curriculum area that requires reasoning and formulation of tests for hypotheses. (Bruner and Suchman as quoted by Ausubel et al.,1978:543).

Rossouw (1989:54) refers to the "guided discovery method" as proposed by the NUFFIELD COURSE which has become quite popular in some areas of South Africa. He does, however, caution educationists not to overemphasise one particular method of instruction. Gunner(1967:60), emphasises the importance of a balance between the discovery method and the learning of factual knowledge. Gunner feels that the learning of a certain amount of facts is necessary for effective discovery to take place.

Macdonald (1990a) concludes that heuristics would seem to be most relevant for courses on thinking skills. Heuristics have a great range of applicability and hence could often be beneficial. They are relatively well-specified and hence programmable. Macdonald, however, also suggests possible difficulties with heuristics, namely:

(1) There is a managerial problem of knowing when to apply a particular heuristic. For example: in which contexts should one try to break a problem into sub-problems?

(2) The heuristics may not be concrete enough to be implemented in an unfamiliar domain (Macdonald, 1990a:93).

According to the relevant literature consulted in this regard, there does not seem to be enough consensus of whether heuristics is the single best method to apply or not. Ausubel et al.(1978:545) contest the issue by stating that strategies of heuristics of discovery show little promise for improvement of education. Macdonald believes that classical heuristics would not be suitable for teaching children from middle to late childhood (Macdonald, 1990a:96).

In this study I accept the point of view that there is much merit in the use of heuristics of discovery in a technology education programme, but that it would have to be implemented alongside other methods to be most beneficial in the South African educational situation.

2.3.5 Critical thinking

There are many educationists advocating the importance of different types of **thinking skills** as the main advantage of a technology education programme. Ndlela (1993:81) is of the opinion that :

> "there is enough evidence that technology is a necessary ingredient to any curriculum that purports to enhance the development of creative and thinking skills among the pupils".

Lovell (1962:102) comments that thinking can never be detached from the total personality, and people cannot think independently of their emotions, needs and values. Rossouw (1989:71) in his study on the importance of a science curriculum with reference to the needs of industry, concluded that skills were perceived as being more important than knowledge. The **most important** skill desired by industry, out of a list of 56 possibilities, was critical thinking. Carlson (1985) warns of the possibility of a curriculum emphasising discrete facts and recall over the development of more complex forms of literacy and critical thinking.(Carlson as quoted by Altbach et al.,1985:11). There is thus an obvious need for pupils in today's schools to be able to be taught the skill of critical thinking. Critical thinking may be defined as:-

> " a composite of attitudes, knowledge and skills that facilitates an in-depth reflective search for valid conclusions which solve problems, resolve doubts or enable one to choose among conflicting doctrines" (Behr,1988:151).

Behr suggests that critical thinking may be developed through consistent practice with statements, propositions and doctrines that require reasoning of different kinds, such as evaluating an argument, making an inference or judging an assumption (Behr, 1988:151). The hierarchy of reasoning levels described by Burton et al.(1960) is summarised by Behr(1988:152) as he proposes that these levels of reasoning should become part of the cognitive behaviour patterns of an individual. He does caution that even the 'brightest' pupils experience difficulty with reasoning skills (especially at the level of deduction and logic - see Table 5 for details).

Ausubel et al. state that critical thinking ability can be enhanced only within the context of a specific discipline. They also feel educationists must guard against catering for an elect few at the expense of the non-exceptional majority.

Ausubel et al. also seem to be wary of how one would go about teaching critical thinking skills to an 'average' learner and emphasise that 'critical thinking cannot be taught as a generalised ability' (Ausubel et al.,1978:543-546).

TABLE 5 -The hierarchy of reasoning levels

LEVEL 1	*LEVEL 2*
Manipulating symbols	Seeing rules of principles
Solving problems	Seeing systems
Defining problems	Seeing trends
Testing hypotheses	Seeing relations
Organising sequences of related steps	Seeing identity of relations
	Analysing forms
LEVEL 3	*LEVEL 4*
Seeing common elements or properties	Drawing inferences (deductions)
Classifying in general	Syllogistic reasoning (logic)
Deduce correlates	

Source:- Behr (1988:152)

Gates et al.(1963:469) state that:-

> " critical ability and reflective thinking tend to develop along with knowledge and understanding in separate fields, rather than as universals or generally transferable values ".

This would therefore suggest that there is very little consensus about the specifics of critical thinking, teaching and learning techniques. In the final analysis, however, there is no doubt that in modern society it is desirable to have citizens who can think critically about what they do. It is therefore essential that critical thinking skills should be deeply imbedded in a technology education programme. Educationists should integrate this desirable aspect holistically, so that critical thinking becomes part of the accepted norms related to learning.

2.3.6 Other forms of thinking ability

2.3.6.1 **Lateral thinking**

Macdonald (1990a:94) in her research work on the Cognitive Research Trust (CoRT) programme for STD.3 pupils, cited the work of De Bono(1968,1970). In an attempt to clarify what lateral thinking is, De Bono distinguishes between vertical thinking (normal) and lateral thinking (unconventional). Vertical thinking is equitable to logical thinking which is sequential and predictable, much like conventional thinking within a frame of reference. Vertical thinking, according to Macdonald, has the necessity to be right at every stage, as well as having everything rigidly defined. In contrast, lateral thinking is not necessarily sequential; it is unpredictable, is not constrained by convention and re-structures the 'problem space'. A complementary role of the two thinking types seems to be desirable for successful problem solving ability. Macdonald feels that thinking is regarded as a skill that can be enhanced by attention to various operations as used in the CoRT programme. Six aspects of thinking were tested:-

(1) breadth

(2) organisation

(3) interaction

(4) creativity

(5) information

(6) feeling, action.

Macdonald concluded her report by remarking that:- "the transferability of the skills to other situations would be one of central interest".
(Macdonald, 1990a:95).

The possibility of using aspects of a CoRT programme for the benefit of technology education, may assist in defining new roles for the teacher and learner in a less formalised learning programme. Lateral thinking needs further consideration within the framework of the criterion "problem solving". Thinking which may be regarded as being different from the norm, must be considered in order to direct educationists into the future of an exploding technological era. Pupils need to be equipped, where possible, with as many relevant alternatives in order to uniquely solve problem situations which may be set in technology education programmes.

2.3.6.2 **Divergent thinking**

Divergent thinking is another way in which pupils think in problem situations. Child (1977:222) carried out a study to differentiate between convergent and divergent thinkers. Child found that the convergent thinker tended to obtain a higher score in an IQ test than a comparative divergent thinking pupil in the same test. Such convergent thinking pupils tended to follow Science subjects at school. Similarly, pupils who showed divergent thinking characteristics, tended to follow English literature, history and modern languages as school subjects. Child does point out that divergent thinking tests which were once considered as a measure of creativity, are no longer viewed as such, but rather as reflecting preferred thinking styles. The **characteristics of divergent thinking** according to Guilford (1962) are:-

(a) Flexibility (the ability to vary ideas over a wide field).

(b) Idea fluency (the number of responses).

(c) Originality (responses which are unique or unusual).

Jordaan et al. (1975:630) summarise divergent thinking as the production of numerous, diverse, unusual and unconventional answers and solutions. This quality could be taught to many students in technology education, and would be most beneficial in solving complex problems.

2.3.7 Creativity

Creativity is a term which has traditionally been related with art. It seems to possess a mystical value which needs to be explored and possibly included in the technology education 'bank' of skills to be learned. There seems to be a great deal of merit in the application of creative ways to solve problems. Jordaan et al. (1975:630) cite the work of Guilford (1962) who put forward the idea that there are a number of 'general abilities' which apply to any form of creativity. These general abilities make creative thinking possible. Interestingly enough, Guilford found that the most important characteristic of creative thinking is divergent thinking. The issue of creativity has received wide publicity by those persons advocating technology education. The statement of intent in the Draft Guideline Curriculum document for technology states:-

> " to develop the practical capability to engage meaningfully and creatively in technological activities " (CHED, 1994:10).

Hartshorne (1992:79) criticises the work of teachers who emphasise expository teaching with little regard for the learning of pupils, and only in exceptional cases is any attention given to 'learning to learn' or the development of independent, creative thinking (*Ibid.*,1992:79). Hartshorne infers that the development of this form of thinking is important for South African education in general.

Ausubel et al.(1978:566) state the following:- "creativity is the highest expression of problem solving". However, Ausubel cautions that creativity is less generously distributed among learners than intelligence or problem solving ability. He concludes that creativity is even less trainable than problem solving ability. Ausubel believes that schools could best be utilised to foster creativity by providing appropriate opportunity for development (*Ibid.*,1978:566). In this way it is useful to use their ideas in the technology education initiative.

This view is confirmed by the work of Jacobs(1991:70) who refers to the problem solving ability of third world children as follows:-

> " those who were fortunate enough to go to school,... almost all of them have been conditioned to follow orders, to doubt their creativity, to accept things uncritically, and to be terrified of enterprise ".

On the basis of the above argument I believe that South Africa is not doing enough to promote creativity amongst the generation of tomorrow. Technology education attempts to link the elements of creativity to the need for pupils to be able to solve problems (CHED, 1994:4).

Ndlela(1993:82) referring to the work of Dodd (1988), proposes that creative and thinking skills should be enhanced and considered as a necessary inclusion in a 'peoples education' curriculum. Technology education could be viewed as a starting point for these skills to be developed. Luthuli (1982:67) concurs that the curriculum should be norm-centred and a reflection of the philosophy of life of the people involved. The subject content should comprise of experiences and opportunities towards 'independence in thought' among others. Both Ndlela and Luthuli tend to think in terms of assisting the black people who have been forced, in the past, into learning a 'not so relevant' curriculum. Through the application of a relevant curriculum, like technology education, communities particularly in the black areas, will be able to learn how to solve problem situations in a logical manner. This could be a desirable 'spin-off' from a successful technology education programme.

De Beer.(1991:53), suggests that change in society occurs mainly because of man's curiosity, inventiveness and desire for improvement. Most noteworthy is that it results from creativity, which leads towards invention. Jacobs(1991:71) recommends that South African teachers should actively create opportunities to be engaged in self-initiated actions of this nature. There appears to be many advantages to the inclusion of creativity in a technology curriculum. Ausubel et al.(1978:593) concluded that the school cannot actualise potentialities for unique creativity, if these potentialities do not exist in the first place. A serious look at developing creativity at as early an age as possible seems to be one possibility. In this way it may be possible to improve the problem solving ability of the future workforce of South Africa. This would continue to advance the economy and improve social conditions within the country in general.

2.4 CRITERION FOUR - MOTIVATION

FOR A TECHNOLOGY PROJECT TO BE DIDACTICALLY JUSTIFIABLE, IT SHOULD MOTIVATE THE PUPILS AT WHICH IT IS TARGETED.

2.4.1 Introduction

Possibly the most widely promoted motivational theory is that of Maslow's hierarchy of needs (Maslow, 1970:35). The concept of motivation affects the teaching and learning of all school subjects, but will be specifically related to technology education. In a didactic context, pupils who are motivated to learn will be able to benefit from the wide variety of subject matter which is proposed as content in a new technology curriculum programme.

Ndlela(1993:79) comments on the UK programme in technology as follows:-

> " it is interesting to note that CDT (Craft Design and Technology) fosters motivation...".

Within the South African context it is fair to assume that the new curriculum should also generate motivation amongst all learners.

2.4.2 Motivation of pupils

Motivation is an area of education which is often problematic. The intensity of motivation among pupils at an institution varies according to the location of the institution, the attitude of the teachers and management, support services and the prevailing infrastructure. In the introduction of a technology education programme, motivation is considered essential to facilitate successful teaching. Most teachers who have completed a teaching course in subject didactics would agree that it is essential to motivate a class group in order for meaningful transfer of knowledge to occur. Duminy and Sohnge (1980:34) correctly state that:- "motivation is the key to successful teaching". This view is supported by Curzon (1985:78) who further suggests that:- " motivation is what initiates and sustains a pupils' involvement in the act of learning and to a large extent determines the direction and efficiency of the pupil's learning ". The motivational state of pupils at schools can be influenced by poor family relationships, as parents or family/friends with whom pupils reside are often ignorant about techniques of being successful at school; they therefore often adopt a disinterested attitude towards the child's educational needs. Such parents/friends themselves, usually did not have the necessary exposure to modern teaching techniques and requirements.

Shepard (1989:19) refers to what psychologists call 'peak experience', which seems to provide learners with the motivation to generate creative activity. Teachers need to acquire the skills necessary to unlock such potential. Arnold(1988:27) states:- " it is necessary therefore in an educational context especially, to distinguish between the skilled performance of a person in terms of a contextual purpose to be fulfilled, and the intrinsic satisfaction it affords him ".

I therefore propose that for projects to be successful the following aspects need attention:-

(1) The management at the school need to be interested in the aims and objectives of the programme.

(2) The teachers must show their enthusiasm and excitement to teach the pupils new concepts and assist in problem solving.

(3) The motivational state of the pupils must be known before selecting a project.

The above mentioned points can lead towards a positive reaction from the pupils and assist in developing their motivation to complete projects and try new ideas. Failure to motivate could mean that pupils will be afraid to try out something which is new and abstract. The teacher must be aware that his/her duty is to prepare pupils in an appropriate way, so that motivation is created and maintained.

2.4.3 Attitude of pupils

It is common knowledge that disadvantaged pupils presently attending township schools, have a tendency to be influenced politically due to their current social situation. It is noticeable that whatever political propaganda is spread, the pupils and teachers tend to react almost immediately to new slogans and suggestions. Such impulsiveness tends to negatively influence the rhythm of classwork and the educational programme in general. Furthermore, the environment is often not conducive to promoting effective teaching and learning. This combination seems to be responsible for attitudinal problems which exist at varying levels and at different schools within the township areas. To suddenly change the attitude of pupils is not possible, but if given time, pupil's attitudes towards learning could be positively 'modified'. All the above tends to impact on the selection of projects that a teacher may decide on.

Teachers play a critical role in helping to bring about change by encouraging pupils to modify their attitude towards work. Such changes are necessary for growth and development of technological capacity in South Africa. Back-to-school campaigns which have been used to encourage pupils back into classrooms, are not enough in themselves to promote effective teaching and learning, although this initiative is a good starting point. A distinct change in attitude from an apparent lack of interest, to one of responsibility and hard work is required. Technology education would necessitate more commitment from the pupil for full benefits of the subject to be realised.

2.4.4 Motivation of teachers

As technology is a completely new subject which is being proposed for inclusion into the general school curriculum for South African schools, the role of the teachers could be seen as a vital link for successful implementation. Furthermore, all teachers would need to be positively motivated towards the common goal of such a project and the upliftment of current South African educational standards. Technology education can play an important role in bridging the proverbial gap from third world to first world standards. Jacobs(1991:72) suggests that "when products and services are of a low quality, many of the underlying reasons for it can be found in poor teaching and training techniques". This situation characterises teachers who, apart from other things, are often demotivated. King(1984:54), also adds that " in third world countries most teachers have a pass-the-buck mentality....at the end we have a mediocre standard of life caused by mediocre workers producing mediocre services and products ".

Although South African teachers over the past few years have had problems and were demoralised by government policies, democracy and unity have prevailed. Problem situations within educational circles which have tended to improve slightly should allow teachers the opportunity to reflect on their teaching abilities and direct more attention to the possibility of raising educational standards. Teachers are a key asset to future planning aimed at improving South African education, and motivated teachers are essential to unlock a dynamic technology education programme.

Biehler and Snowman(1990:536), refer to systems of teacher motivation which can influence the learning outcomes of pupils.

(a) The ability-evaluative system.

(b) The moral responsibility system.

(c) The task mastery motivational system.

According to them, teachers need to be made aware of the behavioural, cognitive and humanistic views of motivation. This could lead to successful didactic encounters within a new and progressive educational system.

2.4.4.1 Teacher attitude

The implementation of a technology programme needs the support of teachers who have an attitude which is conducive to accepting new innovations and changes. There is obviously a close relationship between motivational level and attitude. Jordaan et al. (1975:845), refer to attitude always being connected to a specific object or idea. The attitude of a teacher towards a subject may be favourable or unfavourable, which in turn may lead to either a positive approach or else avoidance. If teachers choose the latter course, technology education could fail.

The prevailing circumstances influencing the teaching and learning of disadvantaged pupils in Kwazulu Natal inspired the inclusion of teacher attitude into this study. There are some teachers who only attend school in order to collect a salary at the end of the month. Personal problems are attended to first, and only then may the pupil's educational needs be considered. Ndlela (1993:105) comments that "most of the teachers in the current system seem to be demotivated and demoralised. Some have developed negative attitudes towards inspections". It would appear that no effective control measures are being enforced to ensure teachers' work is being done correctly.

Some of the teacher unions are partly to blame for this situation (Kwazulu Department of Education and Culture, 1993:62) Teachers participating in a new technology education programme need to be conscientised towards the fact that they cannot teach such an innovative subject with outdated modes of instruction and unprofessional attitudes towards their chosen profession. De Beer (1991:105) suggests that technology is one of the main tools enabling us to face up to the challenges of the future. An attitude of personal responsibility for the general outcome of public life are necessary ingredients for a successful technology education programme.

2.4.4.2 Teacher training

When considering meaningful transfer of knowledge there has to be a medium through which knowledge can be imparted. The inseparable part of the teaching event is the role played by the teacher, together with the student and subject matter. A teacher who is not properly trained will probably not perform well. This has a spiralling effect on the education system.

The subject of technology as is being proposed in a new curriculum, necessitates that teachers be specially trained for the task of teaching the proposed content. The content being prescribed is all encompassing, so a teacher would need to acquire a wide variety of skills to be able to relate content and to demonstrate skill effectively. Technology education should possess it's own body of knowledge. This would mean that although there are possible links with other subjects, technology education would still retain it's own unique identity. This view is also expressed in the Ort-Step Institute's proposed primary school curriculum document (1995:6).

There are educators who would prefer to see the new technology subject related to science teaching. The aims proposed for a new science and technology curriculum are based on those contained in the ANC discussion document on education policy (ANC Education Department, 1994 ; Rollnick and Perold, 1995:10). They propose an integrated approach to the teaching of science and technology. My current study, however, opposes that notion as technology education should not be restricted to only a science perspective. However, the necessity for specialised teacher training remains. There are institutions like CASME and ORT-STEP who are linking up with local and overseas Universities to facilitate teacher education in this field. This would lead to either a further diploma in education (FDE) or a bachelor of education degree (B Ed).

Hawes (1982:9) sums up the situation quite adequately when he states "much education policy, much curriculum policy has failed precisely because it lacks the appreciation of the humanity of humans....". Teacher training is possibly the most costly when considering future implementation but without it there can be no effective teaching and learning at all. An effective and detailed teacher training programme, prior to a teacher being allowed to teach the new subject of technology, is therefore considered to be an essential part of the new technology education initiative.

2.4.5 Curriculum changes

The general school curriculum, which is currently in use at all schools within the ex-Kwazulu Department of Education and Culture, requires modification to include the introduction of technology education. Toffler (1970:370), appealed to curriculum planners to justify why children have to learn what they learn. The motivation of pupils and teachers is closely linked to what is being taught and learnt in the curriculum. What worried Toffler was that children spend a great deal of time learning content which is highly questionable (Ntshoe,1991:227). Grebe (1991:132) also argues for the de-emphasis of content and the more pertinent teaching of skills to handle or manage the knowledge explosion. Hawes (1982:19) warns that for change to occur in the curriculum, teachers need to be sufficiently interested, before planners even begin to contemplate change. He further comments on curriculum developers who tend to disadvantage the rural child by developing syllabuses, materials and examinations for people from more prosperous environments as has happened in Kenya. This situation seems remarkably close to the South African situation.

Rossouw (1989:46) states the following regarding the establishment of a curriculum model:-

> " 'n Ander belangrike invloed op die kurrikulum is die model of raamwerk waarvolgens die kurrikulering geskied. Die model bepaal die elemente van die kurrikuleringsproses, naamlik die handelinge wat uitgevoer moet word, die strukture waarbinne hierdie handelinge uitgevoer moet word en die persone betrokke by die uitvoering van die handelinge ".

Technology education could possibly also benefit from a curriculum model specifically designed to suit the needs and requirements of South Africa. Further research will need to be carried out in this regard.

Ndlela (1993:103) commenting on the need for change towards technology education summarises the issue quite eloquently:-

> " The country needs innovators, shapers, implementers etc. for he various social team roles and expertise ..... a curriculum would eliminate rigid and old-fashioned forms of assessment, but also make provision for the development of creative and problem solving skills".

The advantages of bringing about change in a new democratic South Africa, in favour of introducing technology education into all schools within the province of Kwazulu Natal are viewed as being necessary for the survival of all persons in this country. Curriculum developers can play a leading role in initiating this change by assisting in the adjustment of the school curriculum to include subjects like technology which will be relevant for the work place.

2.5 CRITERION FIVE - MEANINGFUL TRANSFER OF KNOWLEDGE

FOR A TECHNOLOGY PROJECT TO BE DIDACTICALLY JUSTIFIABLE, IT SHOULD FACILITATE MEANINGFUL TRANSFER OF KNOWLEDGE FROM TEACHERS TO PUPILS.

2.5.1 Introduction to effective teaching and learning

For a technology education programme to succeed it should include an opportunity for learners to acquire knowledge meaningfully. In the present situation, such transfer seems inadequate at most Kwazulu Natal schools. The 1991 Annual Report for the Kwazulu Department of Education and Culture indicates only a 35% overall pass for the standard ten examinations. (Kwazulu Department of Education and Culture, 1991:64). Overseas countries like the UK and Australia regard the acquisition of knowledge and skills as being essential components of technology subject curricula (UK School Curriculum and Assessment Authority, 1994:3), (Australian Curriculum Services Branch, 1992:2).

Teachers in South Africa will have to realise their calling to be educators within the ever changing circumstances in which they find themselves. They have a responsibility towards the future development of the country and must therefore ensure that they are prepared to impart knowledge to pupils' in a meaningful and interesting way. Greater effort in this regard would be required from both the teacher and learner, especially to those teachers who intend changing their specialisation to technology education. Conditions and circumstances in the township areas are not always conducive to providing a comfortable environment for effective teaching. An extra effort will be required by all if technology education is to succeed under such poor conditions.

Fuller (1991:21) looked at aspects of third world education practises and noted that:

> " central education ministries set a standard curriculum, encourage teachers to simply drill these 'facts' into the heads of children, then simply test children on memorisation of these bits of knowledge".

If this trend should continue in the South African context, very little effective teaching will be possible. A sound support system will have to be introduced to encourage growth and development in the technological field of study. Teachers and curriculum developers need to be reminded of the different views of learning and should be prepared to modify, if necessary, their existing practices.

2.5.2 Different views of learning

There are a number of researchers who have expressed opinions regarding what learning is. The following extracts highlight the point:-

(a) General agreement has been reached that learning involves a change or modification of existing patterns of behaviour, which will have some influence on future performance (Behr, 1988:45).

(b) Learning implies 'cumulative improvement'. This means that as the learner progresses from one stage of learning to another, he is able to use knowledge gained in one situation for the acquisition of knowledge in other situations (Davis, 1956:278).

(c) Learning involves a change in behaviour which is more or less permanent in nature and which results from the activity, training or observation and not from changes that occur through maturation (Lovell, 1962:125).

(d) Learning has to be viewed as part of a 'whole', between the learner and his environment. This Dewey calls 'learning to think' (Dewey, 1971, as quoted by Curzon, 1985:56).

(e) Bruner views learning beyond the mere acquisition of knowledge. He sees it's end as the creation of a better, happier, more courageous, more sensitive or a more honest man. He also sees the role of schools as an amplification of intellectual skills (Bruner, 1966, as discussed by Curzon, 1985:57).

(f) Ausubel et al. (1978:567) indicates that for meaningful transfer of knowledge to take place, essential elements should be present:-

   (a) A meaningful learning set.

   (b) A logical meaningful learning task.

(c) The availability of relevant established ideas in the learner's cognitive structure.

Ausubel further emphasises the importance of appropriate background knowledge of concepts and principles as being essential for the meaningful transfer of knowledge.

(g) Rosenshine and Stevens (1986), propose that there are specific instructional procedures which teachers can be trained to follow and which can lead to increased achievement and student engagement in their classrooms (Rosenshine and Stevens, 1986 as quoted in Potchefstroom University for Christian Higher Education, B Ed.Study Guide, Instructional Science, 1992:2). This thinking forms the basis of their process-product paradigm. It must be pointed out that Steyn and Fenstermacher (1992) do oppose this approach and plead for a ontological-contextual approach (Steyn and Fenstermacher as quoted in Potchefstroom University for Christian Higher Education, B.Ed study guide, Instructional Science, 1992:3).

2.5.2.1 Views of learning related to technology education

The views most closely related to technology education are those of Ausubel et al.(1978) and Rosenshine and Stevens(1986). Ausubel et al. provide a logical framework for a project in technology from the design phase onwards. The programme should be set out in a holistic manner, and pupils should be led into the design phase systematically. Rosenshine and Stevens (1986) agree that there should be specific instructional procedures that teachers follow. Essentially this idea forms the basis of their process-product approach. The presentation of technology programmes should encourage all pupils to participate enthusiastically within their class situation. This is attainable if a holistic-process approach is applied. The heuristics of discovery method provides teachers with a means of implementing this idea, and the management concept (see chapter 3), will allow all participants the opportunity to manage their individual projects systematically.

2.5.3 Blooms taxonomy

Bloom's taxonomy (1956) is a well known classification scheme with categories arranged in hierarchical order, and divided into three domains: cognitive, affective and psychomotor. Bloom accepts the definition of a behavioural objective as: a 'statement' which describes what the pupil should be able to do once the instruction has been completed. Bloom classified behaviour as what was the 'intended behaviour'- the way in which pupils are to act, think or feel as a result of participating in some unit of instruction (Bloom, 1956, as explained by Curzon, 1985:107).

Technology education seeks to embrace all three of the described domains in order to construct a new, meaningful and relevant subject. Bloom's taxonomy serves to provide a clear distinction between identifiable behavioural traits in learners. These identifiable behavioural traits can be of assistance to all teachers who would seek a means of knowing what pupil qualities should be elicited during a lesson, and can also form part of the evaluation aspect.

TABLE 6 - The three domains - (objectives listed in hierarchical order)

COGNITIVE DOMAIN	*AFFECTIVE DOMAIN*	*PSYCHOMOTOR DOMAIN*
Knowledge	Receiving	Reflex movements
Comprehension	Responding	Basic fundamentals
Application	Valuing	Perceptual abilities
Analysis	Organisation	Physical abilities
Synthesis	Characterisation	Skilled movements
Evaluation		Nondiscursive communication

Source: Callahan and Clark(1977:46)

CHED (1994,3), describing the South African technology education initiative state the following:-

> " The application of the technological process is strongly influenced by prior experience, beliefs, values and attitudes of the learner as well as a continuous interaction between ideas in the mind and actions of the hand ".

The description of objectives listed by Bloom, serves as a point of departure for aspiring technology education teachers to formulate a strategy in which to address the essential aspects of a new programme. Teachers will have to focus on educating the 'whole' child cognitively, affectively and psychomotorily. Technology education programmes will require the application of efficient and effective didactic methods if the desired objectives are to be fulfilled.

2.5.4 Mastery learning

If we consider the criterion of meaningful transfer of knowledge, then the possibility of also applying the principles of mastery learning needs to be looked at more closely. Mastery learning may be defined as a way of organising and managing instruction in which pre-specific performance criteria are achieved. It is also a synonym for Criterion Referenced Instruction (Mager and Pipe, 1979:10). A great deal of research was completed prior to Mager's work; as early as 1963 John B.Carroll gave impetus to this concept. Carroll suggested that teachers should allow more time and provide more and better instruction for students who learn less easily and less rapidly than their peers (Biehler and Snowman, 1990:631). Carroll further observed that teaching ought to be a simple matter if it is viewed as a process concerned with the Management of Learning. This concept will be followed up in Chapter 3 as a possible method for a new technology education programme.

The effective use of mastery learning was stimulated by the formulation of desirable ways to devise instructional objectives and re-assign the teachers to a facilitators role; away from the normal chalk and talk method which has tended to become quite popular. Other benefits would include modular learning units which would require detailed preparation for each lesson. In general lesson preparation is not being carried out as a priority task in most disadvantaged areas.

2.5.4.1 **Evaluation of projects**

Another notable difference to conventional teaching is the evaluation system. Altbach et al.(1985:173) comments:-

> " by working through the sequence of tasks...,students are led to 'mastery' of a 'skill', the achievement of which is indicated by the passing score on an objective-based post-test ".

The majority of these tests which I have seen, had the minimum criteria required for a pass set at around the **80%** mark. This is a significant change compared to traditional methods and has the added benefit of taking less time to complete a module. Modules may then be accumulated as credits to qualify the learner for further study in a particular field.

If these ideas could be adopted into the selection process of technology education projects, then the possibility does exist for teachers to be able to effectively teach pupils new skills, and also measure whether they have been acquired correctly or not. Surely, educationists could learn something from major industrialists who have successfully implemented this form of training into their work situations. The present evaluation system at most schools in South Africa would also need modification if mastery learning techniques were implemented.

This study does acknowledge the possibility of including aspects of mastery learning into a management approach to teaching and learning technology. Projects which are selected could benefit from the mastery approach as the content could be mastered at a quicker rate than normal, thus saving time and so benefit the technology education initiative in general.

2.6 CONCLUSION

The chapter has focussed on five crucial criteria which could be applied to select projects before deciding on any particular didactic method. The acknowledgement of the relevant criteria by teachers is considered to be an important step forward to ensure that technology education is not just another useless attempt to try and introduce something new. When educational authorities in the UK evaluated their first attempt at technology education, they found that their teachers had problems translating the prescribed approach into effective classroom practice (UK National Curriculum Council, 1992:1). Chapter 2 of this study has attempted to try and orientate teachers to consider elements which could impede their effectiveness. This situation may be further complicated by unsatisfactory conditions in certain areas of the province. The criteria described are to be used as a broad framework for teachers and planners to select projects, or implement a theme, which is relevant to the local circumstances and conditions.

CHAPTER 3

APPROACH AND RESEARCH METHODOLOGY

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CHAPTER 3: APPROACH AND RESEARCH METHODOLOGY

INTRODUCTION

The technical education advisory services of the Kwazulu Department of Education and Culture, noted a problem with very low technical drawing results during the 1993 academic year. The problem was particularly noticeable at the comprehensive secondary schools. The management of the technical section decided to embark on a project which would address the problem at an early age, before the pupils' entry into the secondary school. Consequently Standard Five level was considered the most suitable target group. The project was approved early in February 1994 when a curriculum consulting firm was contacted and requested to assist with the development of a suitable new curriculum to address the problem. The consultant presented the subject of technology and integrated it with a management approach. The proposal contained a large technical drawing component to address the need of the Kwazulu Education Department. The officials making the decisions for funding and piloting of the course were in agreement that the proposal complied with the requirements. A sum of R 50 000.00 was set aside for the initial implementation of the pilot programme.

The project was commonly referred to as *the lorry project*, and was finally implemented in 1995 at eight selected pilot schools in Kwazulu Natal.

3.1 HISTORY OF THE PROJECT

The most cost effective means of purchasing the lorry project, which was made up into kit form, was to purchase one thousand kits. A very important aspect of implementation was to know where the project was going to be tested. A number of senior primary schools were visited to try and identify the most suitable locations for the project.

The eight participating schools were fairly evenly distributed from the South to the North coast, representative of the most common feeder schools, and located in the following areas:-

(a) IZOTSHA

(b) UMBUMBULU

(c) KWAMAKHUTHA

(d) UMLAZI

(e) BOTHA'S HILL

(f) KWAMASHU

(g) AMATIKULU

(h) ESIKHAWINI

The prospective voluntary teachers then required training. They were given an initial one week training course on the subject content. This was what may well be called a 'crash course', designed to enable the voluntary teachers to present the course. Due to the short duration (only one week), it could not be called comprehensive, and proved to be problematic later in the study. This one week course was then followed up with a two day seminar, about one month after all pilot schools had started, to address any immediate problems experienced with the drawing section and with the course aims.

A class visit was conducted to each school. The course designer was able to visit two schools with me to gain insight into actual classroom situations. A further one-day seminar was organised to discuss and evaluate the project. Finally a report-back meeting was held to address the following:-

(a) to encourage teachers to express their opinions;

(b) to discuss common problems;

(c) to display their pupils' projects;

(d) to deliver their principal's report and hand in their personal questionnaires.

A noteworthy factor was that, following the training course, it was noticed that not all schools had such items as scissors, glue, crayons, etc. so as to be able to complete the lorry project. This meant that a further requisition had to be authorised to equip the eight schools with back-up kits.

3.2 DIDACTIC MANAGEMENT APPROACH

When considering the vast area of knowledge to be covered by a new technology education curriculum, the planners were still reflecting on which didactic methods would be most appropriate. In order for effective teaching and learning to take place the message being transmitted by every teacher needed to be simple and concise, appropriate to the level of development of each child. The approach had to appeal to children of extremely diverse cultural heritages without losing the impact of the valuable message which this subject had to offer.

It was decided that the most effective method would be to introduce a bridging system in which technology education and management would be integrated. The bridging concept would take into account people's potential and abilities which need to be modified to comply with new demands for change and continuity. This concept was first introduced through the work of Dreyer (1978) and modified into an acceptable technology education approach by Van Den Heever (1994).

Some of the other initiatives considered before proposing the management approach as a possible method tend to place great emphasis on the design element through their respective proposals, viz. Organisation for Educational Resources and Technology Training (ORT-STEP) in South Africa, Design and Technology from the United Kingdom, and the proposal from the Natal Education Department (NED) also from South Africa. The management approach has as its foundation strategic planning which automatically includes design as an element without over-emphasising its importance. A further noteworthy change in approach is the application of a systems approach linked with the process of management. Dreyer calls this a *conceptualised management learning system* (CMLS) and defines it as an integrated systems approach directed by structured strategic planning (Dreyer,1978:5). There are other supporters of a purely systems approach like Myerson (1990:8) and Hellriegel and Slocum (1989:63), who propose an alternative to the process approach. The New Zealand curriculum also proposes an **integrated approach** to learning.

3.2.1 Systems approach versus process approach

At this early stage of technology education in South Africa, it is anticipated that relevant lessons can be learnt from other countries like the United Kingdom, Australia and possibly the United States of America. The United Kingdom, among others, have experienced various problems during their implementation phase and they had to modify their draft proposals. There does not seem to be any clear cut decision on which approach is the best method to adopt - either a system, a process, or a combination of both.

TABLE 7 - A comparison of two approaches

SYSTEMS APPROACH	PROCESS APPROACH
Advantage of looking at the broad outline of a conclusion to a problem.	The process of design seeks a satisfactory problem.
Helps to avoid making simplistic assumptions of cause and effect.	The process is the means by which the required result is achieved.
A broad perspective means that one does not have to consider complex detail of any particular technology.	A more concentrated perspective is adopted which does not necessarily look at the broad picture for a possible solution.
Components may not be considered as isolated units as their togetherness conveys meaning to the designer.	Various possibilities may be considered as separate entities within a process.
The functional outcome of a situation as a system may be defined as its intrinsic meaning.	The end result is also a possible solution which seeks to present meaning through the process.

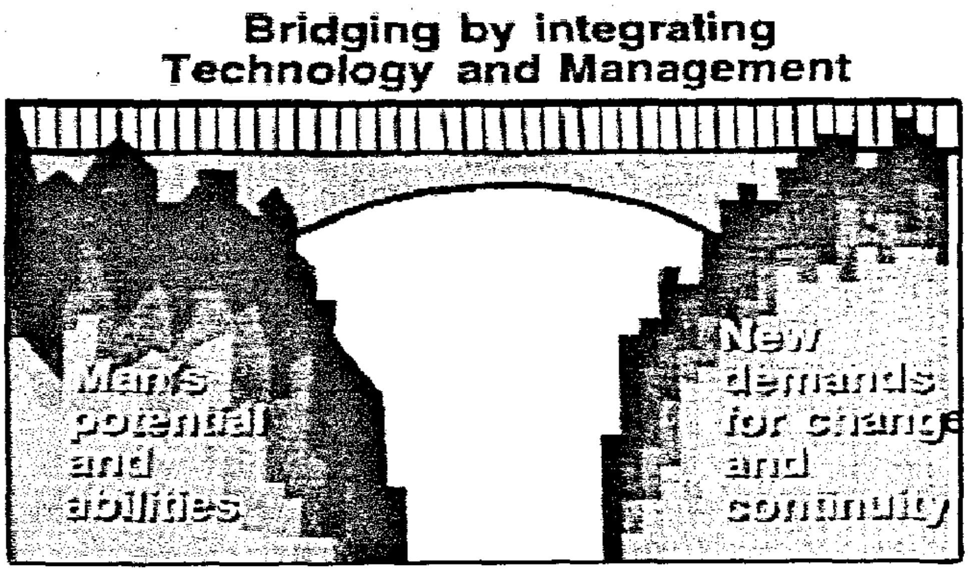
Source: Own table from the following sources:- (Myerson, 1990; NED, 1992; Ort-Step,1995; Dreyer,1978)

3.2.2 Management system applied to technology education

The management steps include making the best use of knowledge, skills and resources. When applied to technology education it should be seen as a means of fulfilling the technological function through the application of knowledge, skills and the use of resources to solve problems. A combination of the system and process approach could be accommodated by the management method for technology education as proposed in this study.

3.2.3 The bridging concept

Figure 1- Bridge diagram



Source: Van Den Heever(1989a:1)

Technology education **must** bridge the gap between the current education system and the requirements of industry, otherwise there would be no need of adding another subject to the existing curriculum. Within Kwazulu Natal schools, educationists are faced with the task of providing relevant educational opportunities for all pupils who are not aware of the stringent requirements being forced on individuals by industry when seeking employment. At present the education system is not capable of fulfilling this interfacing role comprehensively enough, hence the proposal (HEDCOM 2005 project) for the introduction of technology education.

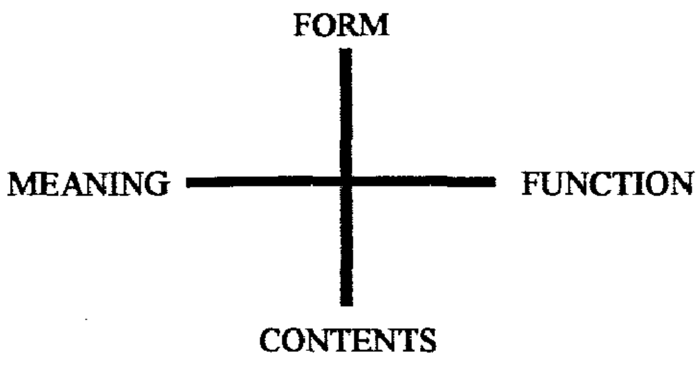
The bridge in literal form is a supporting structure. Similarly, in technological context, it may be seen as supporting the development of latent talents and the potential of pupils within the existing educational structure. The management approach is a convenient facilitator of this process. Teaching and learning in technology education can follow a logical sequence without over-emphasizing any particular facet. This concept could also encourage a positive and responsible attitude towards school and life in general. Through this method it is anticipated that the required life skills will also develop as they are necessary for survival.

3.2.4 Theory of the Conceptualised Management Learning System (C.M.L.S)

The management system being proposed for technology education was an adaptation of the conceptualised management learning system developed by Dr.H.Dreyer (1978:1). A brief overview will enable the reader to verify the suitability of the management concept proposed as a means of effectively presenting technology education.

Within the pedagogic situation it is acknowledged by most educators that a man-reality relationship exists in which the relatedness can be described in terms of communication. Man is intentionally directed (open) to reality, and reality in return offers an appeal which man attempts to answer (Dreyer, 1978:1; Van Der Walt <u>et al.</u>, 1985:123; Viljoen and Pienaar, 1984:165). If we accept that all reality is 'one' or that meaning is attached to reality in it's 'wholeness', it would imply that a specific structure or order would have to be a structure of meaning. Reality in this way is evaluated as meaning. Dreyer (1978:1) refers to this as a *dialectic order* (contents - form and function). The student demonstrates forms and methods to produce a functional outcome (Van Den Heever, 1989a:11). The dialectic order is then extended to encompass a facet of meaning (intrinsic meaning - the truth embedded in reality ie. real-life situations). This yields a structure which is termed an intulogical structure model.

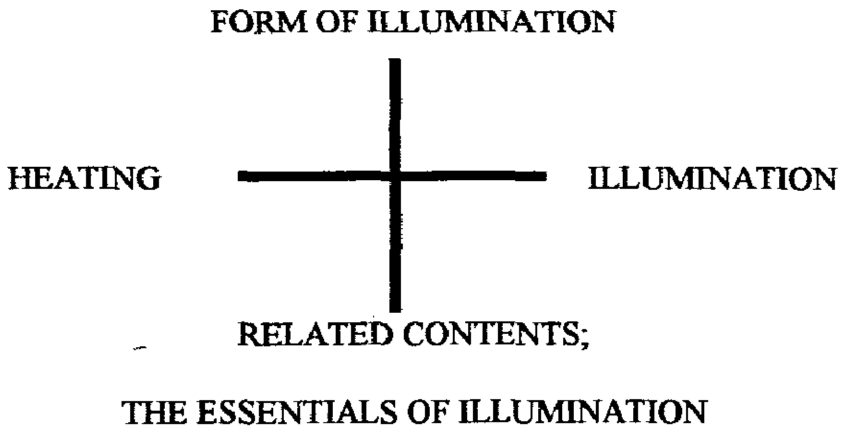
<u>Figure 2 - Diagram of the Intulogical Structure Model</u>



(Dreyer, 1978:1)

Example: Consider the learning objective to be:- 'The pupil must comprehend that heating enables illumination in terms of related contents in a specific form'.

Figure 3 - A practical example of the Intulogical Structure Model



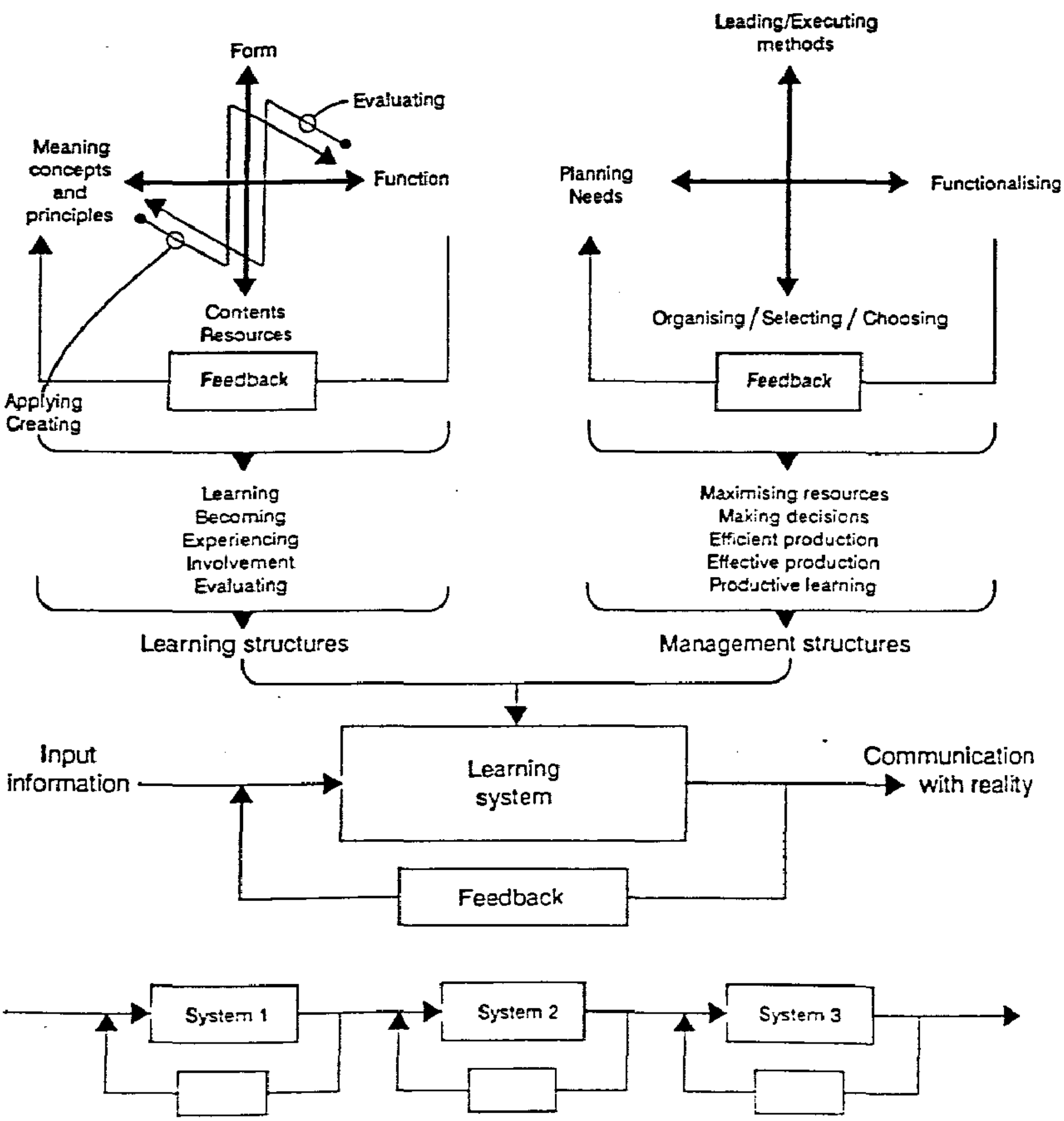
(Dreyer, 1978:34)

Dreyer relates the structural model (Figure 2), to human organisations in order to develop a similar structure comprising a relationship of norms (meaning), human relations (related contents) and organisational forms (forms of communication). When the norms are realised in the functional outcome, an effective output function is realised and when this is not realised an evaluation will reveal how restructuring can enable an effective design to be developed (Dreyer, 1978:35,36).

An empirical investigation into other realms of reality reveal 'similar' structures but in multivalent form (Van Den Heever, 1989a:1). This has given rise to an interrelated structure comprising physical, biotic and conscious realities which enable the structure to interrelate the various sciences in terms of the concept of quantisation and information. An integration of these concepts, (see Figure 4) with a systems viewpoint and a cybernetic model (essentially a control system), has provided the fundamental systems model, structured according to an Intulogical Central Order. Dreyer (1978:4) indicates that the model makes it possible to order the concepts of didactic principles, categories, forms, modalities, objectives, methods, etc.

It is, therefore, an extremely versatile theoretical structure; part of this concept has been adopted for the purpose of teaching technology at schools in this study.

Figure 4- Diagram of the Conceptualised Management Learning System



Sequential relationship of systems

Source: Van Den Heever, 1989a:3

3.2.5 <u>General management</u>

It is useful to discuss the various aspects of general management, as these principles provide a sound grounding to the technology education methodology tried out in this study. To be successful a manager must perform four basic functions viz. planning, organising, leading and controlling (Hellriegel and Slocum, 1989:12). When the management situation is applied to technology education, the child takes his/her place as the manager of their project or problem situation. To successfully complete a project the child must also apply these four basic principles to his/her situation in order to have a means of generating a solution.

Furthermore, there are also skills which successful managers learn to apply to their work situations viz. technical, interpersonal, conceptual and communication. The skills to be learnt may be described as follows:-

(a) TECHNICAL SKILLS indicate the ability to apply specific methods, procedures and techniques to identify, develop and improve (working with things).

(b) INTERPERSONAL SKILLS involve the ability to lead, motivate and work with others (working with people).

(c) CONCEPTUAL SKILLS denote the ability to diagnose and assess different management problems. This requires thinking in terms of relative priorities, probabilities and patterns, rather than concrete certainties (thinking ability).

(d) COMMUNICATION SKILLS signify the ability to send and receive information, thoughts, feelings and attitudes (life skills).

(Hellriegel and Slocum, 1989:24/25).

Other management commentators like Glueck (1979:36) indicate that, in order for individuals to manage successfully, they should develop abilities, attitudes and be motivated. Unfortunately it is not possible to just consider the four basic management functions (planning, organising, leading, controlling) for technology education, as the proposed subject field is quite wide and at this stage encompasses many variants. For a student to be well prepared to handle different tasks it becomes necessary to integrate the principles of management with the principles of strategic planning. This is not a new concept in the world of work as it is automatically a part of any manager's function. In the technology education context it enables logical planning to be considered when addressing projects or simulated problem situations.

3.2.6 Strategic planning

Within general industry the inclusion of Strategic Management is an essential section of a more senior managers' daily work. Without the application of strategic management, the company cannot remain competitive in business. An active element of strategic management is strategic planning, which is used as a basic 'tool' to develop plans for achieving objectives (Robinson, 1986:3).

A strategic plan consists of a number of steps or elements that require answers. The answers to the questions posed assists the manager in setting up a framework for an appraisal of the situation, a choice of strategy, the meeting of objectives, the implementation of policies and evaluation. Glueck (1979:177) states that " strategic planning decisions are the most important ones any manager can make ".

These concepts are to be integrated with the general management functions to provide a basis for students to solve problems, generate designs, make decisions and manage their projects.

3.3 COMPARISON OF CURRENT TEACHING METHODS

3.3.1 Introduction

It is necessary to familiarise the reader with a variety of technology education methodology by comparing the management method tested in this study with other initiatives. The four different proposals to be compared are:-

(a) ORT-STEP (1995). (Organisation for Educational Resources and Technology Training; a private institution based in the Midrand area of Gauteng province).

(b) DESIGN and TECHNOLOGY (United Kingdom - 1995). (The United Kingdom Department of Education revised technology education programme for all schools).

(c) DESIGN and TECHNOLOGY (Natal Education Department. - 1992). (The Natal Education Department pilot programme for technology education).

(d) MANAGEMENT APPROACH (1995/96 - methodology being forwarded by this study and tested at eight 'disadvantaged community' schools in Kwazulu Natal).

3.3.2 ORT-STEP

The Ort-Step Institute proposed a primary school technology curriculum with the following recommended topics and sequence of presentation. (Ort-Step, 1995:5).

DESIGNING
* defining the problem
* analysing the problem
* thinking up solutions
* selecting a solution
* detailing the chosen solution

MAKING
* working with tools and equipment
* operating
* testing

EVALUATING * use of tools and equipment, including maintenance and repair.

3.3.3 Design and technology (United kingdom)

This is the re-designed version, currently being used in the UK Previously the technology education programme was called Craft Design and Technology (abbreviated CDT). The Craft Design and Technology subject had problems when implemented during the early 1990's (United Kingdom Department of Education and Science, 1992:2) hence the new proposal of four key stages:-

Key stage 1 - Pupils aged 5-7

Key stage 2 - Pupils aged 7-11

Key stage 3 - Pupils age 11-14

Key stage 4 - Pupils age 14-16

(United Kingdom School and Curriculum Assessment Authority, 1995:v).

KEY STAGE 3 - age 11-14

Key stage 3 is selected as a comparative example with the experimental group of pupils (average age 13 years) tested by this study.

(A) DESIGNING SKILLS

Include aspects such as the use of a design brief, developing of specifications, working out characteristics and properties of materials.

(B) MAKING SKILLS

Includes aspects such as using a range of processes to form materials, selecting tools and equipment, applying finishing techniques, implementing improvements, etc.

(c) KNOWLEDGE and UNDERSTANDING

Pupils should be taught:-

(a) materials and components

(b) systems and control

(c) structures

(d) products and applications

(e) quality

(f) health and safety

Source: (United Kingdom School Curriculum and Assessment Authority, 1995:6-9).

3.3.4 Design and technology (Natal Education Department)

The proposal of the Natal Education Department also emphasised what they termed 'the design loop'. They advocated a process approach. A brief overview of the 'design loop' method is as follows.

(1) IDENTIFYING NEEDS AND OPPORTUNITIES

(a) The problem

(b) Research

(c) Collect Data

(2) GENERATING A DESIGN PROPOSAL

(a) Generate ideas

(b) Select, formulate design proposal

(3) ORGANISING AND MAKING

(a) Model ideas and test them

(4) EVALUATION

(a) Evaluate

(b) Adjust design if possible

Source: Natal Education Department, 1992.

3.3.5 Management approach

This study proposes that the management process be applied. However, by adopting an integrated approach between general management and strategic planning a logical method of teaching technology education programmes may be systematically applied.

Figure 5 - An example of how management and technology are integrated

PRODUCING AND MARKETING A PRODUCT			
Management steps		Technology	
Making the best use of knowledge, skills and resources		Applying knowledge and skills through the use o resources to solve problems	
1. PLANNING	1.1 **Assignment** Defining the need and stating the problem	1.1.1	Retrieve relevant background information.
		1.1.2	Relate background information to the problem or need.
		1.1.3	State the problem or need.
	1.2 **Requirements**	1.2.1	Specify the requirements in respect of knowledge, resources, skills, products, marketing, type of evaluation and any other as required
		1.2.2	Use background information to understand what the requirements mean.
		1.2.3	State how the requirements influence the design of a product or the solution to a problem.
		1.2.4	Assimilate the necessary background knowledge, together with the relevant resources, and master the necessary skills to solve the problem in terms of the requirements.
		1.2.5	Generate a solution, eg models, drawings, strategies, debates or documentation.
	1.3 **Plan of action, working drawing and strategy**	1.3.1	Apply basic skills to produce a working drawing, plan of action, strategy, method or technique for the solution (refer to 1.2.4 and 1.2.5).
		1.3.2	Include all relevant details and requirements.
	1.4 **Detailed objectives**	Describe the intended result or performance as well as the circumstances under which the performance must take place.	
2. ORGANISING	**Selection of resources**	Apply background knowledge to select resources in terms of the requirements in stage 1.2. Select labour, materials, tools or theoretical essentials.	
3. EXECUTING	Carry out a step-by-step procedure to describe the topic or make the product.	Retrieve and apply the relevant knowledge, resources and skills to execute the strategy or make the product. These could include shaping, joining and finishing.	
4. EVALUATING	Assess whether the product solves the problem or satisfies the need.	Assess the quality of the product (personally or with guidance) by comparing the final product with the requirements in stage 1.2.	

Source: Van Den Heever(1994:7)

The technology application would include the following four management functions:-

* Planning
* Organising
* Executing
* Evaluating

The above management functions are integrated into all aspects of Strategic Management as described in Figure 5 above.

3.3.6 Teaching methods for technology education

If one considers the desired features of a technology education programme, then foremost in most minds is the question 'How does one teach this subject effectively?' If we consider the new proposal put forward by the UK, it is evident that the teaching methods they favour are assignments, focussed practical tasks and investigative tasks (United Kingdom School Curriculum and Assessment Authority, 1994:3). The New Zealand Department of Education's proposal (1993:10) puts forward an idea of flexible, open and collaborative approaches to classroom teaching. The idea is to accommodate student perspectives, interests, aspirations and learning styles. The New Zealand curriculum proposal eludes to the following:

> " the successful management of knowledge, skills and resources is crucial to group activities in technology ".

The essence of the management approach contained in this study is in some ways similar to that outlined in the New Zealand Technology proposal . A teaching method which integrates the principles of management and strategic planning will accommodate the process of optimisation. Optimisation in this instance refers to making best use of the available knowledge, skills and resources. Management methodology presented to teachers at the eight pilot schools only focussed on the discussion method of teaching.

The literature revealed that there are various commonalities among the various technology curricula. This study emphasises the management perspective in an attempt to get away from the great emphasis on design by the other curricula reviewed above. There is no doubt that design is an important factor when considering possible solutions, but in this study it is not considered to be didactically sound to teach pupils technological concepts purely from a design point of view. The main reason for this view is because the concept of design as a focal point is rather abstract to most learners who have never experienced technology education in their junior years. The management approach automatically includes design as an aspect of strategic planning hence creating a balance. In such a manner, a child should be able to follow a logical sequence to find a solution to a given problem scenario. When applying the management approach to a problem, depending on the level of comprehension of the child, various depths of knowledge could be applied to suit the class group within the framework of the four basic management functions - planning, organising, executing and evaluating.

3.4 METHODOLOGY OF THE TECHNOLOGY EDUCATION PILOT PROJECT TESTED BY THIS STUDY

3.4.1 Introduction

The technology education programme was designed to provide pupils with hands-on skills in making a project, learning the basic principles of technical drawing and management, and then being able to apply this to make a project of their own design. The pilot study was conducted at eight senior primary schools in Kwazulu Natal.

The schools, presented in table 10, numbered from 1 - 8, were located within circuit boundaries of the Kwazulu Natal province. The schools are orientated from a South to North direction (also see Figure 6 - Kwazulu Natal map for further details).

figure 6

CIRCUIT DISTRICTS AND OFFICES

KwaZulu Department of Education and Culture

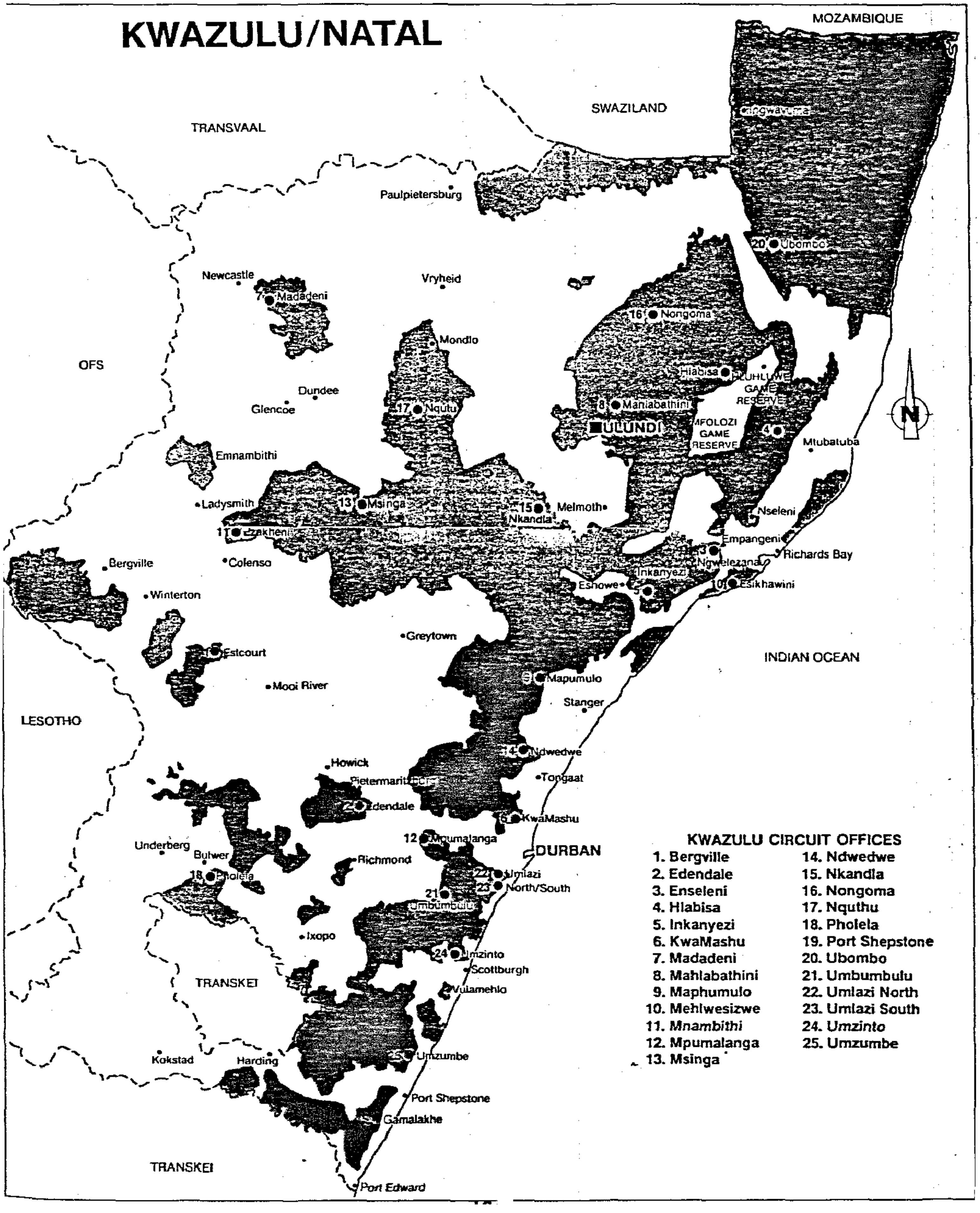


TABLE 8 - The classification, area and number of kits allocated to the participating schools

SCHOOL No.	CIRCUIT	GEN. AREA	No.of KITS
(1) RURAL	P/SHEPSTONE	IZOTSHA	60
(2) RURAL	UMBUMBULU	UMBUMBULU	180
(3) URBAN	UMBUMBULU	KWAMAKHUTHA	90
(4) URBAN	UMLAZI - S	UMLAZI	150
(5) RURAL	MPHUMALANGA	1000 HILLS	60
(6) URBAN	KWAMASHU	KWAMASHU	80
(7) RURAL	MEHLWESIZWE	AMATIKULU	50
(8) URBAN	MEHLWESIZWE	ESIKHAWINI	120
TOTAL KITS			790

3.4.2 Size of sample

3.4.2.1 **The pilot project**

As can be seen above, 790 lorry project kits were distributed to the eight schools. A further 60 kits were delivered to a school in the Underberg area, but the teacher who was to present the course was promoted to another school before the project could be started. The programme was discontinued at this school. The anticipated number of participants was to have been 790, but not all teachers presented the course to pupils for whom they had initially requested kits. The total number of pupils who actually participated in the pilot project was 493.

3.4.2.2 **The experiment**

For the experiment a sample of 480 pupils was decided upon. This sample of 480 was to be further subdivided into two separate categories to form the experimental group and the control group. 240 pupils who had completed the course should have formed the experimental group while another 240 who had not completed the course, but were from the same school as the experimental group, were to be the control group. Since the sample was so large and spread out, the experimental design had to be kept fairly simple. Pupils from the two groups were not paired off and only two variables were kept constant, namely school and standard. Although I later wished that I paid more attention to gender as a variable, even this would have been difficult to do. Implementing the pilot study and setting up the experiment was very time-consuming and complex. Any further considerations or additions to the research design would have made the study unmanageable. As it is, the research produced a multitude of data which could not be reported or analysed due to the sheer size of the project. Due to circumstances beyond my control only 205 pupils were part of the experimental group while 175 pupils made up the control group (See Table 10). The selected pilot schools were divided into rural and urban areas to ensure that a reasonable distribution of people was tested and prevailing circumstances in disadvantaged could be highlighted.

In order to clearly identify the ages of pupils who participated and formed the target group of the study, all pupils who completed a questionnaire form, were requested to include their age in years. The following table (9) displays the comparative average ages of pupils in the respective groups.

TABLE 9 - Average age of pupils participating in the experiment

N=380			
EXPERIMENTAL GROUP N=205		CONTROL GROUP N=175	
URBAN SCHOOLS N=92	AVERAGE AGE IN YEARS	URBAN SCHOOLS N=83	AVERAGE AGE IN YEARS
JAJA MEMORIAL	13,5	JAJA MEMORIAL	13,1
KHALIPHA	11,9	KHALIPHA	12,1
KWAZI	12,9	KWAZI	13,8
ILEMBE	12,6	ILEMBE	13,0
URBAN AVERAGE AGE	12,7	URBAN AVERAGE AGE	13
RURAL SCHOOLS N=113	AVERAGE AGE IN YEARS	RURAL SCHOOLS N=92	AVERAGE AGE IN YEARS
INSINGISI	13,3	INSINGISI	13,5
TOBI	12,7	TOBI	13,2
BOTHA'S HILL	13,6	BOTHA'S HILL	13,6
ISINYABUSI	13,7	ISINYABUSI	NOT USED
RURAL AVERAGE AGE	13,3	RURAL AVERAGE AGE	13,4

TABLE 10 - Experimental group participants according to gender

N=205			
URBAN SCHOOLS N=92	BOYS	GIRLS	TOTAL
JAJA MEMORIAL	18	01	19
KHALIPHA	09	21	30
KWAZI	10	04	14
ILEMBE	14	15	29
TOTAL	51	41	92
PERCENTAGE	55%	44%	100%
RURAL SCHOOLS N=113	BOYS	GIRLS	TOTAL
INSINGISI	22	08	30
TOBI	20	10	30
BOTHA'S HILL	16	07	23
ISINYABUSI	16	14	30
TOTAL	74	39	113
PERCENTAGE %	65%	35%	100%

TABLE 11 - Control group participants according to gender

N=175			
URBAN SCHOOL N=83	BOYS	GIRLS	TOTAL
JAJA MEMORIAL	02	15	17
KHALIPHA	07	23	30
KWAZI	02	03	05
ILEMBE	17	14	31
TOTAL	28	55	83
PERCENTAGE %	33%	66%	100%
RURAL SCHOOL N=92	BOYS	GIRLS	TOTAL
INSINGISI	00	29	29
TOBI	14	16	30
BOTHA'S HILL	19	14	33
ISINYABUSI	COULD NOT USE DATA.		
TOTAL	33	59	92
PERCENTAGE	36%	64%	100%

3.4.3 Programme design

3.4.3.1 Overview

The programme was set up in a kit form together with supporting materials. The aim of the lorry project was for pupils to be able to transport a load of sand. In order to do this they were required to follow a structured course in making the lorry and being taught aspects of management, technical drawing and some craft. The specific idea behind setting the task of the lorry to carry sand, was to ensure that no simple cardboard replicas were made. Students who participated learnt about technical drawing to enable them to complete a working drawing for the actual assembly process. This included being able to apply the technical process of development to mark out the metal loadbox section for the lorry to carry sand.

Students were also taught the four basic management functions (plan, organise, execute and evaluate) for them to be able to manage the assembly of their lorry. After completing the lorry project all pupils were supposed to apply the management principles to a vehicle of their own design. Students were allowed to use the chassis from the lorry project but had to find their own resources for the completion of their design (see Appendix C for photographs of completed projects by some of the participating pupils). The craft skills (cutting, filing, marking, assembling, etc.) were viewed as being an enrichment to the pupils at schools in the townships where they would not normally have had such an opportunity. The technical drawing section was used as an introduction to all those pupils who wish to attend a comprehensive high school for technical education next year. The impact of the pilot study could in this way have an on-going effect, and could, if necessary, be followed-up during the next year. The management functions taught to the pupils, were presented in a very general form. The aim was for students to learn to manage any future projects in a systematic and logical manner, as well as being applied outside the school to real life situations at home.

3.4.3.2 **The lorry kit**

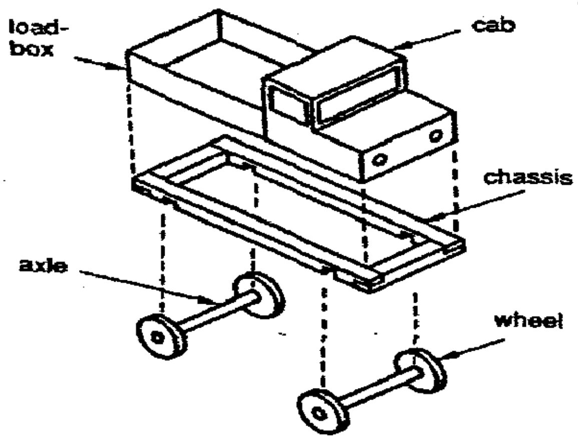
The kit consisted of the following items:-

(a) A teacher's instruction manual which included answers to all drawing questions as well as enrichment of a variety of different subject areas.

(b) A student workbook consisting of loose pages covering all aspects of the project.

(c) A wooden chassis, two wooden axles, four wooden wheels, an aluminium plate to make the loadbox and a cardboard page for the cab section. Two pieces of sandpaper were also supplied to clean up any rough edges.

Figure 7 - Diagram of the lorry kit



3.4.3.3 Assembly procedure of the lorry project

STEP 1

Students were required to start with the assembly of the cardboard cab section. This was designed to provide the pupils with a model from which to learn the principles of technical drawing. Once having glued the cab together, they could view it from the front, top and side in order to orientate them spatially. Spatiality seems to be a problem especially among the black pupils. Other exercises were also set using the cab section viz. working from the concrete to the more abstract.

STEP 2

The emphasis was on the assembly of the wooden chassis section. This included the glueing together of the frame, fitting the axle and sanding the rough edges off the wheels.

STEP 3

The metal loadbox had to be developed from a flat piece of metal which involved measuring, marking-out, cutting, bending and folding, to form the loadbox.

3.4.3.4 Back-up kit

Following the crash introductory course for volunteer teachers, it was noted that the schools did not have any equipment with which to assemble the lorry kit. Items necessary for the assembly of the lorry included glue, rulers, scissors and tinsnips. The requirements for the drawing was a few basic drawing instruments like set squares, compass, eraser and pencil.

Therefore a second kit, which was called the **back-up kit**, had to be purchased for all participating schools. The back-up kit consisted of the items shown in Table 12.

TABLE 12 - The back-up kit

WAX CRAYONS	TWO SETS
PENCILS (HB)	TEN
PENCIL SHARPENER	TEN
MATHEMATICS SET	TEN
SCISSORS	FIVE
TIN SNIPS	ONE
FLAT FILE (SMOOTH)	TWO
FILE HANDLE	TWO
WOODEN BLOCK	TWO
GLUE (GENKEM)	ONE
SANDPAPER	TWENTY (50 X 30 mm)
SUITCASE	ONE

The kit was considered sufficient to support ten pupils, working in a group. A total of eighty kits were purchased (80 x 10 = 800 pupils) to include all pupils who should have received a lorry project kit (See Table 8) for the pilot project. The items in the back-up kit were used as follows:-

(a) The wooden block was placed in the middle of the metal sheet to make the loadbox section. The sides of the box section were then bent around the wooden block to give the loadbox section a square shape.

(b) The files and sandpaper were used to remove sharp edges from the aluminium loadbox section once cut and bent into shape. This exercise complied with general safety practice in the workshop.

(c) The crayons were used to colour in the different surfaces of the cab section depicting the front view, top view and side view, as required by the technical drawing component of the project.

(d) The mathematics sets contained drawing instruments for the joining up of lines on the worksheets as well as completing a working drawing. A working drawing is the final draft of an idea before the actual item is made.

(e) The suitcase was supplied because no storage was available when the lorry kits were delivered. The suitcase thus assisted teachers in keeping all the equipment together.

3.4.4 Course outline

The course design was such that a number of interrelated activities were completed by the pupils under the guidance of the volunteer teachers. A logical sequence of execution was ensured by applying the principles of management which form the underlying structure of the programme. The teacher's manual was divided into eight chapters having the following headings:-

Chapter 1 : How to manage making a toy lorry.

Chapter 2 : Reading and making a working drawing.

Chapter 3 : Safety measures.

Chapter 4 Exploring wood and woodworking tools.

Chapter 5 : Exploring metal and metal working tools.

Chapter 6 : Exploring plastics.

Chapter 7 : Electrical knowledge.

Chapter 8 : A design folio.

3.4.4.1 Time allocation

The teaching time allocated varied from one x 30 minute lesson per week to two x 30 minute lessons per week. The latter was considered to be more suitable although also not the ideal. This subject requires as much time as possible in the curriculum. The majority of the pilot schools commenced teaching from the first week in the first term until the last week of the second term (approximately 20 weeks), when they had an opportunity to report back and display their products. At this meeting, I collected from all teachers the pupil questionnaires, comments from the teacher who presented the course and also the pilot school principals' comments as part of the raw data for this study.

3.4.4.2 Selection of schools

The selection of schools had to comply with certain guiding criteria (see Section 3.1). All schools chosen were community schools with the ex-Kwazulu Department of Education and Culture. They constituted a general cross-section of what this study has termed the disadvantaged communities of Kwazulu Natal. The demographic locations of the schools were firstly considered in categories of rural and urban. The spread of schools was then considered from a circuit point of view to include as many circuit areas as possible and still be able to maintain contact with teachers fairly frequently.

The other criteria for the selection of schools were the following:-

(a) The school should be a feeder school for one of the comprehensive high schools (those schools which offer technical subjects).

(b) The principal of the school should have some interest in technology education and should be willing to support a programme if selected.

(c) There should be a teacher willing to be trained to present the technology subject.

(d) The facilities at the school should be reasonably good, although this was not a crucial factor as this was a pilot study to test the feasibility of technology education amongst disadvantaged school pupils.

As has been previously mentioned, all schools selected for the project, are regarded as being feeder schools in their respective areas for comprehensive high schools who all offer technical education.

3.4.5 Description of schools

3.4.5.1 School number one

This school is situated in a rural area approximately 25 - 30 kilometres from Port Shepstone in an area known as Izotsha. The school accommodates 953 pupils ranging in standards from Class 1 to Standard 5. There are 21 teachers and 16 classrooms at the school. The school does have one tap on the site for drinking water but the toilets are of the pit type. The classroom used for technology education was the standard size of a classroom of roughly 8 metres x 8 metres. There were no ceilings fitted; lights were available but there were no electric plug points. A chalkboard was available for use by the teacher and all pupils sat at double desks. There were no storage cupboards available in the classroom, but the principal did allow the partly completed models to be stored in his office. There were 60 lorry kits delivered to this school and 56 pupils actually participated. The male teacher was very enthusiastic about the course and a fair degree of discipline was evident in the way things were done at the school. The teacher's subject background was Mathematics.

3.4.5.2 **School number two**

This school is situated next to the main road linking the coast with Pietermaritzburg and is about 8 kilometres from the circuit office in Umbumbulu. The school is also approximately 20 kilometres from the South Coast town of Winkelspruit. The surrounding area is classified as a rural area. This school has an enrolment of 410 pupils who are accommodated in 15 classrooms and has 14 staff members. The school caters for Standard 3 - Standard 5 pupils only. There is tap water for drinking but the toilets are of the pit type. There is no electricity at the school. The teacher was a female whose normal teaching subject was English. 180 lorry kits were delivered, but unfortunately only 38 pupils participated in the programme. This was due to the teacher deciding that a large group was too difficult to manage. There were numerous disruptions to the learning of these pupils who participated in cultural and musical activities as a priority over technology education.

This school had possibly the best facility as far as floor space is concerned as they used a partly-completed Science laboratory. However, the space could not be maximised as the pupils were all seated at double desks. A cupboard extended the entire length of the room for some 14 metres, so storage was not a problem at this school. The classroom did not have ceilings or lights fitted. This school was also the last to complete the questionnaires (approximately 2 months late) due to their cultural and musical activities.

3.4.5.3 School number three

The school is situated in an urban township area, bordering a large well equipped teacher training college. The exact location is approximately five kilometres from the neighbouring Amanzimtoti business centre. Class groups ranged from Class 1 - Standard 5 with an enrolment of 679 pupils. There are 17 classrooms; some classrooms have electricity which is in working condition. The staff compliment is 19, and the teacher who volunteered for the technology education programme has a Mathematics and English subject background. There are flush toilets but they were not in working order. Drinking water at standing taps was also available. The room in which I attended a lesson did not have a ceiling and unfortunately also had electrical wires from plugs hanging loose out of socket and switch points. This school managed to cram 66 pupils into the classroom, using double desks, and accommodating three pupils per desk. This made it very difficult to administer the course and was not considered conducive for optimising the opportunity to promote technology education. The school also had no storage facility within the classroom, so problems were experienced when the partly assembled models had to be stored in the principal's office. These models were kept in a large cardboard box which caused damage to the models at the bottom of the box. 90 lorry kits were delivered and 77 pupils were reported to have participated in the course. The school forms a stark contrast with the College of Education next-door to it.

3.4.5.4 School number four

This school is located in Umlazi township just south of the Durban International Airport. The enrolment is 998 with classes ranging from Standard 3 - Standard 5. There are 24 classrooms with a staff compliment of 30. The volunteer teacher had a Mathematics and Geography background. The school is fully fenced and even has security watchmen on duty after hours. It is classified as an urban school. There is electricity available and flush toilets were also in use. A noticeable feature of the school was the piles of empty bottles which adorn the front entrance. These are collected by the pupils to raise funds. Two class groups were accommodated in the programme - roughly 50 pupils per classroom. There were 110 kits delivered and 98 pupils participated. This school was noticeably one of the better organised schools in the pilot programme and complied with all instructions timeously.

3.4.5.5 School number five

This school is classified as a rural school and is located about five kilometres from the village of Botha's Hill, within the Valley of a Thousand Hills. The school offers instruction for pupils from Standard 3 - Standard 5 and has an enrolment of 554. There are 15 classrooms plus a newly fitted out learning centre donated by Telkom. There are 16 teaching staff and the volunteer teacher had a general teaching background as he was teaching Mathematics, Science, Languages, etc. There was a standing water tap for drinking water, but the toilets were of the pit type. The school is fenced with a mesh fence which seems to serve the purpose of keeping animals out quite adequately. This school is also very active in cultural and musical competitions; it has attained various awards. The technology classroom was not very crowded. 60 lorry kits were delivered but only 25 pupils participated in the programme. The classroom did not have lights but it did have an electrical plug point. There were no ceilings fitted to the room.

3.4.5.6 School number six

This school is located in KwaMashu township to the north of Durban. The school is a relatively modern school in comparison with most other schools in the project and was officially opened in 1990. It has electricity, ceilings in classrooms, water and flushing toilets. The school is classified as being in an urban area. It has an enrolment of 984 pupils, and offers teaching from Standard 3 - Standard 5 only. There are 22 classrooms and the staff compliment is 27. The voluntary teacher had a Mathematics teaching background. 80 kits were delivered but only 38 pupils participated in the programme. This school also seemed to have too many other activities like cultural competitions and music for a significant thrust towards technology education to be realised. The teacher did express his feelings about reshuffling his timetable from Standard 4 to Standard 5 as well as having no storage space provided for the partly completed models. I was witness to a number of cab sections being squashed.

3.4.5.7 School number seven

The school is situated in a rural community approximately eight kilometres from the town of Gingindhlovu on the north coast of Durban. The school accommodates 380 pupils, and is presently in a transitional stage phasing into full high school status. They offer classes from Standard 4 - Standard 7 at present. They do not have any water supply other than rain water tanks and no electricity connection has been made as yet. A pit toilet system is being used. The school has 12 classrooms with a staff compliment of 18. This school was the last to be included in the technology pilot programme as the selected teacher's background was Technical Drawing. An amazing asset to this school has been the zeal of the principal who is a strong supporter of technical education in general. Despite the lack of good facilities, the school was given 50 kits and 48 pupils participated.

3.4.5.8 School number eight

This school was the most northerly, situated in the township of Esikhawini approximately ten kilometres from the town of Empangeni also on the north coast of Kwazulu Natal. The school is classified as being in an urban area and is also, like school number six, a relatively new school.

The school is in a transitional stage of accommodating pupils from Standard 1 - Standard 5. At present they offer classes from Class 2 - Standard 5. The school has electricity, ceilings in the classrooms, water, flushing toilets and accommodates 1415 pupils. There are 24 classrooms and a staff compliment of 28. The voluntary technology education teacher has a background of Mathematics and Science as his main teaching subjects. The teacher used his personal classroom locker to store the partly completed models, which helped to prevent damage. The principal at the school was also quite keen that the programme should succeed at his school. There were 120 kits delivered and 113 pupils participated in the programme which was most encouraging to see.

3.5 TEACHERS

A brief overview of the eight voluntary teachers, who are all employed by the Department of Education and Culture (Ulundi) is displayed in Table 13. It is interesting to note that although technology education is not aimed at being gender biassed, approximately 90% of the teachers and principals who participated in the experiment were males. Another interesting point is that only one of the eight teachers had a technical background (school number 7).

A general summary of the teachers' attitudes towards the subject was that during the initial one week course all were very keen to try the subject out. They all decided on the number of kits they required, which were then delivered by myself. Thereafter, once they realised that a great deal of 'extra' work was required to prepare lessons, some decided not to include as many pupils as they initially intended. This point is most significant in terms of problems which can be expected if technology education is introduced to all schools within the province.

TABLE 13 - A comparison of teachers who participated in the pilot programme

SCHOOL No.	TEACHER'S GENDER	PRINCIPAL'S GENDER	TEACHER'S SUBJECT BACK-GROUND
ONE	MALE	MALE	MATHS.
TWO	FEMALE	MALE	ENGLISH
THREE	MALE	MALE	MATHS/ENGL.
FOUR	MALE	MALE	MATHS.
FIVE	MALE	MALE	MAT/SCI/ENG
SIX	MALE	FEMALE	MATHS.
SEVEN	MALE	MALE	TECH.DRAW.
EIGHT	MALE	MALE	MATH/SCI

Table 14 displays the difference between the number of lorry kits requested by the teachers for pupils at their pilot schools and the actual number of pupils who received a lorry kit and participated in the programme

TABLE 14 - The number of lorry kits delivered compared with the number of pupils who participated in the experiment

SCHOOL No.	KITS DELIVERED	PUPILS WHO PARTICIPATED
ONE *	60	56
TWO	180	38
THREE	90	77
FOUR *	110	98
FIVE	60	25
SIX	80	38
SEVEN *	50	48
EIGHT *	120	113
TOTALS	750	493

Those schools marked with an asterisk had the most enthusiastic and goal-orientated teachers. The attitude of the principals of the above mentioned teachers appeared to be far more supportive of the pilot programme and therefore tended to provide positive support for the experiment and the teacher. This point is also significant if technology is to be implemented at other schools within the province.

It must be noted that a tremendous emphasis seems to be placed on music and cultural activity practices in Zulu speaking schools. In some cases the pupils were not available for the teachers to teach them the technology programme, either often enough and/or for long enough.

3.6 ASSESSMENT PROCEDURE OF PUPILS' QUESTIONNAIRE

The questions were related to three major sections requiring answers. The aim of the questionnaire was primarily to provide some factual data to contribute towards the continued development of the technology education curriculum currently being planned for South African schools (See Appendix A).

Section 1

These questions (see Appendix A) were structured to elicit the views of pupils in the experimental group regarding the lorry project. The information will be used to provide a general overview of the programme. Section 1 was only answered by those pupils who had completed the lorry project. The main aim of the questions posed, was to try and establish the pupils' personal views regarding the lorry project and associated equipment. The opinions of the participating pupils could then be compared for further development of the technology initiative in Kwazulu Natal. There were 14 questions posed in this section numbered (a) - (n).

Section 2

The questions set in Section 2 were designed to provide factual information regarding pupils' socio-economic background. All pupils were requested to disclose information regarding their family life and living conditions. The experimental group as well as the control group responded to these questions. This section had only 9 questions numbered

(a) - (g) with the main emphasis on all participating pupils' home conditions. This was considered necessary to establish whether or not home conditions actually play a part in the development of a pupil with respect to technology education programmes.

Section 3

The questions in section 3 were sub-divided into two distinct sections viz. management and technical drawing.

The first section (questions 1 to 5) focussed on:-

** The Management concept as applied to teaching and learning of technology as a subject. The questions were extracted from the management section of the student workbook . Some questions were directly from the text while others required some insight which should have been explained by the teachers during their presentation of the section.

The second section (questions 1 to 13) targeted:-

** The Technical Drawing section as applied to the lorry project. All questions were extracted from the workbook. As the section was far more detailed than the management section, 13 questions were posed to both the experimental group and the control group.

The aim of questions in section 3 of the questionnaire was to confirm whether or not a pupil who has never been exposed to technology education could acquire the required drawing and management skills during their normal school education.

A copy of the post-test questionnaire for pupils appears in Appendix A. The answers to the student questionnaire appear as Appendix B.

3.6.1 Evaluation methods

The success of the pilot study was evaluated using the following methods:-

(a) *POST - TESTING*:-

** **The post-test planning**

** The action plan and delivery of the post-test was to a sample group of 60 pupils from each of the eight pilot schools. This would have resulted in a total of 240 questionnaires being returned from the experimental group and another 240 questionnaires being returned from the control group.

** The first group which was named the experimental group should have consisted of 30 pupils who had completed the lorry project.

** The second group of 30 pupils, who attended the same school as the first group (experimental group), were named the control group.

** The intention of the control group was to compare their questionnaire results with those of the experimental groups in order to try and prove hypothesis number 2 correct (see section 1.5).

** **The post-test result**

The total of 60 pupils per group at each of the eight pilot schools was considered to be a reasonable sample for statistical purposes. However this 'ideal' was not fully realised. The final delivery of questionnaires numbered the following:-

** The Experiment Group returned 215 out of a possible 240.

compared with....

** The Control Group who returned 175 of their possible 240.

** *This provided a total response of* ***390*** *from both groups out of the* expected total of 480.

(b) *PRE-TEST* : It must be noted that **no** pre-test was conducted. This was a weakness within the project. Once I realised the value of a pre-test, the lorry project was already in progress and no pre-test could be administered.

(c) *CRASH COURSE FOR TEACHERS* :The eight teachers had all been subjected to a crash course of one week on technical drawing and the assembly of the lorry project. The basics of technical drawing using the examples given in the lorry project manual served as the point of departure. The teachers, with the exception of only one, were not technically orientated at all and experienced technical drawing for the first time during the one week course. All teachers seemed to enjoy the craft side or application of basic hand skills, practised during the assembly process of the lorry project.

(d) *VISITS:-* During the course all schools were visited once while a lesson was in progress. The aim of this visit was to try and assist with any problem areas. The course designer accompanied me to two of the schools for him to witness the effects of the course design on pupils.

(e) *SEMINARS:-* Two seminars for the participating teachers were conducted during the pilot programme. The first was for two days and covered further drawing practice and course design objectives, while the second was for one day covering possible evaluation methods.

(f) *FINAL MEETING:-* A one day final meeting with the teachers was held to view a sample of the pupils work, to view the individuals' own designs and for teachers to report verbally about their experiences during the course. A few principals' reports were presented by the teachers with only one of the eight school principals actually arriving to present his report personally. Photographs of some of the projects were also taken at this final session (see Appendix C).

A questionnaire was given to all teachers who participated in the pilot programme. They were each requested to complete the questions posed to them to gain useful information into the difficulties experienced by teachers when presenting a technology education course.

3.7 CONCLUSION

Chapter 3 covered possibly the most exciting part of the entire study which was the setting up of the project and the implementation at eight selected pilot schools. Furthermore, the introduction of a management approach to technology education programmes, is a step forward in what I believe to be a logical method to present technology courses in the future. The questionnaires compiled and issued to all pupils selected to represent the experimental and control groups, proved to be quite a handful to manage due to me not being able to monitor all the tests. I was only able to carry out a test among pupils at one of the eight schools. However, I do believe that the results illustrated in chapter 4 of the study do provide a fairly accurate record of the current state of disadvantaged school education with special reference to technology education. I do believe that if one does not plan technology programmes carefully with the actualities of the present situation among South African disadvantaged schools, then programmes are likely to fail in future.

CHAPTER 4

RESEARCH RESULTS

CHAPTER CONTENTS

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CHAPTER 4: RESEARCH RESULTS

INTRODUCTION

This chapter describes the quantitative results of the technology education programme. The programme was divided into two major sections. Firstly, the pilot project which included 493 pupils from eight selected pilot schools and, secondly, the experiment which included 380 pupils. The results of the experiment are described and tabulated in this chapter.

4.1 THE PILOT PROJECT

4.1.1 Overview of the pilot project

The pilot project was decided upon by the management of technical education during the latter part of 1994. I was assigned to the project in February 1995 to take over as the co-ordinator and to implement the plan. The task included the selection of pilot schools in order to test the validity of technology education for Kwazulu schools. As a starting point, school principals in different circuit regions were visited to assess their interest in testing the programme. The principal had the task of requesting a volunteer teacher from his/her staff to implement the project at the school, if selected. Management of technical education decided that the pilot schools should ideally accommodate the existing technical education high schools. The selected higher primary schools who finally participated, were all feeder schools for technical high schools within their circuit areas. The eight selected schools, all offering class groups at grade 7 (standard 5) level, were located mainly in the coastal area of Kwazulu Natal, from the Port Shepstone district in the South to Empangeni district in the North.

4.1.2 Results of Pilot Project

4.1.2.1 Teacher training

The results from the drawing section as well as the management section indicate that the training received by the teachers was in fact inadequate. The pupils' performance was expected to have been much better in terms of the acquired content and application of relevant principles. Teachers tended to only follow the teacher's manual without having a thorough knowledge of the topics they were teaching.

4.1.2.2 Time allocation

The time set aside in the general school curriculum proved to be somewhat problematic. The subject proved to be quite difficult to manage in the time allocated to the teachers. Most of the school principals offered only one hour per week and seemed to relegate the subject to the end of the day session. Table (19) provides information on the pupils response to the actual time allocated to making the lorry. 53% of the experimental group decided that the time allocation was adequate. However, I personally had serious reservations about a one hour session per week allocation. In order for students to participate fully in the project time is a critical issue. The pupil has to acquire knowledge of principles related to technology and then put this knowledge into practice through the application of hand skills after planning a design strategy. This work can take the form of a lecture, discussion, working alone or even as a group. In such a manner the pupil is able to experience all three learning skills viz. cognitive, affective and psychomotor.

4.1.2.3 Storage facilities

There was a lack of available storage facilities for the equipment supplied as well as the incomplete projects. The equipment supplied needs to be stored in a safe place. Most of the disadvantaged schools do not have adequate storage facilities either in the form of lockable storerooms or steel cabinets which may be locked in a classroom. If specialised equipment is to be supplied to all schools at a future date, special lockable facilities will need to be included in the planning phase. There was also a lack of shelving or cupboard space in the classrooms to store the incomplete models being made by the experimental pupils.

4.1.2.4 Language

At the target level of grade 7 (standard 5), and an average age of 12,5 years, there was a notable lack of command of English. The teachers tended to convert to mother tongue instruction whenever they had to explain something in greater detail. The course was only supplied to pilot schools in English and it is therefore quite possible that some of the concepts regarding management and technical drawing could have been better understood if the course was presented in Zulu. Language was therefore found to be a problematic area.

4.1.2.5 Role of the Principal

It was evident that the principal of the school plays a tremendous role in the success or failure of the technology education programme. If the principal is not interested in the concept, then he/she will most likely relegate the subject to a time slot that is not considered important and this is the period which is usually used if cultural activities or similar events take place. The principal has the power to either support the technology programme in its entirety or conversely to consider the programme as being insignificant. The principal also has the ability to influence the local community of the potential of the subject and create an expectancy among the parents. The converse of this scenario also holds true. The principals in the pilot programme who supported the efforts of the teachers caused the programme to be much more effective than programmes in schools where principals were disinterested.

4.1.2.6 **Interests of Girls**

Once the pilot lorry projet was started at the schools, it became evident that not all the participants enjoyed making a lorry. The lorry was initially chosen because of it being a common item in daily life. Prior to the project it did not occur to either myself or the developer that there would be mixed classes and that not all the girls would be interested in making a lorry. Girls tended to be more interested in undertaking a sewing or knitting project. Project selection would have to include different interests among learners in mixed class groupings, especially at the junior and senior primary school phases.

4.2 THE EXPERIMENTAL PROJECT

4.2.1 Introduction

The experimental project was considered necessary to assess the success of the programme in an objective way. The project was designed as a loosely structured experiment as opposed to one in which variables are tightly controlled. The variables which were kept constant were school types (four urban and four rural), standard of pupils and age group. The gender variable was not controlled. It was noted that some of the teachers selected more boys than girls for the lorry project. Teachers also varied the numbers of the pupils in the experiment to suit themselves. Ideally 30 experimental pupils should have been compared to 30 control group pupils from each of the eight schools. It was therefore hoped that a total of 480 pupils would participate in the experiment: 240 from the experimental group and 240 from the control group. However, only 380 pupils finally handed in questionnaires which form the quantitative evaluation presented in this chapter. One of the teachers who decided on his own initiative to use his grade 8 (standard 6) pupils as the control group. This data was excluded from the study but accounted for part of the reason why only 380 questionnaires were completed out of a possible 480. The results were tabulated and further classified into data from urban and rural schools.

4.2.2 Experimental group

The pupils who completed the lorry project were named the experimental group. The number of this group totalled **205** and was sub-divided into 92 urban pupils and 113 rural pupils.

URBAN EXPERIMENTAL GROUP = 92	**RURAL EXPERIMENTAL GROUP = 113**

4.2.3 Control group

The pupils in the control group did not complete the lorry project. The control group was used as a means of gauging the average ability of pupils from the same schools and standards who were NOT subjected to a technology education programme ie. the lorry project. Pupils in the control group numbered **175** in total. The control group was sub-divided into 83 urban pupils and 92 rural pupils.

URBAN CONTROL GROUP = 83	RURAL CONTROL GROUP = 92

4.2.4 Participants

Tables (15) and (16) contain an overview of the pupils and schools involved in the experiment.

TABLE 15 - Summary of responses from urban schools

SCHOOL NAME	EXPERIMENT GROUP	CONTROL GROUP	TOTAL
JAJA MEMORIAL	19	17	36
KHALIPHA	30	30	60
KWAZI	14	05	19
ILEMBE	29	31	60
TOTAL	92	83	175

TABLE 16 - Summary of responses from rural schools

SCHOOL NAME	EXPERIMENT GROUP	CONTROL GROUP	TOTAL
INSINGISI	30	29	59
TOBI	30	30	60
BOTHA'S HILL	23	33	56
ISINYABUSI	30	00	30
TOTALS	113	92	205

4.2.5 Comments regarding participation

At the school in Kwamashu, viz. Kwazi Higher Primary, there were only 5 pupils in the control group compared to 14 in the experimental group which makes the data from this school less balanced than, for instance, samples from Khalipha Higher Primary School. Jaja Memorial Higher Primary supplied 19 pupils from their experimental group and compared them with 17 pupils from their control group. However, 15 of the 17 pupils from the Jaja Memorial control group were girls which did not provide a good balance. The reasons for schools not providing the correct number of responses ranged from them not having enough time to reasons like stayaways and unrest in the area.

The school near Amatikulu called Isinyabusi Higher Primary, used their standard 6 pupils as a control group. There was no valid reason for this anomaly so these responses could not be included in the comparative results as these pupils were not considered part of the target group of standard 5 pupils. That is the reason why their comparative response is marked down as 00 or 'Not used' in all comparative tables showing the control group results.

4.3 RESULTS OF THE EXPERIMENT

The questionnaire was divided into three sections as follows:

Section 1: Questions related to the lorry project and the pupils' ideas on technology education in general. This section was only answered by the experimental group.

Section 2: Questions related to the socio-economic background of both the experimental group and the control group.

Section 3: Questions were set to compare both the experimental and control group's knowledge of management and technical drawing.

4.3.1 Pupil evaluation of the project

It was necessary to firstly gain information (detailed in Section 1 of the questionnaire) about the project from the pupils point of view. Only the experimental group (who completed the lorry project) were asked questions like: *did you enjoy the project?, was the kit of an acceptable standard?* etc. (see table 19 for details) in order to gain some insight into the applicability of the methodology used for the project. Pupils were required to supply a yes or no response. There were quite a few pupils who did not respond at all. For convenience, this lack of response is recorded as NR (NO RESPONSE). The pupils' responses, displayed in table 17 below, could be summarised as follows:-

(a) The majority (90%) of pupils enjoyed the lorry project.

(b) They were interested in making the project (83% agreed).

(c) Ironically, 60% of pupils decided that they would like to make something else, other than a lorry.

(d) 82% of pupils decided that the kit was produced and supplied at an acceptable standard.

(e) Pupils agreed (81%) that they had gained valuable knowledge and skills via the project.

(f) 84% of pupils suggested that all pupils should take a course in technology.

TABLE 17 - Pupils' views concerning the lorry project

QUESTION	URBAN N=92			RURAL N=113			TOTAL N=205		
	NR	Yes	No	NR	Yes	No	NR	Yes	No
(a) Did you enjoy the project?	11	76	05	04	108	01	15	184	06
(d) Did you have an interest in making the project?	06	71	15	12	99	02	18	170	17
(e) Would you have preferred to make something else?	02	50	40	01	74	38	03	124	78
(f) Was the kit supplied of an acceptable standard?	06	70	16	01	99	13	07	169	29
(l) Do you think you have learned some valuable lessons by doing the project?	01	76	15	16	90	07	17	166	22
(m) Would you suggest that all school pupils should take technology education as a separate subject ?	04	69	19	02	104	07	06	173	26

TABLE 18 - Experimental group's views of the teaching programme

N=205				
QUESTION (b) What section did you enjoy the most?				
	URBAN N=92	RURAL N=113	TOTAL No. of Responses	Percent (%)
(1) Learning how to manage ?	23	93	116	56%
(2) Planning the project ?	32	84	116	56%
(3) Making sketches and drawings?	26	85	111	54%
(4) Making the toy lorry ?	66	100	166	81%
(5) Making your own design ?	27	50	77	38%
Average			117	57%

Table 18 is not accurately calculated from a statistical point of view, as the pupils were required to answer the question by placing a tick in the columns marked (1) - (5). Each student could therefore suggest more than one answer. This essentially nullifies the value of "N" for the group. This may be a weakness in the study although the table does provide a rough estimate of what pupils thought of the different options. Of note is the low percentage for question b - (5)- *Making your own design.* Pupils seemed to avoid this option. The majority of pupils indicated their support for question b - (4) - *Making the toy lorry.* This is possibly due to fact that no other subject in the school curriculum seems to offer a practical component of this nature. Question b - (1) *Learning how to manage* also obtained good support. This point is interesting as it is unique to many pupils' learning experience at this level.

TABLE 19 - Pupils' views of time allocation

N=205				
QUESTION (I) How did you find the time allocation for the project ?				
	URBAN SCHOOLS	RURAL SCHOOLS	TOTAL No. of Responses	Percent (%)
** Too Short ?	25	33	58	28%
** Too Long ?	15	19	34	17%
** Just right ?	49	59	108	53%
** No Response ?	03	02	05	02%
TOTAL	92	113	205	100

Table 19 reflects the trends of responses received regarding the students' perspective of time management. I was able to check on the project at irregular intervals so the question posed to the experimental students: *How do you find the time allocation for the project?* was an attempt to gain insight from the persons who were actually affected by the time factor. In some instances I observed that there was not enough time made available to teachers by the principal. However there were some pilot schools at which it appeared that the teacher was allocated a reasonable amount of time to complete the project. It is noteworthy that at least half (53%) of the total responses indicated that the time allocation was adequate. I have difficulty in accepting the truthfulness of this point as I noted that there seemed to be insufficient time allocated to teachers to undertake some of the required detailed work. No school showed me a design folio in which each pupil was supposed to plan his/her project. This is an important phase of technology education which must be applied to all initiatives in problem solving. My general observation therefore was that teachers seemed to have difficulty in undertaking the pilot programme while cultural and music events appeared to dominate as priority "subjects". The possible reason for these results could be due to the pupils trying to please the researcher or their teacher.

TABLE 20 - Pupils' views about the level of difficulty

N=205				
QUESTION (J)	Did you find the lorry project -			
	URBAN SCHOOLS	RURAL SCHOOLS	TOTAL No. of Responses	PERCENT (%)
** Too Easy ?	42	30	72	35%
** Too Difficult ?	08	27	35	17%
** Just right ?	38	54	92	45%
** No response ?	04	02	06	04%
TOTAL	92	113	205	100%

Table 20 reflects that more urban pupils (46%) found the project was too easy than their rural counterparts (27%). This is possibly due to the urban school pupils being more exposed to kit-like toys at their homes. The assembly of the lorry was essentially very simple but it was the means through which pupils could learn to make their own design after completing the final assembly as the introductory phase. The rural pupils had significant agreement that the project was just right (48%). This is possibly due to the concept being unique as the rural schools usually do not include any craft type of work in their general curricula.

4.3.2 Data regarding socio-economic background

Data regarding the socio-economic background of both the experimental and control groups of pupils was questioned in Section 2 of the questionnaire.

Tables (21) - (24) provide summarised data which focussed specifically on the pupils' family life. It was necessary to ascertain whether pupils were living in conditions which could adversely effect their academic performance and future opportunity. Furthermore, it was necessary to gain insight into their family relationships in order to compare the entire programme with "advantaged" pupils.

TABLE 21 - Relationship between pupils and their parents

N=380					
QUESTION (a) Do you live with your parents while you attend school?					
SECTION 2	"YES" Response Experiment Group N=205		"YES" Response Control Group N=175		Average "YES" % for both groups
	Total	%	Total	%	
URBAN	83	90	71	86	88%
RURAL	98	87	85	92	89%
TOTAL	181	88	156	89	89%

Table 21 indicates a comparison between the experimental and control groups response to the question: *Do you live with your parents while you attend school?* For ease of reference only the "YES" responses are recorded and percentage is calculated by dividing the total yes responses by the total number of responses from a particular group. Findings from this question revealed lower results than expected. The expectation was that a larger percentage did NOT live with their parents. After conversing with the teachers I discovered that this unexpected result could be attributed to a misunderstanding among black pupils. Pupils tended to regard all their relations as immediate family. The results indicate that 88% of the experimental group claim to live with their parents leaving a total of 10% who do not. Similarly I could deduce that 12% of the control group pupils do not live with their parents when attending school. The results of the experimental groups did indicate that less rural (87%) than urban pupils (90%) live with their parents while the comparative results from the control group revealed the exact opposite: (92% rural) and (86% urban). These results are not totally reliable due to the possible misinterpretation of the question.

TABLE 22 - Pupils coming from divorced homes

N=380					
QUESTION (c)	Are your parents divorced ?				
SECTION 2	"YES" Response Experiment Group N=205		"YES" Response Control Group N=175		Average "YES" % for both Groups
	Total	%	Total	%	
URBAN	12	13	17	20	17%
RURAL	26	23	34	37	29%
AVERAGE	38	19	51	29	23%

Table 22 displays the responses to the question regarding the incidence rate of divorced parents. This question was considered necessary to establish just how strong the family units were. Noticeable was the higher incidence of divorce among the rural community (average of 29%) compared with the urban pupils (average of 17%). The poor response could be due to a misunderstanding of the word "divorce". Often the rural man acquires a second family in the city and his first wife rarely sees him although he supports the family financially. One may ask: *Is this divorce? Or separation? Or maybe polygamy?.* The total average incidence rate of divorce reported by the two groups is 23% which is rather high and could influence future learning outcomes.

TABLE 23 - Pupils' home living conditions

N=380							
QUESTION (d)							
SECTION 2	Percentage "YES" Responses URBAN N=175			Percentage "YES" Responses RURAL N=205			AVE "YES" % for both Groups
	Exp Grp %	Con Grp %	Ave %	Exp Grp %	Con Grp. %	Ave %	
Do you live in a house ?	96	87	92	97	93	95	94%
Does the house have electricity ?	97	86	92	54	63	59	76%
Does the house have water ?	91	88	90	23	27	25	58%
AVERAGE AS A PERCENTAGE	95	87	91	58	61	60	76%

Table 23 above displays how urban and rural pupils compared when considering their homes. The comparison revealed that there was a fair amount of equality (92% : 95% responses with a 94% average) between the two groups. However, the question did not cover all aspects of home conditions and could have included a further question, *What is your house made of?*. Many of the rural pupils could possibly live in a wattle and daub type of house which I would consider to be most uncomfortable and could influence future project selection in technology education. The results on the availability of electricity indicated that the rural areas have significantly less electrified homes (59% rural : 92% urban responses with a 76% overall average) than the urban areas. If one considers the vast rural areas of Kwazulu Natal and the type of huts which are erected in those areas then such a result was to be expected. When selecting a project on electricity many teachers may expect all pupils to already have a working knowledge of electricity as it is used in "most" homes. This is not the case in rural areas as only 59% of the rural pupils sampled had electricity. Furthermore, teachers may expect pupils to work at night on their project tasks. This will obviously not be possible at a large number of rural homes.

The water situation in rural areas was even more startling. The comparison by average percent is 90% of urban areas have water in their homes while only 25% of rural area pupils have water in their homes. The overall pupil average from the experiment was only 58%. This is another factor which has implications when developing technology education themes involving water. If students do not have water in their homes their perception about the use of the substance will be different to that of pupils in urban areas.

In Table 24 below it was noticeable that both the experimental and control groups in the rural and urban areas did not vary very much with a general average of about four brothers and sisters per family. A typical family unit thus consists of the pupil, two parents, two brothers and two sisters - a total of seven persons per family. This number, although lower than expected, may be compared with a typical advantaged pupil family of about four or five members in total. The study did not attempt to establish what size the pupils' homes were. In the urban area the homes are generally two or three roomed buildings, while the rural areas tend towards a rondavel type of structure or two rooms per family. This causes crowded conditions and could effect technology education programmes negatively due to children experiencing unpleasant living conditions. Such children are thus not exposed to modern amenities, spaciousness, running water, etc. which technology education planners often take for granted, having come from advantaged backgrounds. Generally one could say that the disadvantaged child will tend to think differently to an advantaged child due to the background from which they emerge. Technology education aims to influence the child positively to help alleviate such problems in the future, but developers need to be cautioned that disadvantaged pupils in require a different approach to that being adopted in an advantaged environment.

TABLE 24 - The size of the family unit

N=380				
EXPERIMENTAL GROUP				
QUESTION (e) SECTION 2	URBAN SCHOOLS	RURAL SCHOOLS	TOTAL	AVERAGE per FAMILY
How many brothers/ sisters do you have ?	N=92	N=113	N=205	
No. OF BROTHERS	174	282	456	2.22
No. OF SISTERS	156	257	413	2.01
CONTROL GROUP				
QUESTION (e)	URBAN SCHOOLS	RURAL SCHOOLS	TOTAL	AVERAGE per FAMILY
How many brothers/ sisters do you have ?	N=83	N=92	N=175	
No. OF BROTHERS	167	178	345	1.97
No OF SISTERS	157	192	349	1.99

TABLE 25 - Pupil's familiarity with the concept "technology education"

N=380					
QUESTION (f) Have you heard/read about technology education ?					
SECTION 2	Percent "YES" Response EXPERIMENT Group N=205		Percent "YES" Response CONTROL Group N=175		Percent AVERAGE "YES" Response
	Resp.	%	Resp.	%	
URBAN	64	31	37	21	27%
RURAL	93	45	66	38	42%
AVERAGE	157	38	103	30	35%

In table 25 above the "yes" response for the urban group expressed as an average (27%) was surprisingly lower than the rural group average (42%). This question was intended to establish whether or not pupils had any idea of technology education prior to this programme. I think the urban group answered more honestly than the rural group as the lower figure is indicative of the current lack of knowledge regarding technology education in general. The larger number of "yes" answers (42%) from the rural pupils is possibly due to the introduction of the pilot project at their schools rather than them reading or hearing about it from another source prior to the project being initiated. Furthermore some of the pupils may have tended to be embarrassed about admitting they had never read about the technology education before and therefore just answered 'yes'. I am of the opinion that very few pupils, particularly from disadvantaged schools, have actually heard or read about technology. This opinion is based on the fact of technology education is still being developed in South Africa.

TABLE 26 - Pupil's interest in technology education

N=380					
QUESTION (g) Are you interested in technology education ?					
SECTION 2	Percent "YES" Response EXPERIMENT Group N=205		Percent "YES" Response CONTROL Group N=175		Percent AVERAGE "YES" response
	Resp.	%	Resp.	%	
URBAN	84	41	44	25	34%
RURAL	105	51	38	22	38%
AVERAGE	189	46	82	24	36%

The results of the experiment shown in table 26 above, tend to indicate that pupils seemed a little cautious to indicate their true feelings about technology education with only 36% of respondents indicating their interest. The differences noted in the total number of actual respondents can be accounted for as NO RESPONSES. The experimental group response of 46% is noticeably greater than the comparative result from the control group of 24%, indicating that the experimental pupils were more positively disposed towards technology education as they had gained greater insight into subject content than the control group.

TABLE 27 - Projects pupils would like to make

N=380		
QUESTION (h) What projects would you like to make?		
SECTION 2 SUGGESTIONS	Response as a percent EXPERIMENT Group N=205	Response as a percent CONTROL Group N=175
Car	28%	15%
House	22%	19%
Lorry	20%	14%
Aeroplane	15%	Nil
Bus	11%	01%
Other	04%	03%
No Response	Nil	48%
TOTAL	100	100

The aim of this question was to gather further ideas from the pupils for future course development. As can be viewed from table 27 above, the experimental group displayed more insight into technological applications currently employed in society than the control group. The control group also returned a very high NO RESPONSE of 48% indicating they had little insight into what could possibly be introduced into their rather 'mundane' school life. This factor is combined with their disadvantaged backgrounds where they have possibly not been exposed to such a variety of toys. The suggestion in the table above marked as "other" included the following ideas: ship, train, knitting, electrics, school, helicopter, spaceship, motorbike.

By comparison, the control group suggestions indicated as "other" included knitting, school, sewing and drawing. This question confirmed the point that pupils who have not been exposed to a technology education programme are less likely to be creative and innovative than those who have had such exposure.

TABLE 28 - Grade from which technology should be taught

N=380		
QUESTION (g) At what standard should you begin to learn about technology education?		
SECTION 2	Percent Response of Experimental Group N=205	Percent Response of Control Group N=175
Std. 3 - Grade 5	18%	20%
Std. 4 - Grade 6	15%	11%
Std. 5 - Grade 7	***40%***	***27%***
Std. 6 - Grade 8	12%	02%
Other	07%	25%
No Response	08%	15%
TOTAL PERCENTAGE	100%	100%

Table 28 indicates that 40% of the experimental group responded in favour of starting technology education at standard five level (grade 7). This was probably due to this project being started at Std.5 level and consequently was the level that the majority of respondents could clearly identify with. Pupils may have also wanted to please both their teacher and the researcher with their response. However, a total of 33% of pupils from the experimental group decided that technology education should begin earlier than standard 5 level while a total of 19% decided it should begin after standard five level. 27% of the control group indicated that technology education should commence at standard five level with 31% deciding it should begin earlier than standard five and 27% indicating it should commence after standard five level. There were 15% of the control group who were undecided.

The reason for the majority of responses deciding to commence technology education at standard five level could be attributed to a lack of insight into anything other than what had transpired at the eight Std. 5 level pilot schools. The intention of this question was to contribute to the HEDCOM 2005 PROJECT which is currently being implemented as a pilot programme starting at Grade 1 (Class 1) and progressing to Grade 9 (Std. 7). The intention of this National project is to provide a basis for curriculum development as technology education will be a compulsory school subject up to at least Grade 9 (Std. 7) in the very near future.

4.3.3 Results of the management section

This section was answered by both the experimental group and the control group. The management questions formed the first part of section 3 of the questionnaire. The theory of management as a method for technology education is explained in detail in chapter 3. From the results received from the experiment (see table 29), I could deduce that a child who has never been taught aspects of management does not acquire such knowledge in the normal school curriculum. However, it is also noticeable that the results obtained by the experimental group were lower than expected. The management section questions were intended to ascertain whether the concepts of management, which teachers had to present, were clearly understood in terms of such concepts being applied to real life situations.

TABLE 29 - Comparison of group averages regarding knowledge of management concepts

QUESTIONS	EXPERIMENTAL GROUP N=205	CONTROL GROUP N=175	Percentage DIFFERENCE between the groups
	Average Percentage of correct answers	Average Percentage of correct answers	N=380
(1) What are the four steps in the management process? (4 marks)	47,8%	11,3%	36,5%
(2) What value has management for the world of work? (3 marks)	1,3%	4,2%	-2,9%
(3) Why is it necessary to first plan before we start making a project? (4 marks)	10,6%	7,3%	3,3%
(4) Why is it necessary to evaluate the project after you have finished making it? (2 marks)	28,8%	16%	12,8%
(5) What does it mean to market a product? (1 mark)	42,9%	28,6%	14,3%
GRAND AVERAGE	26,3%	13,5%	12,8%

The marking memorandum may be referred to in Appendix B. Table 29 provides a comparative summary of how the two groups responded to the management section. A discussion of the different questions follows:-

Question 1 showed a distinct difference (36,5%) between the responses received from the two groups in favour of the experimental group. This was to be expected as the general school child is not exposed to management terminology. Those pupils in the control group who did answer correctly viz.(11,3%), may have derived the information from their friends who were part of the experimental group. It seems as if pupils at Std. 5 level are hardly ever exposed to the concept of management through the general school curriculum and that a subject like technology education would be useful to introduce pupils to this concept. The 36,5% gain in favour of the experimental group is evidence of this point.

Question (2) was somewhat of a surprise. The control group returned a more positive response than the experimental group by 2,9%. I suspect that some of the teachers who administered the test to the respective control groups felt sorry for them and gave them some clues. Essentially, if a child after being taught about management in the experimental project did not know the value of management for the world of work, then the entire group " missed the proverbial boat!" It must be remembered, however, that the teachers were not very familiar with the concept of management and that there was not enough time available to provide comprehensive training to teachers before they presented the technology course. The responses to question (2) suggest that the teachers themselves failed to understand the value of management for the world of work and, therefore, could not teach it to pupils.

Question (3) was also poorly answered by the experimental group, with only a slight gain of 3% over the control group. The whole idea of learning aspects of management, is to allow pupils to be able to plan for themselves. The final phase of the project should have included a new design of a vehicle which the pupils had to plan for themselves. Only a few pupils of the total of 380 actually achieved this phase and no planning was carried out for the designs that were shown to me (see photographs of own designs). Table 20 also confirms this point, as only 38% of pupils responded that they liked making their own design. This factor could also relate to pupils' "phobia" of technical related subjects. (see Section 2.1.8 in Chapter 2)

Question(4) was much better answered by both groups, with a gain of 12,8% for the experimental group. The lorry project provided the experimental group with an opportunity to become more aware of the necessity to critically evaluate a product after it has been made. The general education system does not always focus on quality of the end product so pupils are sometimes unaware of the importance of evaluating a final product, a final draft of work, etc. The experimental group was supposed to evaluate their completed lorry project and so inculcate this concept. Obviously this point was overlooked by some of the teachers.

Question (5) was answered with a satisfactory gain of 14% by the experimental group. The question was about the meaning of marketing a product and the response indicated that a pupil who has completed a technology project generally knows more about business related topics than those pupils who may acquire the knowledge "secondhand" from a friend. The control group seemed to possess more knowledge about this question than I anticipated. I suspect that their knowledge could have been gained via assistance from teachers or experimental group friends.

Grand Average: The results reveal that after participating in the lorry project, the experimental group had gained roughly double the amount of knowledge about management than the control group. However, the total gain shown by the experimental group was rather disappointing due to what could be perceived as a weakness in the transfer of knowledge. If the teachers were better trained in the finer details of management, the results may have been noticeably higher in favour of the experimental group.

4.3.4 Results of drawing section

4.3.4.1 **Introduction**

The second part of section 3 of the questionnaire (see Appendix B for memorandum) examines the technical drawing component which was considered necessary to enable the students to plan their own projects, and then draw out their ideas. This graphical representation of information applicable to making and/or assembly could then be applied to future selected technology projects.

The intention of the section of technical drawing was due to the fact that no Kwazulu Natal Department of Education Primary Schools offer Technical Drawing to pupils within the present educational system. They are only exposed to technical drawing at Std.6 level (Grade 8) if they attend one of only 27 schools offering technical drawing within the province of Kwazulu Natal. It was, therefore, considered an important part of the pilot project to introduce graphical representation to pupils at an earlier age ie. at Std.5 level (grade 7). Furthermore, the importance of the inclusion of the subject is that all projects which need to be made or assembled will, at some stage, require drawing in graphical form. Pupils' creativity can best be expressed when they display (through drawing), their individual ideas before the making or production stage of any model.

TABLE 30 - Pupils theoretical application of technical drawing

QUESTION	EXPERIMENTAL GRP. AVERAGE PERCENTAGE N=205			CONTROL GRP. AVERAGE PERCENTAGE N=175			DIFFERENCE IN AVERAGE PERCENTAGE
N=380							
	Urban	Rural	Grp.Average	Urban	Rural	Grp. Average	
(1) In the given drawing of the lorry project, name the parts indicated by an arrow.	88.9%	72.2%	79.7%	29.2%	50.2%	40.2%	39.5%
(8) When three views of a drawing are shown separately it is called first...........projection	8.7%	32.7%	21.9%	0	0	0	21.9%
(9) When making the loadbox of the lorry you had to mark-out, cut and fold the metal. What is this process called?	0	21.2%	11.7%	0	0	0	11.7%
(13) Why is it necessary to complete a working drawing before making any model?	100%	15%	53%	24%	0	11%	42%

4.3.4.2 Pupils' theoretical application of technical drawing

Table 30 reflects the answers received from both groups of pupils. Responses to questions 1, 8, 9 & 13 were linked together as they required a recall of facts type of response (see Appendix B for details of answer required). Question 1 (*In the given drawing of the lorry project, name the parts indicated by an arrow*) was well answered by both the groups although the difference in average was 39,5% in favour of the experimental group. The control group seem to have been assisted by their friends who did the project as their results seemed to be greater than expected of a group that had viewed the question for the first time. There were also some responses which had exactly the same mistakes indicating that there was a possibility of copying going on.

Question (8) - (*When three views of a drawing are shown separately it is called first.....projection*) was a question which proved to be difficult for the control group who could not answer the question correctly (0%). The term required was first angle orthographic projection and is a term common to technical drawing indicating a method of drawing layout. The teachers themselves did not understand the term very well hence the poor result of the experimental group. The gain of 21,9% is probably much more accurate than the result of question (1) above.

Similarly question (9) - (*When making the loadbox of the lorry you had to mark-out, cut and fold the metal. What is this process called?*) was also testing

TABLE 31 - Application of technical drawing to concrete situations

N=380							
QUESTION	EXPERIMENTAL GROUP. AVERAGE PERCENTAGE N=205			CONTROL GROUP. AVERAGE PERCENTAGE N=175			DIFFERENCE IN AVERAGE PERCENT.
	Urban	Rural	Grp. Average	Urban	Rural	Grp. Average	
(2) Make a free hand drawing of the wheels of the lorry in the space provided. Use any method.	61.9%	56.2%	58.8%	36.1%	57.1%	47.1%	11.6%
(3) In the space provided print the following letters.	82.6%	93.8%	88.8%	53%	79.4%	66.9%	21.9%
(7) Copy the given drawing in the space next to the one shown, using drawing instruments.	56.5%	61.9%	59.5%	39.8%	36.9%	38.3%	21.2%

whether or not they knew the correct technical name for the process they undertook to make the loadbox section of the lorry. The process called "DEVELOPMENT" is common to engineering practice and is taught in technical drawing courses. The experimental group showed a gain of 11,7% over the control group who could not answer the question at all (0%). Once again I thought the teachers did not fully understand the concept clearly themselves.

Question 13 (*Why is it necessary to complete a working drawing before making any model?*) was poorly answered and was very disappointing as it was necessary to assess whether or not there was some any application of the value of technical drawing. The result of only 5,3% for the experimental group indicates a lack of clear understanding on the part of the teachers as well as the pupils. Strangely the control group did not obtain a zero percentage, although 1,1% indicates they never had much knowledge of the concept. The poor result confirms the problems associated with 'crash-course' training of teachers very clearly.

4.3.4.3 Application of technical drawing to concrete situations

Table 31 reflects the answers provided by both groups to questions 2, 3, and 7 *of section 3 of the questionnaire* (see Appendix B for the model answer). These particular questions required the pupil to work from concrete or given situations and draw/print using simple linework. Linework is taught in all technical drawing courses as it forms an integral part of graphical communication.

Question 2 (*Make a freehand drawing of the wheels of the lorry in the space provided. Use any method*) revealed only a small difference of 11,6% between the experimental and control groups. The nature of the questions were very elementary and could therefore explain the lack of a great difference between the two groups. One could philosophise and conclude that pupils within a general education background are able to acquire basic linework skills necessary for graphical communication.

Similarly question 3, was also very simple as pupils were required to copy given alphabetical letters using the techniques applicable to printing in technical drawing. Again, printing is an essential part of all school technical drawing programmes. The difference of (21,9%) obtained from the two groups reveals that if one is taught the techniques and also practise these techniques then one can implement these skills when required. These printing techniques could assist in improving the handwriting of pupils in general educational programmes as well. Question 7 was not well answered. The idea behind the setting of the question was to see by comparison whether or not a pupil who has never handled instruments used for technical drawing can actually use them to good effect. However, the programme which the experimental group followed lacked the ingredient of good teacher training. Consequently I observed that not much emphasis had been placed on this facet of the programme. The result was that

TABLE 32 - Application of technical drawing to more abstract situations

N=380							
QUESTION	EXPERIMENTAL GROUP. AVERAGE PERCENTAGE N=205			CONTROL GROUP. AVERAGE PERCENTAGE N=175			DIFFERENCE IN AVERAGE PERCENT.
	Urban	Rural	Grp. Average	Urban	Rural	Grp. Average	
(4) Colour in the different sides of the box shown as an example. Then fill in the missing top view in the space provided.	50%	61.9%	56.6%	16.9%	31.5%	24.6%	32%
(5) Look at the models shown and fill in the missing view.	42.9%	53.9%	49%	7.8%	26.6%	17.7%	31.3%
(6) Use your ruler and measure the dimensions from the model shown. Indicate the width, depth and height of the model. Enter the measurements on the table given. If there is no measurement then fill in a zero.	47.4%	39%	42.8%	9.3%	17.2%	13.5%	29.3%
(11) Write the number in the circle of the view that corresponds with a view shown by the arrow.	52.9%	56.5%	54.9%	23.5%	30.8%	27.3%	27.6%

I could clearly see that the answers were not drawn with the drawing instruments supplied but rather through the use of a ruler. Pupils tended to not draw to the given scale. Scale drawing is an integral part of any technical drawing programme. The difference between the experimental and control groups was 21,2%. A credit of one mark was awarded to those pupils who had attempted to produce a reasonable replica of the given figure even though it was evident that only a ruler had been used.

4.3.4.4 Application of technical drawing to more abstract situations

Table 32 displays questions 4, 5, 6, 11 which were considered to be of a more technical nature than those questions in table 31 (see Appendix B for more details). Questions illustrated in table 32 involved the interpretation of technical drawing figures. The general results from this section provided an average difference between the experimental and control groups of about 30% which was the largest difference noted among the drawing section questions. The experimental group had acquired much more knowledge about the concepts and principles of technical drawing than the control group. This was to be expected because technical drawing is currently taught as a separate subject in the technical school curriculum and does not overlap with any other school subject in a general school curriculum. With the exception of one teacher at the school on the North Coast named Isinyabusi, all the other teachers were participants in the technical drawing learning area for the first time. Question (6) (*Use your ruler and measure the dimensions from the model shown.......*) may be singled

TABLE 33 - Utilisation of technical drawing principles

N=380							
QUESTION	EXPERIMENTAL GROUP. AVERAGE PERCENTAGE			CONTROL GROUP. AVERAGE PERCENTAGE			DIFFERENCE IN AVERAGE PERCENT.
	Urban	Rural	Grp. Average	Urban	Rural	Grp. Average	
(10) Make isometric freehand drawings of the given models in the space provided on the squared paper.	60.9%	55.8%	58.1%	28.3%	48.6%	3.9%	19.1%
(12) Two views of different models are shown below in first angle orthographic projection. Draw firstly an isometric view to assist you to find the missing third view.	(A) 20.7%	9.3%	14.4%	(A) 9.0%	0	4.3%	10.1%
	(B) 19.0%	6.2%	12%	(B) 6.0%	0	2.9%	9.1%

out as revealing problem areas which should be covered within the mathematics subject field. The pupils in the control group seemed to have had great difficult in measuring. One would expect that they would have learned how to do it in Mathematics, but this was not the case. The difference between the two groups was 29,3% on average. Noticeable was that the experimental group did not actually score very high on this section either, which reinforces this aspect as a problem area. This could be due to a lack of teacher expertise. Surprisingly enough, question (11) - (*Write the number in the circle of the view that corresponds with a view shown by the arrow*) which involved the recognition of corresponding correct views from a variety of choices, was answered much better. This aspect of the experiment could be linked to observation skills learned in the technology programme. It was of course possible to answer correctly by guessing, but in this table it is quite clear that if this were the case, the experimental group out-guessed the control group by 27,6%.

4.3.4.5 Utilisation of Technical Drawing Principles

Table 33 displays the results obtained from the experimental and control groups for questions 10 &.12 (see Appendix B for memorandum details). Questions 10 and 12 from section 3 of the questionnaire were questions which advantaged the experimental group more than the control group as the experimental group should have practised the questions during the lorry project programme. These two questions were intended to explore the pupils' problem solving ability and the application of technical drawing principles. Question 10 (Make isometric freehand drawings......) obtained a 19% average difference between the experimental and control groups. Surprisingly, the control group was able to grasp the concept quite well and achieved a 39% average. Perhaps the control group received assistance from teachers since pupils from some schools performed better than the average (which implies teacher assistance) but the evidence is too vague to be reliable. Nevertheless, the experimental group once again performed much better than the control group achieving a 58% average.

Question 12 (involving the application of first angle orthographic projection) was the most difficult of all the technical drawing questions set. The idea behind this type of question, which is quite common in technical drawing question papers, was to see whether or not the experimental group in particular could apply the principles learned during the programme. The ability to read and apply a working drawing to a project is considered to be significant. As shown in table 33 the control group achieved an average of 2,9% while the experimental group attained an average of 12%. However, the experimental group did not attain a high score which can be attributed to the teachers' ability to teach this subject without comprehensive training. It was most encouraging to find that the experimental group scored four times as high as the control group despite the teachers' lack of knowledge and drawing skills. It shows that some groundwork was laid to prepare the experimental group for technical courses in high school. Technical drawing is a universal language used in industry throughout the world and clearly needs to be included in technology programmes.

4.4 Conclusion

The emphasis of this chapter has been to display the results of the experimental project for the technical drawing section. The results attained by pupils were most satisfactory considering the prevailing circumstances. The respective tables 30, 31, 32 and 33 provide an overview of the findings related to the introduction of technical drawing into senior primary phase at school at disadvantaged schools where the circumstances are far from ideal. The results in general did display certain trends which were in some ways rather predictable but also revealed a few surprises. All in all, the research produced irrefutable evidence that an introductory programme at Grade 7 level is useful and beneficial for pupils to prepare them for technical studies later on. They learn skills and knowledge which disadvantaged children cannot acquire by chance. The potential "good" which is locked up in the subject, needs to be revealed to all teachers and pupils within the province of Kwazulu Natal.

CHAPTER 5

ANALYSIS OF RESULTS

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CHAPTER 5: ANALYSIS OF RESULTS

INTRODUCTION

The chapter focusses on the links between theory and practice for technology education project selection. Cross references to previous chapters direct the reader to specific and relevant points of interest. The analysis of data gathered from the experiment at the eight pilot schools is discussed in order to explain important aspects of the findings. It should also be noted that this section is divided into five main sections that consist of the five identified criteria for project selection (see chapter 2).

5.1 CRITERION: SOCIO-ECONOMIC BACKGROUND

5.1.1 A review of relevant theory

This criterion is discussed in detail under Chapter 2 (Section 2.1):- " For a technology project to be didactically justifiable it should correspond with the socio-economic background of the pupils at which it is targeted ". The apartheid era is to blame for the dilemma that educationists face together with a number of associated problems. This factor has played a major role (see Section 2.1.4) and has caused thousands of pupils, now classified as disadvantaged, to forfeit their right to fair and equitable education facilities and resources. The need for equality in education and in particular from those persons responsible for compiling technology curricula cannot be over-emphasised.

The uprising of students in 1976 (see Section 2.1.5.4) was the climax of in inadequate monetary policy for schools and ushered in a historical period which was to bring about change by education authorities. The resourcing of schools to enable pupils to make projects in technology education is highlighted (see Section 2.1.6) and is also an area of the proposed new technology curriculum which is likely to cause major problems. This is due primarily to financial constraints as well as standards within the province which are not equitable among pupils at all schools. In this dissertation I plead for changes to be made to the school system (Section 2.1.6.3) and consequently the need for equality among all school pupils who are likely to be required to make technology educational projects (see Section 2.1.6.4).

The projects which will have to be made should include both hand skills and a theoretical component (see Section 2.1.7). In terms of available and required resources such an exercise could prove to be problematic. In order to overcome the apparent 'phobia' for technical related subjects (see Section 2.1.8) displayed by pupils from disadvantaged communities, educational planners need to stop concentrating on the apartheid past and focus on improving their future prospects in this field. Technology education is perceived to be a logical means of addressing this particular problem. However there are negative influencing factors like family relationships (see Section 2.1.9) which seem likely to interfere with a simple transition taking place.

The socio-economic background of pupils in South Africa is therefore totally different to that found in the United States of America (see Section 2.1.2) and must be carefully considered when selecting projects.

5.1.2 Relevant findings from empirical research

5.1.2.1 **Pupils not living with their parents**

There appeared to be at least 10 - 13% of the experimental group pupils who did not live with their parents while they attended school (see section 4.3 - table 21). This means that they are either under the care of a relation or friends. The didactic expectations of the school is therefore influenced by this circumstance as there is very little or no parental guidance to some of the pupils in the disadvantaged community schools.

5.1.2.2 **Incidence of divorce among parents**

Another important aspect also noted in Chapter 4 (Section 4.3 - table 22) was the incidence of divorce among parents. The experimental group indicated 10% of their parents being divorced while the control group response was 15%. The majority of divorce occurred among the rural school children's parents. In terms of different types of projects to be completed by pupils this high incidence of divorce is a factor to consider.

5.1.2.3 **Pupils' physical home living conditions**

The socio-economic background of the pupils was further highlighted in Chapter 4 (table 23) and may best be described as follows:-

(a) Pupils not living in a house

The disadvantaged pupils tested in the experiment revealed that 6-8% of pupils did not live in a house.

(b) Pupils not having electricity

8% of the urban pupils tested did not have electricity in their homes while **24%** of rural pupils claimed not to have electricity in their homes.

It would have been a very interesting question to have asked - "what is your home made of?" as many of the rural area pupils are possibly living in wattle and daub mud huts. This type of structure is very prevalent in the rural areas of Kwazulu Natal and within the squatter settlements around the industrialised urban areas.

(c) Pupils not having piped running water

The lack of running or piped water was noteworthy from the results of the experiment. While only **10%** of the urban pupils did not have water in their homes, **75%** of the rural pupils indicated that they did not have water within their homes. The lack of this commodity could seriously impact upon perceived ideas regarding the use of water in technology educational projects because of the lack of exposure to the substance.

5.1.3 Analysis of findings related to socio-economic background

5.1.3.1 Family relationships

The experimental and control groups submitted interesting responses to questions posed regarding their family circumstances (see Section 2 of questionnaire - Appendix A).

11% of pupils tested did not live with their parents while attending school (see table 21); the two groups returning very similar responses. Although not very high this factor could account for some of the discipline problems among pupils. To add to this problem responses from both groups revealed that an average of 13% of pupils' parents were divorced (see table 22). Rural families had a higher incidence of divorce than urban family; in fact, nearly double the number for both pupil groups. As the study concentrated on disadvantaged pupils it was necessary to establish the average size of a black family. Responses received indicated that the pupils have an average of seven in their family unit consisting of mother, father, two brothers and two sisters (see table 24).

5.1.3.2 Home facilities

The pupils in the experiment provided information about their physical home conditions. 94% of pupils live in a house with 76% of the houses having electricity and only 58% having water on tap (see table 23). The lack of water and electricity at home is therefore likely to influence the types and size of projects which pupils can complete for homework.

As more pupils start to live in better housing which has electricity, water and telephones, etc., the level of expectation of teachers presenting technology subjects could be raised. However, this study was founded on the idea that because of poor socio-economic backgrounds, teachers would have to be more aware of inequalities when selecting technology themes and projects. If a teacher has a multi-cultural class, as is becoming the norm at many schools, different outcomes are likely to emanate from such exercises.

5.1.3.3 School facilities

The physical facilities at many black community schools within the province tend to be below the expectations of the education planners. The findings from visits to the eight pilot schools revealed inadequate storage facilities for projects and a general lack of space in classrooms due to the tendency to overcrowd (see Section 3.4.5). Most of the community schools within Kwazulu Natal need to be upgraded to provide the minimum required standard conducive to improve teaching and learning. The living conditions in and around schools in the rural areas will take a longer time to change. However, all technology planning for project selection needs to take cognisance of the fact that programmes will tend to differ depending on where the school is situated and the prevailing circumstances. This is not to say that there should be different technological standards set for different areas, but rather that a different emphasis will need to be placed on the various aspects considered important to a particular cultural group and area within the provinces of South Africa.

5.1.3.4 **Resource material**

Due to poverty existing particularly among some of the rural areas, the resourcing of schools will require serious attention (see Sections 3.4.3.2 and 3.4.3.4). Following my visits to the pilot schools and after conducting discussions with the principals, it was evident that there is a problem with the collection of school fees. Many parents feel that it is the duty of the Department of Education to provide facilities and resources for their children. The tendency from educators from advantaged schools who had tried similar pilot work (see Section 3.3.4) was for parents to make a contribution to the project being undertaken either via resource materials, research material or information. If one then considers the disadvantaged schools to be under-resourced and without parental support, they will require significant funding to enable them to participate on an equitable basis.

5.1.4 Detailed criteria

- *Family relationships*
- *Home facilities*
- *School facilities*
- *Resource material*

5.1.4.1 **Criterion:- Family relationships**

Pupils from disadvantaged backgrounds experience circumstances which are different to advantaged pupils. Pupils do not all live with their parents when they attend school (see table 21) and the incidence of divorce is also prevalent (see table 22). This would mean that there is likely to be less parental support at home and could also influence the discipline of the child. When projects are being selected which may require completion at home, teachers need to be aware of possible difficult circumstances which may be experienced by the child at home.

5.1.4.2 Criterion:- Home facilities

The home living conditions are not always conducive to enhancing a pupils performance. The lack of common facilities like electricity, water, telephones, etc. (see table 23) could influence the way a pupil responds to certain technology education projects. Whenever a technology education project is being selected the perceived points of departure for different themes should not be taken for granted eg. a rural school project on water should evoke different reactions than a comparable urban school. Homework assignments could be very restrictive at many of the rural schools.

5.1.4.3 Criterion:- School facilities

The school facilities at most community schools throughout Kwazulu Natal need to be upgraded. Store rooms and/or lockable cupboards are not installed in many classrooms and some schools are not fenced and locked after hours. Classrooms are also overcrowded and specialist rooms for technology are not available. As inequality exists between urban and rural schools in general, the selection of projects will need to be carefully selected in order to accommodate such a lack of necessary facilities.

5.1.4.4 **Criterion:- Resource material**

There is likely to be a lack of adequate resource material especially at disadvantaged schools. The parents do not seem to be very participative in the school life of the child and therefore pupils lack parental support. When projects are being selected the possibility of kits could be considered viable in such circumstances as it is not likely that suitable resource material will be available in disadvantaged areas. However, the use of project kits does tend to negate the creativity of the teacher who, ideally, should be free to choose any project. The use of "high-tech" equipment is not necessary to start courses but should be considered for future development.

5.1.5 Conclusion

The selection of projects is closely linked to resources which may or may not be available (human, financial and physical). The main criterion for this section is socio-economic background and is considered to be one of the five important criteria influencing project selection in technology education programmes. When selecting a technology education project within the context of socio-economic background the teacher should be aware of more specific supportive criteria:- family relationships, home facilities, school facilities and resource material.

5.2 CRITERION: DEVELOPMENTAL LEVEL

5.2.1 A review of relevant theory

The study summarised the cognitive developmental theories proposed by different education psychologists and commentators like Piaget, (see Section 2.2.2.2 and table 3) regarding the learning trends expressed by pupils at different ages. Piaget developed four important and identifiable stages of child development for different age groups viz. sensorimotor and pre-operational stages during the early years followed by concrete and formal operational stages from age 7 and older. The lack of significant insight displayed by teachers towards the pupils' learning habits and acquisition of knowledge in the general school curriculum, should not be carried over to technology education. Some teachers appear to be rather apathetic at times and important psychological facts which they learned on teacher education courses, are not applied to their lesson presentations. When a teacher selects a technology education project he/she must be aware of the possible difficulties a child may experience in understanding, for example, a hydraulic principle when they come from a remote rural area (see Section 2.2.2.4). The child may not necessarily have been exposed to this type of technology in his/her life before and therefore may not have a mental image of the article nor the actual capability of hydraulics. The teacher must therefore be equipped to adapt the lesson to suit the developmental level of the child in whatever circumstances may prevail.

The affective development (see Section 2.2.2.3) was also considered to be an important factor in this regard and one aspect of the developmental process of all children which tends to be neglected the most. Unless teachers become more sympathetic towards developing latent talents in children from disadvantaged backgrounds, there will continue to be a lack of equality in the standards of pupils in a class group at a school which may accommodate both advantaged and disadvantaged pupils or possibly only disadvantaged pupils from a poor community background. Some teachers, tend to over-emphasise the cognitive development (see Section 2.2.2.1) to the detriment of the child. The danger exists of pupils being under developed in the affective or creative part of their being. This study pleads for technology education in South Africa to be balanced in order to educate the child holistically.

5.2.2 Relevant findings from empirical research

5.2.2.1 **Management aspect**

The findings under the management questions (see section 2 of the questionnaire) confirmed the fact that a child who is not being exposed to technology education, and being taught the principles of management, does not acquire such knowledge through a general school curriculum (see table 29).

5.2.2.2 Technical drawing aspect

Furthermore, the technical drawing section revealed that pupils who had completed a course in technology education, performed much better than pupils who had not completed such a course (see Section 4.3.4). It was evident from the findings that even pupils who have had a course in technology education also have difficulty in comprehending some of the concepts from both a management and technical drawing perspective.

5.2.2.3 Application of principles

Pupils tested by the experiment also tended to experience difficulty with the application of principles learned in management and technical drawing. This was contrary to the viewpoint of Davis (1956:278) (see Section 2.5.1.1) who stated that learning takes place when information learned from one situation is transferred to another situation. Project selection is closely linked to developmental levels of pupils in both urban and rural settings. An awareness of this criterion should prevent teachers from selecting projects far too advanced for the class, too abstract for rural pupils or too difficult to make at poorly resourced schools. Although variety should be encouraged, the teacher must not lose sight of the actual level of comprehension of the pupils.

5.2.3 Analysis of findings related to developmental level

5.2.3.1 **Lack of exposure to technical education**

Firstly, it needs to be stated that traditionally most of the black pupils within the province of Kwazulu Natal do not follow a technical related curriculum (see Section 2.1.8). Due to the pupils coming from backgrounds which do not expose them to modern technical equipment, they tend to regard learning about new innovations with suspicion. The resultant tendency in the past has been to not follow courses related to technical education. This study focussed on Grade 7 pupils who are not exposed to any technical information. The findings, particularly in section 3 of the questionnaire which covered technical drawing concepts, illustrates the point in question quite convincingly (see chapter 4 - Section 4.3.4). The results clearly indicate that technical knowledge is not merely acquired in the general school curriculum. The modern black family needs to experience for themselves the advantages of modern technology in order to be able to apply it to their daily lives.

5.2.3.2 **Language Barrier**

The findings from the programme reveal that pupils had difficulty in clearly understanding the meaning of some of the technical words used. Furthermore, even some of the easier concepts like distinguishing between parents and friends or relations caused some concern amongst the respondents. The choice of different types of projects to be made proved to be very difficult for some of the control group to express and many pupils did not respond. All technology learning programmes are at present developed in English. The translation of course material into mother tongue language could be required as a matter of urgency for all younger learners who are negatively effected by the current language barrier.

5.2.3.3 Level of difficulty of projects

The level of difficulty of projects selected should accommodate all learners. The results from the experiment identified a difference (see table 20) between urban and rural pupils' ideas about the lorry project level of difficulty. 16% more rural pupils than urban pupils decided the level was correct. If there is such a discrepancy between such a small sample of pupils one can imagine large differences among all other school learners. Technology education projects will have to be set at levels of difficulty to suit all learners and progress in classic teaching style from the concrete to the more abstract.

5.2.3.4 Perceived levels of development

The teacher will need to be aware of the perceived level of development of all pupils taking technology education courses. Due to inequalities between previously advantaged and disadvantaged pupils teachers will need to clearly identify common starting points especially among mixed class groupings. Teachers must therefore not take the grade level of the pupil as the actual level of development. Disparities noted in the results of the experiment also exist between urban and rural pupils. The technology education programmes will have to accommodate all learner differences. When selecting projects teachers will have to be made aware of and also plan their teaching strategies for the different levels of development. Teachers would also have to be better equipped to handle this criterion comprehensively. The pupil tested by this study were all of the age group 12 - 13 years, and seemed to be quite capable of learning technological basics from a structured learning programme.

5.2.4 Detailed criteria

* *Lack of exposure to technical education*
* *Language barrier*
* *Level of difficulty of projects*
* *Perceived levels of development*

5.2.4.1 **Criterion - Lack of exposure to technical education**

Traditionally pupils from disadvantaged communities did not take technical education courses. They followed a general curriculum which does not enhance one's technological ability. The experiment conclusively revealed that technical education concepts are not acquired from studying general course material (see

Section 4.3). Teachers selecting technology education projects must be aware of the tremendous lack of technical knowledge which disadvantaged pupils possess.

5.2.4.2 Criterion - Language Barrier

There is a lack of clear understanding by pupils learning via second language instruction. The medium of instruction, especially at the junior levels, (grade 1 - grade 5), would need to be mother tongue. In chapter 2 (Section 2.3.2) it was noted that language is linked to problem solving (also see Section 2.2.2.1). The majority of technology books are presently only available in English. When teachers select technology education projects the language problem must be carefully considered as a lack of understanding could negatively affect many of the target pupils.

5.2.4.3 Criterion - Level of difficulty of projects

Each teacher will be expected to make choices about what projects in technology education are to be taught. There may be certain themes set by the school management to guide a teachers' choice eg. water, structures, mechanisms, etc. However, the projects selected being selected should not be too difficult for pupils to comprehend and neither should they be too easy as that inhibits the learning objective.

5.2.4.4 **Criterion - Perceived levels of development**

Stages of development of the child may cause a child to be either more advanced or retarded than the apparent norm. The more remote the school and child is from urbanised society, the more abstract will the transformation process probably be. When technology education projects are selected a teacher must first establish a concrete starting point to avoid misconceptions due to incorrectly perceived levels of development especially in multicultural classes.

5.2.5 Conclusion

The developmental level among learners will differ considerably between individuals and could further be influenced by urban and rural school settings. Teachers who select projects should be aware of the implications of advancing either too fast or conversely too slowly with a project or theme. The criterion should assist teachers to gauge the possible learning outcome fairly accurately. Developmental level as the main criterion is supported by sub-criteria:- Lack of exposure to technical education, language barrier, level of difficulty of projects and perceived levels of development.

5.3 CRITERION: PROBLEM SOLVING

5.3.1 Review of relevant theory

The literature study outlined in chapter 2 (Section 2.3.2) discussed the theory of problem solving skills and provided the reader with a few comparative viewpoints. There was no "clear-cut" answer on how problem solving should best be taught. Chapter 2 (Sections 2.3.3, 2.3.4, 2.3.5 and 2.3.6) forward ideas on how teachers could apply different methods to assist pupils in solving problems on their own. Technology education has as its main focus the concept of problem solving. This is not something totally new as many other subjects within the general school curriculum also promote aspects of problem solving.

All learners of technology education programmes need to be equipped to deal with pre-set problems in a logical and sequential manner. There was consensus from the literature readings, that the ability to solve problems was a very desirable ability for pupils to master. These skills are emphasised in all technology education courses and one may single out the viewpoint of Gagne (1985) who promotes the concept of transfer of learning where one acquires the ability to use a skill learned in one particular situation to solve another similar situation (see Section 2.3.2). The theory did not in any way exclude the acquisition of knowledge as being undesirable, but rather that it was an integral part of establishing a foundation for problem solving. Much of the disadvantaged pupils problems have stemmed from the fact that they tended to lack a solid theoretical foundation due to past laws (see Section 2.1.5) which placed them in a situation which was considered detrimental to good teaching and learning practice (see Section 2.1.6.4).

5.3.2 Relevant findings from empirical research

5.3.2.1 **The experiment**

The findings (see chapter 4) revealed that pupils who had never completed a technology education programme did not acquire such knowledge from other general education subjects. Pupils tended to accept just as much information as the teacher was able to teach them without critically analysing the content. This is not a strange phenomenon to South African education but is rather the norm.

5.3.2.2 **Apparent lack of problem solving abilities**

A simple example of lack of problem solving ability was evident in the pupils' poor measuring ability (see chapter 4 section 4.3.4.4). Now one may assume that measurement is something every child at Std.5 (grade 7) level should know and understand but teachers who select projects need to be made aware of this discrepancy. Other questions focussed on the matching up of different views in technical drawing which the control group had difficulty in completing correctly.

5.3.2.3 **Lack of confidence in project design**

The final project was for the pupil from the experimental group to make their own project using the chassis provided in the lorry kit. The management approach, if taught correctly , required from each pupil to develop his/her own design folio which was the theoretical planning for each individual's project design. There were a few excellent designs but none of the required planning was provided to show how the pupil had arrived at the solution. The technology programme should not just promote an emphasis on design but should include all other related concepts which will support the final design and making phase; essentially a balanced approach to problem solving should be emphasised.

5.3.3 Analysis of findings related to Problem Solving

5.3.3.1 **Teacher training**

The experiment indicated that a lack of adequate teacher training can influence the learning outcomes of any programme. The crash course was administered to participating teachers at eight pilot schools.. This proved to be a poor method of training as too much knowledge was expected to be acquired in a very short time. Specific reference is made in chapter 4 (see discussion of tables 30 and 31) to a lack of adequate training which influenced the results of pupils. Teachers would thus require in-depth training in a variety of topics related to technology education prior to implementation on a large scale within Kwazulu Natal.

5.3.3.2 **Cultural diversity**

The ability to solve problems in a logical manner is a most important aspect of technology education. As this study was targeted only at disadvantaged pupils it was not possible to ascertain the difference between different culture groups and to what extent this influenced their ability to solve problems. However, it is obvious that culture has a strong influence upon the way a person thinks, moves and views life in general. The results from the management section are of particular importance as in black culture the man is considered to be the absolute head of the home. The wife fulfills a subservient role. The experiment targeted the female pupils to be equal in terms of problem solving using management methods. This may be contrary to their culture and could also apply to other culture groups.

5.3.3.3 **Prior learning**

The emphasis of the experiment was to prove that if one has never been exposed to technical education then one does not merely acquire such knowledge through learning a general curriculum. The results obtained from section 3 of the questionnaire indicate that the experimental group out-performed the control group in most aspects of the programme. This proved the point quite convincingly. Planners and teachers need to take cognisance of the fact that the majority of learners in Kwazulu Natal, will fall into the category of "lack of prior learning" due to past inequalities within the education system and subject package options. Without having a background which has been developed from as early as grade 1 (class 1), the child tends to lack the ability to solve problems which may be in a form different to rote learning.

5.3.3.4 **Reasoning ability**

If one is to solve problem situations then it is necessary to be able to reason a situation until a solution emerges. The experiment revealed that the experimental group were better able to solve problem situations created via the drawing section questions (see table 33). However, the experimental group cannot be considered to be "experts". The group in general had difficulty in reasoning out new problem solutions although they had been taught some basics. The education system has not provided much opportunity for pupils to develop reasoning ability due to the nature of courses offered and followed by a large majority of the school-going population. Reasoning could therefore be problematic in technology education programmes unless strategies are developed to inculcate this desirable feature into technology areas of learning.

5.3.4 Detailed criteria

* *Teacher training*
* *Cultural diversity*
* *Prior learning*
* *Reasoning ability*

5.3.4.1 **Criterion:- Teacher training**

Possibly one of the most important aspects of any future technology education programme is teacher training. The experiment highlighted areas of the training of pilot school teachers which was unsuccessful (see management and drawing sections in chapter 4). Intensive pre-training and re-training of teachers in Kwazulu Natal will need to be addressed as a matter of urgency if one considers the enormity of the proposed technology initiative. Teachers will need to be well prepared to handle a large variety of possible themes and must be able to select a project suitable for them to teach effectively to their pupils.

5.3.4.2 **Criterion:- Cultural diversity**

There exists a large cultural diversity among learners at schools within the province. This study focussed on the black child in education as they constitute the majority of disadvantaged learners. The new school dispensation has introduced different culture groups into one class group. When projects are being selected and a variety of problems are to be solved, the teacher should be aware that different projects may advantage certain culture groups and possibly disadvantage others.

5.3.4.3 **Criterion:- Prior learning**

Technology education project selection must include prior learning of the pupil as part of the criteria for a teacher to be able to make an informed choice. If the prior learning of a particular class group is not what was expected then a teachers' work schedule will be reversed to first cover subject matter which should already be known. This process can be very time consuming and frustrating to both teacher and pupil.

5.3.4.4 **Criterion:- Reasoning ability**

For a technology education project to be selected by a teacher it should involve the reasoning ability of the class group. Pupils from disadvantaged backgrounds and rural areas must be encouraged to participate in problem solving using reasoning techniques to find logical solutions. This skill could be problematic to develop due to the past education system which only offered general subjects to most pupils in Kwazulu Natal.

5.3.5 <u>Conclusion</u>

Problem solving is an important criterion to be included in project selection related to all technology education courses. If a pupil can learn to solve problems independently and apply relevant theory to other situations, he/she has gained an advantage in life. Technology education places a great emphasis on the awareness of problem solving as an active skill to be taught and learned by all participants.

5.4 CRITERION: MOTIVATION

5.4.1 Review of relevant theory

In chapter 2 the theory discussed to support the fundamental principle of motivation, included the work of Maslow (1970), Duminy and Sohnge (1980) and Shepard (1989) whose ideas all reflect the desirability of motivation to influence working situations within industry and technology courses (see Section 2.4.2). Maslow indicates that if a person does not have his/her most basic needs like food and shelter satisfied first, then he/she will not be able to respond to higher order needs. This concept has a direct reference to technology education in terms of project selection.

Motivation of pupils is viewed as being the key to successful teaching (see Section 2.4.2) and therefore needs to be included in project selection requirements. Having completed a technology programme should enable an individual to compete for employment or further study having received good foundation education and developed positive attitudes and work ethics (see Section 2.4.3). This would not be possible without the teachers also being motivated (see Section 2.4.4) to assist in bridging the gap between first and third world thinking.

5.4.2 Relevant findings from empirical research

5.4.2.1 **Motivation for the pilot project**

The results outlined in chapter 4 (see table 17) were from questions to the experimental group who had completed the lorry project. Their response in general was very positive and could be described as showing positive signs of them being motivated to participate in a technology education project. The teachers started out most enthusiastic to present the pilot project to as many pupils as possible following the first introductory course.

5.4.2.2 **Teaching time allocation**

The time allocation for the subject also tended to complicate the matter, with principals not always insisting that technology education receive the necessary priority. Some teachers tended to become despondent when they realised that technology projects are more time consuming than general school subjects. Once again I should have anticipated this, as the pilot study although being approved by senior management, was not officially considered a section of the general school subject package. 53% of the experimental group responded that the time allocation per period was adequate but at the conclusion of the programme it was evident that some of the content had not been covered. Observations made by me during my visit to all schools revealed that the average of one hour per week was not adequate.

5.4.2.3 **Curriculum changes**

The need for curriculum changes and education policy was also evident. Once an official curriculum has been established, the time allocation could be considered in a more serious light. There is an urgent need to introduce pupils in Kwazulu Natal province to relevant subject packages which would entail a total review of the existing curriculum. The introduction of a subject like technology would be an excellent starting point.

5.4.3 <u>Analysis of findings related to motivation</u>

5.4.3.1 **Pupil interest**

One important factor which the actual design of the lorry project tended to exclude was that both boys and girls did not have the same amount of interest in the making of a lorry project. The girls generally tended to show much less interest in the lorry project than the boys. However, this problem was addressed with a follow-up programme not covered by this study. The boys seemed to be most interested in the lorry project and helped the girls with problems they experienced in the assembly of the lorry kit. The girls from the experimental group had particular difficulty in bending the metal plate to form the loadbox section of the lorry. The plate, although only approximately 1,6mm thick, did require some strength to bend. This factor seemed to possibly have placed the girls in an unfair position to try and compete with their male counterparts. The motivational aspect of the girls in a class group could become slightly problematic for teachers unless their interests are catered for.

5.4.3.2 Teacher preparation

There seemed to be no doubt at the end of the lorry project that teachers need to be very well prepared in order for them to be positively motivated to teach technology courses. After the one week orientation course, teachers realised that they required more preparation time than they were possibly accustomed to. Some teachers reduced their class group numbers which displayed a lack of motivation in the execution of their task as well as a change in their attitude towards the project in general. The reason behind this "change" could be attributed to lack of sound training and also that they were only voluntary teachers who were not necessarily looking for additional work.

5.4.3.3 Principals' support

The findings from the experimental project revealed that where the principal was very supportive of the teacher and had interest in the project the programme tended to be conducted in an organised manner. The teacher felt more confident knowing that the principal was interested and the time allocated for the project was generally during the main part of the day rather than at the end of the daily programme. The lesson sessions at the end of the school day tended to be regarded as less important and were invariably "lost" to cultural activities.

5.4.3.4 **Pupil attitude**

The attitude of pupils appears to be an important aspect of technology education. Historically many of the disadvantaged pupils resisted the education system from the apartheid era which negatively influenced the motivational aspects of learning. The project results revealed that the new subject content which technology has to offer was well received by pupils from disadvantaged communities (see table 17). The diversity of projects which can be made seemed to appeal more to pupils from the experimental group who indicated their possible preferences (see table 27) without any "No Responses", unlike the control group. This was an indication that the attitude of the experimental group was much more positive towards new concepts than the control group who had not been told of technology education prospects.

5.4.4 Detailed criteria

* *Pupil interest*
* *Teacher preparation*
* *Principals' support*
* *Pupils' attitude*

5.4.4.1 **Criterion:- Pupil interest**

Project selection for technology educational programmes needs to include the diverse interests of pupils when making a choice. The experiment revealed that the interests of boys differs from those of girls. Teachers must ensure that both boys and girls receive a fair distribution of relevant topics and that there is not an over-emphasis either way as this could lead to motivational problems.

5.4.4.2 **Criterion:- Teacher preparation**

Teachers who are to present technology education courses will have to increase their amount of preparation time and should seriously consider the different levels of commitment required before selecting a particular project. The observations made during the lorry project were that if a teacher is to present technology courses then the level of preparation will have to be improved. If a teacher decides to select a particular technology education project, he/she must firstly consider the implications related to the preparation which will be required.

5.4.4.3 **Criterion:- Principals' support**

When technology education projects are being selected, the entire programme should be considered an important part of the school curriculum and carry the support of the principal. This should ensure that the lesson time is adequate, that there are no interruptions in the learning programme and that resources will be available. Problems which a teacher may experience will be dealt with at a high level instead of "battling" along on their own.

5.4.4.4 **Criterion:- Pupils' attitude**

Attitude of the learners with specific reference to technology educational project selection needs to be considered. Pupils should have an acceptance of the capability of the teacher to present the facts and must be in a position to become partners in a technological project or theme. Teachers must select projects to accommodate prevailing attitudes among learners due to circumstances not always being favourable and limited resources being available at present.

5.4.5 Conclusion

When teachers select projects in technology they must ensure that motivation in inculcated into the teaching and learning process to ensure success. If a project is not inclined to develop motivation among learners, it is likely to be abandoned in an incomplete state. The sub-criteria of pupil interest, principals' support, pupil attitude and teacher preparation will ensure to some extent that the selected project is likely to produce a motivated response.

5.5 CRITERION: MEANINGFUL TRANSFER OF KNOWLEDGE

5.5.1 Review of relevant theory

At present the South African education system appears to have a less than acceptable level of transfer of knowledge and skills taking place (see Section 2.5.1). Different researchers have expressed their views on what learning actually is (see Section 2.5.2) and the study provides details in comparative form of the different viewpoints. Such views on learning include the acquisition of knowledge, behavioural changes which occur holistically rather than fragmented. Generally most of the researchers' findings focus on a change which occurs in the capacity of an individual to think, reason, and apply knowledge learned to different and unique situations. Blooms taxonomy (1956) forwards a relevant hierarchical order of learning categories subdivided into three domains viz. cognitive, affective and psychomotor. This philosophy could assist teachers in providing a holistic approach to developing technology education programmes.

Technology educational programmes should facilitate positive educational changes required by industry and society. The educational development of the youth, especially in disadvantaged areas, bring upliftment to such areas as learners are expected to contribute back to their communities. Teachers following a newly developed technology programme need to be completely aware of the requirements of the child in terms of their capacity to acquire knowledge and apply it to real life situations. To assist in the transfer of knowledge chapter 3 has forwarded a possible methodology of the management approach to acquire technological knowledge in a most meaningful way.

5.5.2 Relevant findings from empirical research

5.5.2.1 **Management as a method**

The results from the management section (see Section 4.3.3) clearly indicated that teachers did not have a sound knowledge of the management concepts themselves. Results obtained did not average greater than 50% indicating a lack of clear understanding and application of principles. The criterion of meaningful transfer of knowledge was impeded by this factor. Additional material and further reading would have to be done by teachers if better results were to have been achieved. Noticeable was question (2) from the management section which revealed a negative mark to the experimental group when compared with the control group (see table 29). This is highly irregular but tended to indicate, in this instance, that general knowledge was better than course content knowledge. If the management concept is taught correctly it should prepare all pupils to solve problems in a logical manner.

5.5.2.2 **Lack of technical drawing knowledge**

The drawing section questions revealed that the pupils were able to grasp a few sections of the work quite well (approximately 50% average), whereas the application of knowledge to more complex questions revealed an approximate average of 20% (see chapter 4 discussion of tables 30, 31, 32, 34). The comparison between the experiment and control groups revealed that pupils do not merely acquire technical drawing abilities in a general school curriculum.

5.5.3 <u>Analysis of findings related to meaningful transfer of knowledge</u>

5.5.3.1 **Transfer of knowledge**

Teachers tended to lack knowledge about meaningful transfer of lesson content especially with sections of management and technical drawing. Due to teachers being under-prepared for the task, the responses from the experimental group tended to be below the anticipated average (see tables 29 and 30). Incompetent teachers sometimes neglect their responsibility to educate the *whole* child in terms of cognitive, affective and psychomotor skills. Such knowledge is taught during subject didactic teacher training courses but is not effectively applied by all teachers.

Educators who will be future presenters of technology programmes will need to acquire a clear understanding of the ways in which pupils learn under different conditions.. The selection of projects will depend on the teacher being able decide how to handle a particular project being selected. If the subject material is extremely varied, tending in some instances to be quite technical in nature, then recognising how a pupil acquires knowledge will play a significant part in the planning of lessons and the setting up of different project themes.

5.5.3.2 Reasonable timetable allocation

During the experiment the timetable allocation was problematic. Due to the project being only considered to be a pilot programme, some principals tended to overlook the importance of the subject. Furthermore, the actual lesson time was below that which is considered suitable for meaningful transfer of knowledge to take place. Some of the principals allowed other activities to interfere with the technology lesson time which was relegated to the periods at the end of the school day.

5.5.3.3 Balanced learning programme

The experiment was essentially prescribed work provided by the education department for teachers to follow. It was considered to be a suitable starting point and the findings of the research confirm this point. There are other technology education options available which tend to be unbalanced due to the emphasis placed upon design (see Sections 3.3.2 and 3.3.3). Pupils need to acquire knowledge in a curriculum which has a balanced approach; inclusive of design but not over-emphasising this factor.

5.5.3.4 **Teaching methods**

The methodology applied during the experiment was considered suitable as an initial starting point. The use of a kit was found to be most appropriate for disadvantaged schools who had never been exposed to technology education before the lorry project. The use of a kit ensured that adequate resources for a project were available and also that all teachers followed the same content. The management methodology was introduced but was not really implemented as part of the programme. Future courses should include management as a useful instrument to co-ordinate classroom activities.

5.5.4 Detailed criteria

* *Transfer of knowledge*
* *Timetable planning*
* *Balanced learning programme*
* *Teaching methods*

5.5.4.1 Criterion:- Transfer of knowledge

Avenues of the brain which are activated by different teaching methods need to be identified by the teachers who are to present technology education programmes. This aspect of the criterion may be applied to project selection and should be included as part of specialised training for the technology education teacher training courses. Furthermore, the psychological theory which is applicable should be taught in practical ways so that it no longer appears abstract. It should become an inclusive part of the selection process. At present the emphasis seems to only be on the content aspect of courses.

5.5.4.2 Criterion:- Timetable planning

Project selection for technology education courses should be linked to timetable planning. Limited time may be allocated by the particular institution for the technology course. The lesson time is possibly one of the most critical aspects related to meaningful transfer of knowledge when technology education programmes are being planned. An unplanned timetable will cause teachers and pupils not to undertake relevant projects due to possible disruptions caused by unnecessary period changes. The timetable should therefore be planned around the needs of the technology subject with as many double lessons as possible.

5.5.4.3 **Criterion:- Balanced learning programme**

Technology education programme selection will need to include a balance of the learning content. There should be no over-emphasis of any particular facet in order for maximum effective learning and transfer of knowledge to occur. A balanced programme could be likened to a balanced diet which ensures that the physical body remains in a healthy state.

Some technology courses have tended to overemphasise the design aspect which tends to unbalance the programme. Project selection should be guided by choices which include balance to direct the learner into a meaningful learning experience.

5.5.4.4 **Criterion:- Teaching methods**

Variation in methods and techniques is one of the problem areas in our present education system as many teachers have fallen into the mould of mediocrity. When technology education projects are being selected teachers will have to ensure that they are able to implement enough variety in their teaching methods in order to maximise the teaching /learning effect. This could also involve the application of different media or a change of learning environment in order for the lesson objectives to be attained.

5.5.5 Conclusion

The criterion of meaningful transfer of knowledge is indeed an important aspect of any teaching and learning encounter. The ultimate goal of the teacher is for all pupils to understand and apply the relevant content to situations within the school as well as outside the school. Pupils are being prepared for a career and a life within the context of the world. Any advantage gained via successful teaching and learning contributes to the upliftment of all South Africans. The sub-criteria of transfer of knowledge, timetable planning, balanced learning programme and teaching methods should ensure that the pupils will benefit from a well prepared teacher being able to teach effectively.

5.6 SUMMARY

The future development of technology education for disadvantaged pupils in South Africa is closely linked to the criteria outlined in this chapter. The foundation for project selection is therefore laid upon the criteria of socio-economic background, developmental level, problem solving, motivation and meaningful transfer of knowledge. All criteria are supported by sub-criteria which need to be met in terms of the criterion context. The application of the criteria should ensure that a teacher is empowered to make a project choice based upon intended and expected outcomes, linked to prevailing circumstances and/or conditions. If the criteria are applied to project selection then teachers will be assured of covering most of the expected problem areas in a unique and exciting subject brimming with potential.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

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CHAPTER 6 : CONCLUSIONS AND RECOMMENDATIONS

INTRODUCTION

In this final chapter there is a brief summary which will provide the reader with an overview and highlight the most important aspects of this study. Conclusions regarding the five main criteria (problem [a] of chapter 1) will be provided and will include hypothesis number one. This will then be followed by conclusions derived from the detailed or supporting sub-criteria (problem [b] of chapter 1). The conclusions regarding the experiment (problem [c] of chapter 1) will then be linked to the second hypothesis. Finally, there are guidelines (problem [d] of chapter 1), recommendations and suggestions for the implementation of new technology education curricula and possible areas of further study.

This study focussed on *four* problem areas (see chapter 1) which were the following:-

(a) Which didactic criteria should be used by South African teachers teaching the subject *Technology* in primary and secondary schools when they select practical projects to be included in the curricula?

(b) How effective was a proposed set of criteria for project selection when a pilot study was conducted among 480 disadvantaged pupils in grade 7 (standard 5)?

(c) To which extent were 205 pupils in the experimental group, who completed a technology education project, better prepared for technical education than 175 pupils in a control group who did not participate in the project?

(d) Which guidelines based on empirical evidence from this study can be suggested for the implementation of Technology curricula in South African schools?

6.1 SUMMARY OF THE AIM AND PLANNING OF THE STUDY

The possibility of introducing a new subject called technology into the school curriculum prompted this study. Various ex-departments of education in Kwazulu Natal decided to try out technology education programmes at certain of their schools. This exercise was not a complete success, but much valuable information was obtained from these initiatives. Finally in 1995, the HEDCOM 2005 technology project was initiated in an attempt to establish a new curriculum for technology, peculiar to South African conditions.

This study was confined to the so-called traditionally disadvantaged school pupils in Kwazulu Natal and only at Standard five level (grade 7). Having observed other pilot project initiatives within the province by the ex-Natal Education Department and the ex-House of Delegates, I decided that the content of some of their projects was too advanced for the calibre of pupil found at township and rural schools. This problem prompted this investigation to identify possible criteria from which a teacher could check whether or not the choice of project was likely to lead to a successful didactic encounter or not. The five criteria described in chapter 2 of the study are fairly generalised but do cover the most important aspects considered essential for technology education project selection.

6.2 CONCLUSIONS REGARDING THE FIVE MAIN CRITERIA FOR PROJECT SELECTION

Research data gathered by this study focusses on five main criteria in order to answer problem (a) of the study (see chapter 1 Section 1.4). All five criteria were chosen to demarcate certain areas that require attention by a teacher when selecting a technology project (also see previous Section). The five main criteria identified were:-

(1) Socio-economic background (Section 2.1)

(2) Developmental level (Section 2.2)

(3) Problem solving (Section 2.3)

(4) Motivation (Section 2.4)

(5) Meaningful transfer of knowledge (Section 2.5)

6.3 CONCLUSIONS REGARDING HYPOTHESES

It will be recalled that the study was guided by two hypotheses, namely:

Hypothesis (1):

The following set of broad criteria will prove to be didactically sound, relevant and profitable when they are utilised to select a technology project for 480 disadvantaged pupils in Grade 7 (Std. 5):

(a) Socio-economic background

(b) Developmental level of the student

(c) Problem solving

(d) Motivation

(e) Meaningful transfer of knowledge

These broad criteria will lead to the identification of a series of detailed criteria which can be used by teachers from various subject fields to select technology projects for pupils at all school levels.

Hypothesis (2)

In a post-test evaluating children's perceptions of a few basic technological concepts the average marks obtained by pupils in the experimental group will be significantly higher than that of pupils in the control group, where "significant" is taken to mean that the average marks obtained by the experimental group in each section of the post-test will be <u>at least double</u> the average marks obtained by the control group.

Hypothesis (1) was found to be true. It was shown in Chapter two that the five broad criteria were didactically sound and relevant. The second part of this hypothesis was proved to be true in Chapters three and four when they were used to select the lorry project for 480 pupils in Grade 7. The presentation of the lorry project to these pupils was shown to be profitable since the targets stated in hypothesis (2) were met (see discussion of Hypothesis (2) below). Finally, the last part of Hypothesis (1) was proved true in Chapter 5 when the broad criteria led to the identification of detailed criteria (see Section 6.4 below).

Hypothesis (2) was also found to be true. It was shown in Chapter 4 that in the technical drawing section the experimental group results were in general higher than those of the control group (approximately double: see tables 30 - 33). This proved that pupils who have not previously been exposed to a technology programme will not acquire such knowledge from a general school curriculum. The management section also indicated that the experimental group had acquired significantly more knowledge than the control group (see table 29).

6.4 CONCLUSIONS REGARDING DETAILED CRITERIA FOR PROJECT SELECTION

The five main criteria for project selection stated above (Section 6.2) required supporting criteria. Four criteria were selected to support each of the five main criteria (see chapter 5). These twenty-five criteria are considered essential for all teachers to apply when selecting technology education projects. In order to accommodate all the important facts described in this study as well as to provide a useful guide for teachers to apply during the selection process, a checklist was developed (see table 34 below).

6.4.1 Technology project selection check-list

Technology education teachers are likely to experience a lack of time when having to prepare for new projects or themes. In order to assist in this process the check-list (shown below) may be applied. A future technology teacher can simply answer all the questions while considering different projects or themes and make an educated choice. The check-list is designed in a yes/no format for easy application. The more " yes" answers to the questions, the more suitable the project choice is likely to be.

TABLE 34 - A project selection check-list

CRITERION	YES	NO
SOCIO-ECONOMIC BACKGROUND		
* Can this project be done WITHOUT parental support ?		
* Can the project be done WITHOUT work at home?		
* Are there adequate school facilities?		
* Is there adequate resource material available?		
DEVELOPMENTAL LEVEL		
* Have the pupils been exposed to technical education before?		
* Will all pupils clearly understand the language being used?		
* Is the level of difficulty suitable for all pupils in this grade?		
* Do you perceive the pupils' developmental level to be adequate for the project?		
PROBLEM SOLVING		
* Are you adequately trained to present this project?		
* Is the project compatible with the culture of most pupils in the class?		
* Do pupils have suitable prior learning for this project?		
* Does the project develop pupils' reasoning ability?		
MOTIVATION		
* Does the principal support your project?		
* Will the project arouse pupils' interest?		
* Will the project create positive attitudes towards technology?		
* Will you have sufficient time to prepare for this project?		
MEANINGFUL TRANSFER OF KNOWLEDGE		
* Does your timetable allow enough time for this project?		
* Is this project in line with psychological theories of learning?		
* Are the various aspects of technology covered in a balanced manner?		
* Is there a variety of teaching methods being used in the project?		

6.5 CONCLUSIONS REGARDING THE EXPERIMENT

Problem (c) (chapter 1) focussed on the extent to which 205 experimental group pupils who completed the lorry project were better prepared for technical education than 175 control group pupils who did not participate in making the lorry project. This problem was also linked to hypothesis number two (chapter 1) where the researcher hypothesised that in a post-test the experimental group marks obtained would be at least double the average marks obtained by the control group.

6.5.1 Conclusions regarding the management section

The results of the management section were tabled in chapter 4 of this study. Teachers tended to have difficulty in clearly understanding the reason for learning management as a method for technology presentation and the application of management to the world of work. There were five questions answered by both groups of pupils. Four of the five questions returned responses in favour of the experimental group with marks approximately double of those returned by the control group. As the teachers appeared to experience some difficulty with the management concept there was no application of the principles to a pupil's own design of vehicle. The management method proposed by this study was therefore not implemented as intended by the researcher. Photographs of completed projects of pupils own design are displayed to show what is possible for pupils to make using their own resources and ideas (see

Appendix C). The management method is still considered to be a good approach to teaching and learning technology education programmes and projects.

6.5.2 Conclusions regarding the technical drawing section

The experiment revealed that technical drawing is one section of learning content which should be included as a priority in all technology education courses. The experimental group average result was in general approximately double the marks returned by the control group. Hypothesis (2) was proved to be true as shown earlier (see Section 6.3).

6.6 GUIDELINES AND RECOMMENDATIONS FOR THE IMPLEMENTATION OF TECHNOLOGY CURRICULA

6.6.1 Management approach

The management approach is a possible method for teaching the concepts of a technology curriculum. However the level of training of the teachers needs special attention in order for meaningful transfer of knowledge to succeed. The management approach lends itself to being extremely useful when planning a project by following universal principles which may also be applied to everyday living of an individual.

6.6.2 Teacher training

The teachers who are to present the new subject must be very well trained to present the content. The diversity of the subject content will probably lead to specialist teachers being trained for the upper levels (above grade 9 or standard 7). Special in-service training courses will need to be developed as well as a trained support service to ensure the technology teacher maintains progress regardless of their geographical location. Pre-service technology education courses will also need to be developed to provide for future teaching staff at all schools within the province.

6.6.3 Project selection

The criteria described by this study are designed to be used by teachers to evaluate projects being selected for a specific purpose. Ideally teachers should be able to gauge the level of difficulty and the target groups' possible diversities in interest, ability, cultural and social backgrounds, level of motivation etc. Teachers should then be able to prepare a lesson after selecting a project within the context of a theme which leads to effective teaching and learning.

6.6.4 Gender of pupils

The interests of a group of boys and girls must be carefully considered. Not all projects are suitable for mixed sex groups. The lorry project for instance was more suitable to the interests of boys than it was for girls. This problem can be overcome if the teachers follow the criteria provided in the check-list.

6.6.5 Technical drawing

Technical drawing is an important aspect of the planning phase of a technology project and should become an integral part of a new technology curriculum. At the higher levels like Std.6 and Std.7 (grades 8 and 9), where a pupil is attending a technical school, it may be possible to link the technology course requirements with the technical drawing course. This would enable a meaningful application of technical drawing principles to be introduced to interesting and relevant projects or themes.

6.6.6 Rural network

Rural school pupils must receive the same attention and support as the urban school pupils. Geographical locations will possibly make travelling to various schools on a regular basis quite difficult and very costly. It is recommended that schools particularly in rural areas form a network to support one another.

Resource materials and support may also be provided via district and circuit offices.

6.6.7 Resource material

Resource material will have to be purchased for a large percentage of schools who will offer the technology programme. Planners will have to consider possible themes to be followed well in advance in order to make bulk purchases of cardboard, paint, crayons, glue-guns, tools etc. similar to the manner in which textbooks are purchased. Schools which can afford to provide their own resource materials should not be restricted but should still follow the themes which should be prescribed for a particular academic level.

6.6.8 Community support

A community should assist the educational authorities in protecting the investment made to initiate technology courses at both rural and urban schools. The prevention of vandalism and theft will ensure continuity in the learning programme and that supplies of tools and materials for projects remain at schools for their children's upliftment. All communities should be well informed of the potential of technology education courses and what the long-term benefits will be for the entire community.

6.6.9 Storage of equipment

Adequate secure storage rooms should be made available for all schools to store equipment and resource material in a safe place. Ideally a strong-room should be built at each institution although this situation seems unlikely due to budget constraints. Burglar-proofing of specialist technology rooms will be inevitable and should be included in all planning. The general school education classroom which has technology at the junior and senior primary levels (grade 1 - grade 7) should have a lockable steel cabinet in each classroom or a least one in the principals' office which must be able to lock.

6.6.10 Specialist classrooms

All schools should be considered for the establishment of a specialist technology room (similar to a technical drawing room) in which there is adequate space, storage facilities, working surfaces and equipment. This will ensure continuity and standards of technology programmes are maintained. Teachers will also be motivated to produce work of quality as all conveniences will be readily available.

6.6.11 Homework

It is recommended that rural schools are not given work to complete at home until such time that all homes are electrified. If high standards are to be attained then a pupil should not be disadvantaged due to his/her home conditions.

6.6.12 Language medium

Future technology education courses will need to be translated into the three main languages of Kwazulu Natal viz. English, Zulu and Afrikaans. This is of particular importance at the junior primary phase where pupils have not developed proficiency in a second language.

6.6.13 Teacher training course content

New technology education courses for teachers should be general in nature rather than starting off too specific. Once a sound foundation has been established it may be possible to convert a general academic teacher into a technology specialist. This re-training is likely to be quite a lengthy process and will also be very costly.

6.6.14 Finances required for new programmes

In order to introduce technology education into all schools within the province of Kwazulu Natal considerable finance will be required for the equipping, training and resourcing for projects. Planners will need to ensure that such finance is made available from the provincial budget.

6.6.15 Timetable requirements

Adequate time must be allocated to technology education courses. Technology project work will be a combination of knowledge and skills and therefore additional time will be necessary to complete projects. At least one double period (one hour) per week would be the minimum amount of time required. This time should be increased at the more senior levels (grade 8 and above) to approximately three to four double lessons (three - four hours) per week.

6.7 RECOMMENDATIONS FOR FURTHER STUDY

The following themes are identified through the initiation of this didactic study as being possible areas for further research:

6.7.1 What should a teacher training course in technology education include in terms of content and didactics?

6.7.2 Which resources could be prescribed for technology education, especially in rural areas, to ensure equity with urban schools?

6.8 FINAL CONCLUSION

This study has proved that a child who has been exposed to technology education will possess double the amount of knowledge compared with a similar child who has never been exposed to technology education. This suggests that most children do not acquire such knowledge via a general education curriculum. The study has pleaded for a balanced technology education programme to be introduced into Kwazulu Natal schools which should be taught using the management method. Technical drawing should be included as an integral part of any new curriculum as it is a universal "language" to express ideas graphically and assist in detailing project parts to be made. Teachers have been provided with five main criteria and twenty supporting sub-criteria developed into a check-list for application when selecting technology education projects. These twenty-five criteria should assist all teachers in making educated choices based on the cultural differences and geographical diversity of the pupils. Equity at all levels of technology education must prevail regardless of whether the pupils are from urban and rural schools. Teachers should be aware of the differences which exist and should compensate for these differences by modifying the context of a project or problem situation to suit the pupil class group. Technology education is considered to be the most appropriate subject to be introduced into the school curriculum to address the provinces' needs for better trained and economically active citizens.

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APPENDIX

A

KWAZULU NATAL DEPARTMENT OF EDUCATION

*NAME:*____________________
*SCHOOL:*__________________
*AGE:*______________________
BOY ________ *GIRL* _________
STD. 5

Advisory Services
Technical Education
P/Bag X 04
ISIPINGO
4110

Re: TECHNOLOGY PROJECT QUESTIONNAIRE

Dear STUDENT

You are requested to complete this questionaire to the best of your ability. The idea of this questionaire is to try and see how we can improve on the TECHNOLOGY EDUCATION PROGRAMME which you have / have not had the opportunity of taking part in.

INSTRUCTIONS

(1) ANSWER ALL THE QUESTIONS.

(2) IF YOU ARE UNSURE OF THE ANSWER WRITE DOWN WHAT YOU THINK THE ANSWER COULD BE.

(3) IF YOU HAVE NOT HAD THE OPPORTUNITY TO TAKE PART IN THE LORRY PROJECT ******DO NOT WORRY. YOU WILL NOT BE EMBARRASED BY ANYONE**, AS THE RESULTS ARE CONFIDENTIAL AND WILL ONLY BE USED FOR RESEARCH PURPOSES.

(4) DO NOT COPY YOUR FRIENDS WORK. WE WOULD LIKE TO KNOW WHAT **YOU** THINK ABOUT THE PROJECT.

(5) PLACE A TICK OR CROSS IN THE BOX THAT YOU CHOOSE AS BEING CORRECT OR GIVE DETAILED ANSWERS WHEN ASKED.

SECTION 1 (ANSWER THIS SECTION ONLY IF YOU MADE THE LORRY PROJECT).

(a) DID YOU ENJOY MAKING THE PROJECT?. | YES | NO |

(b) WHAT SECTION DID YOU ENJOY THE MOST?.

(1) learning how to manage.		
(2) planning the project.		
(3) making sketches and drawings.		
(4) making the toy lorry.		
(5) making your own design.		

(c) WHAT SECTION DID YOU NOT ENJOY?.

(d) DID YOU HAVE AN INTEREST IN MAKING THE LORRY?. | YES | NO |

(e) WOULD YOU HAVE PREFERRED TO MAKE SOMETHING ELSE?. | YES | NO |
IF YOU ANSWER YES THEN EXPLAIN. (DO NOT THINK ABOUT PHASE 2 WHEN YOU ANSWER).

(f) WAS KIT SUPPLIED OF AN ACCEPTABLE STANDARD?. | YES | NO |

(g) WHAT IMPROVEMENTS TO THE KIT CAN YOU SUGGEST?.

(h) WHAT OTHER MATERIALS ARE AVAILABLE FOR MAKING PROJECTS IF A KIT IS NOT SUPPLIED?.

(I) HOW DID YOU FIND THE TIME ALLOCATION FOR THE PROJECT?.

(1) TOO SHORT.
(2) TOO LONG.
(3) JUST RIGHT.

(j) DID YOU FIND THE LORRY PROJECT - TOO EASY.
TOO DIFFICULT.
JUST RIGHT.

(k) WHAT SECTION/S DID YOU FIND DIFFICULT TO UNDERSTAND?.

(l) DO YOU THINK THAT YOU HAVE LEARNED SOME VALUABLE LESSONS BY DOING THE PROJECT?.
EXPLAIN. | YES | NO |

(m) WOULD YOU SUGGEST THAT ALL SCHOOL PUPILS SHOULD TAKE TECHNOLOGY EDUCATION AS A SEPARATE SUBJECT?. | YES | NO |

(n) WHAT DO YOUR PARENTS THINK ABOUT TECHNOLOGY EDUCATION?. EXPLAIN.

SECTION 2. (TO BE COMPLETED BY ALL STUDENTS).

(a) DO YOU LIVE WITH YOUR PARENTS WHILE YOU ATTEND SCHOOL?. | YES | NO |
IF NO THEN WITH WHOM?.

(b) FATHER'S WORK?. ________________
MOTHER'S WORK?. ________________

(c) ARE YOUR PARENTS DIVORCED?. | YES | NO |

(d) DO YOU LIVE IN A HOUSE?. | YES | NO |
IF YOU ANSWER YES..THEN—
* DOES THE HOUSE HAVE ELECTRICITY? | YES | NO |
* DOES THE HOUSE HAVE WATER? | YES | NO |
* IS YOUR HOUSE IN A RURAL AREA?. | YES | NO |
* IS YOUR HOUSE IN AN URBAN AREA?. | YES | NO |

(e) HOW MANY BROTHERS DO YOU HAVE?. ____________
HOW MANY SISTERS DO YOU HAVE?. ____________

(f) HAVE YOU HEARD/READ ABOUT TECHNOLOGY EDUCATION?. | YES | NO |

(g) ARE YOU INTERESTED IN TECHNOLOGY EDUCATION?. | YES | NO |

(h) WHAT PROJECTS WOULD YOU LIKE TO MAKE?.
LIST AS MANY AS YOU LIKE.

(g) AT WHAT STANDARD SHOULD YOU BEGIN TO LEARN ABOUT TECHNOLOGY EDUCATION?.

SECTION 3.

ANSWER AS MANY QUESTIONS AS POSSIBLE EVEN IF YOU HAVE NOT HAD AN OPPORTUNITY TO DO THE LORRY PROJECT.

MANAGEMENT

(1) WHAT ARE THE FOUR STEPS IN THE MANAGEMENT PROCESS?.

(a)
(b)
(c)
(d)

(2) WHAT VALUE HAS MANAGEMENT FOR THE WORLD OF WORK?.

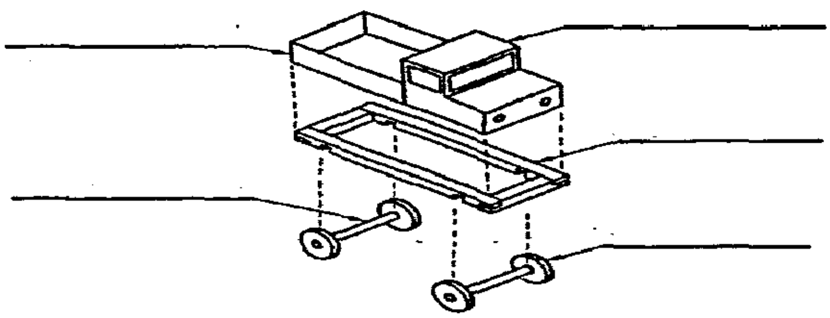
(3) WHY IS IT NECESSARY TO FIRST PLAN BEFORE WE START MAKING A PROJECT?.

(4) WHY IS IT NECESSARY TO EVALUATE THE PROJECT AFTER YOU HAVE FINISHED MAKING IT?.

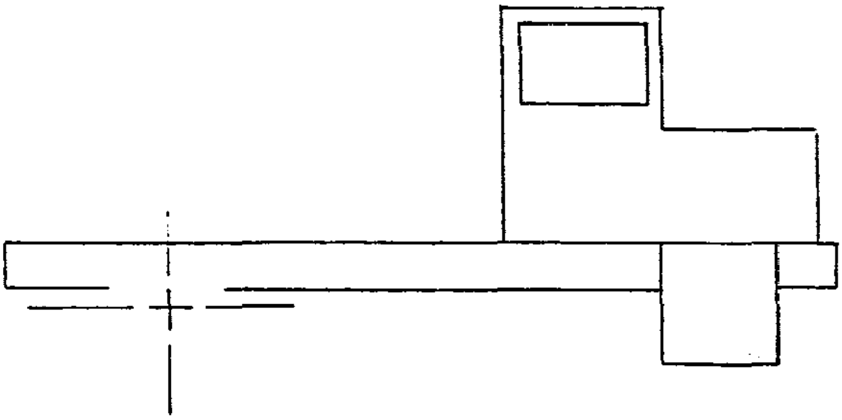
(5) WHAT DOES IT MEAN TO "MARKET A PRODUCT"?.

DRAWING

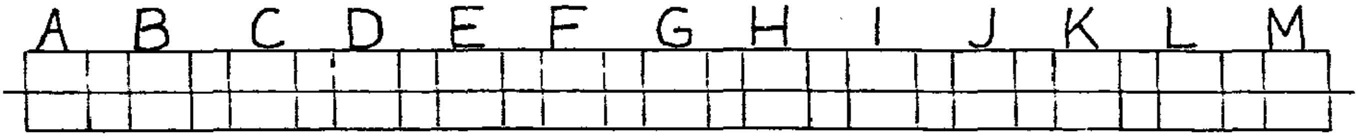
(1) IN THE GIVEN DRAWING OF THE LORRY PROJECT, NAME THE PARTS INDICATED BY AN ARROW.



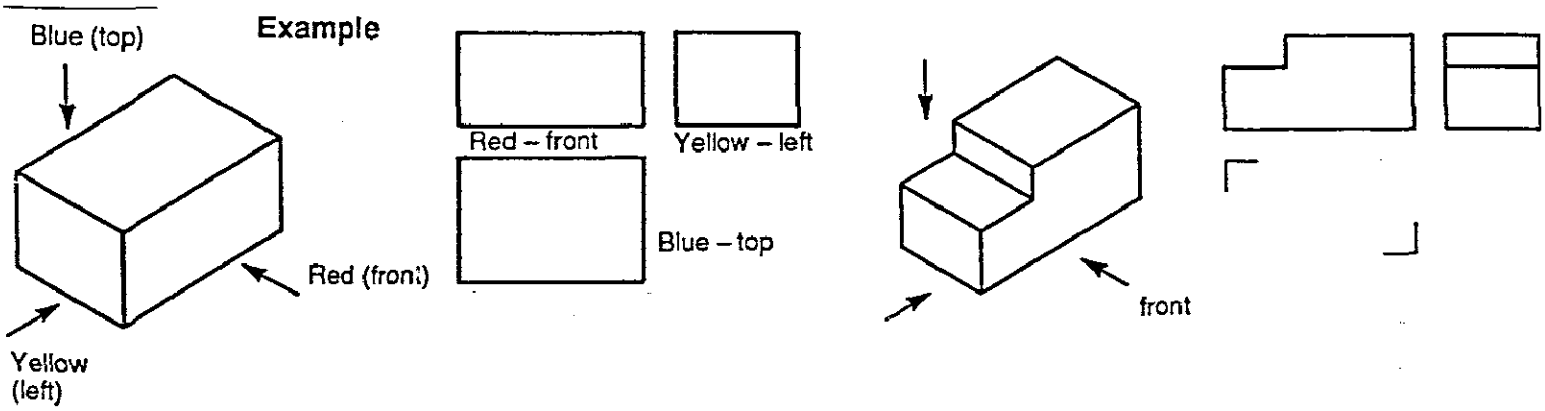
(2) MAKE A FREEHAND DRAWING OF THE WHEELS OF THE LORRY IN THE SPACES PROVIDED. USE ANY METHOD.



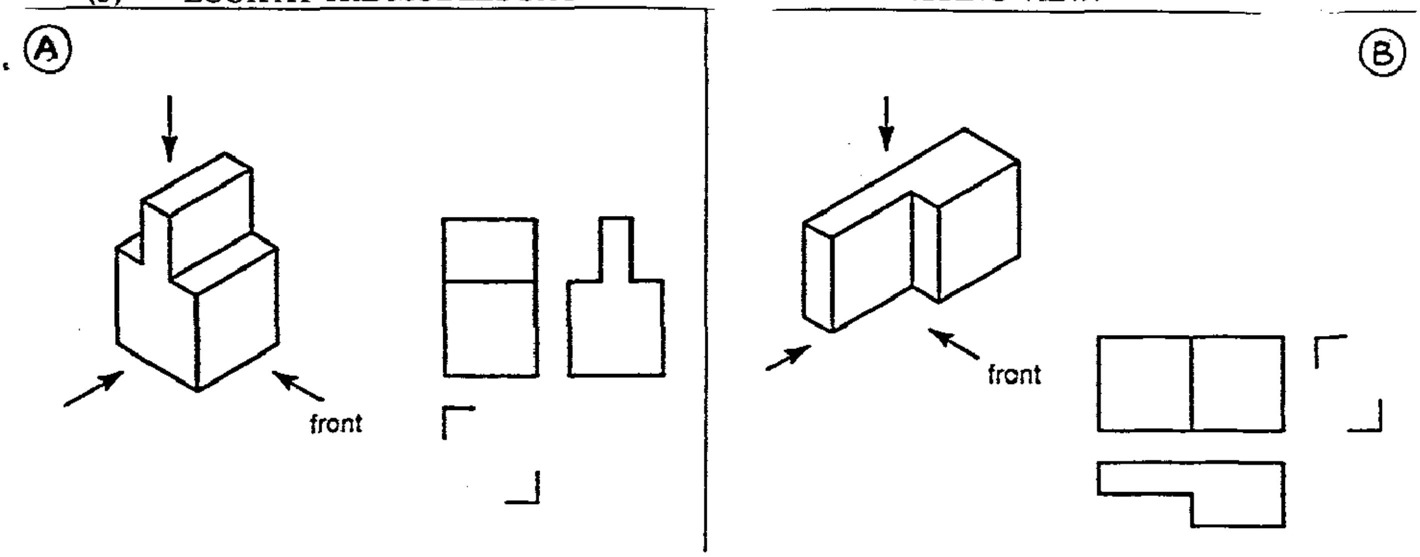
(3) IN THE SPACE PROVIDED PRINT THE FOLLOWING LETTERS.



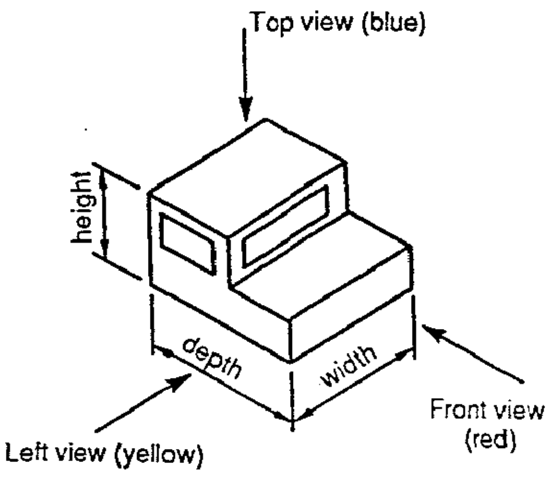
(4) COLOUR IN THE DIFFERENT SIDES OF THE BOX SHOWN AS EXAMPLE. THEN, FILL IN THE MISSING TOP VIEW IN THE SPACE PROVIDED.



(5) LOOK AT THE MODELS SHOWN AND FILL IN THE MISSING VIEW.



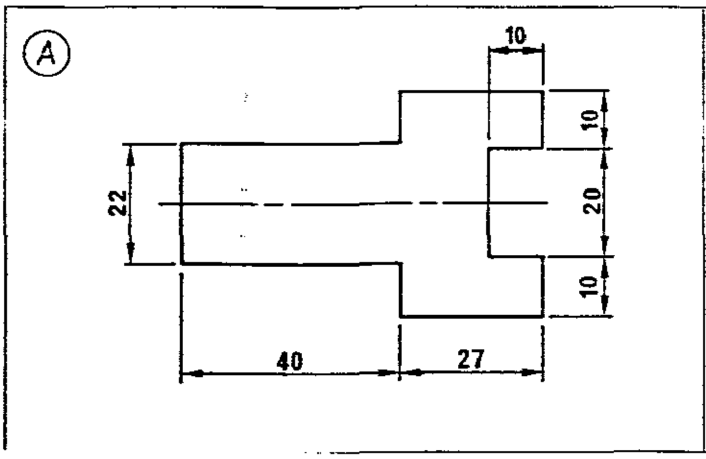
(6) USE YOUR RULER AND MEASURE THE DIMENSIONS FROM THE MODEL SHOWN. INDICATE THE WIDTH, DEPTH AND HEIGHT OF THE MODEL. ENTER THE MEASUREMENTS ON THE TABLE GIVEN. IF THERE IS NO MEASUREMENT THE FILL IN A ZERO.



PICTORIAL VIEW DRAWING

View	Dimensions in millimetres (mm)		
	Width	Height	Depth
Front	18		0
Top			
Left			

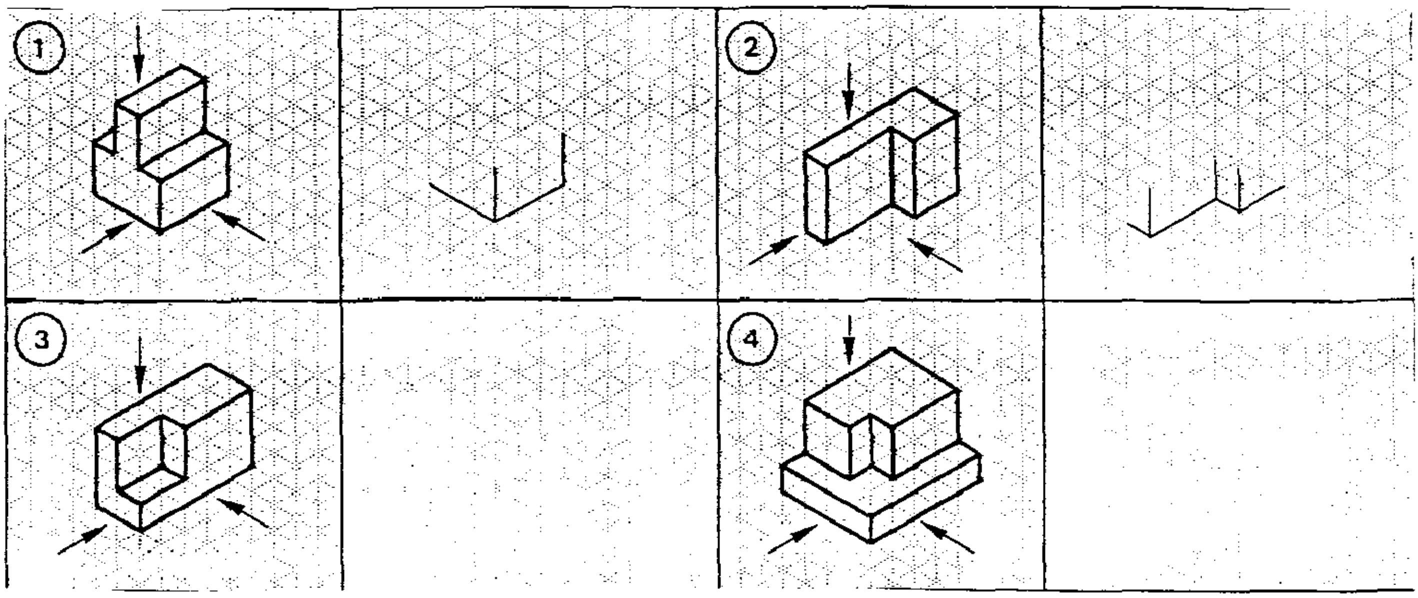
(7) COPY THE GIVEN DRAWING IN THE SPACE NEXT TO THE ONE SHOWN, USING DRAWING INSTRUMENTS.



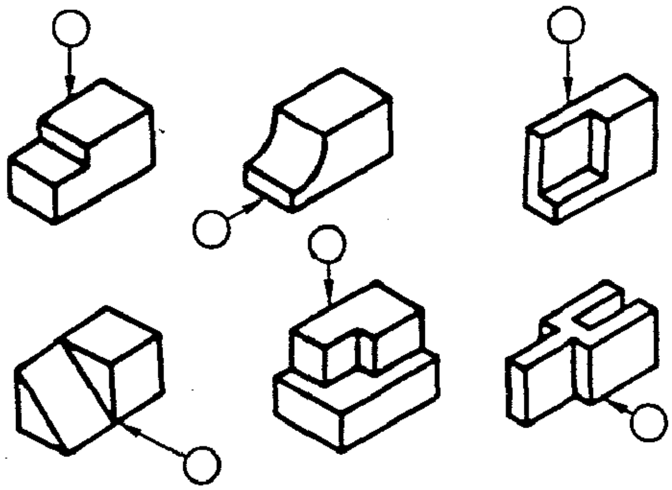
(8) WHEN THREE VIEWS OF A DRAWING ARE SHOWN SEPARATELY IT IS CALLED FIRST ____________ PROJECTION.

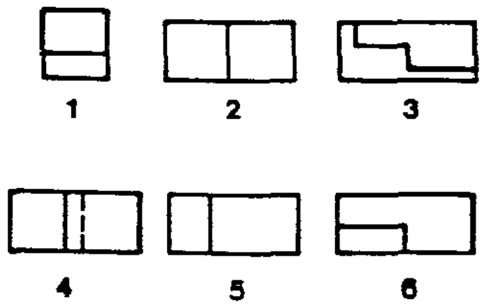
(9) WHEN MAKING THE LOADBOX OF THE LORRY YOU HAD TO MARK-OUT, CUT AND FOLD THE METAL. WHAT IS THIS PROCESS CALLED?.

(10) MAKE ISOMETRIC FREEHAND DRAWINGS OF THE GIVEN MODELS IN THE SPACE PROVIDED ON THE SQUARED PAPER.

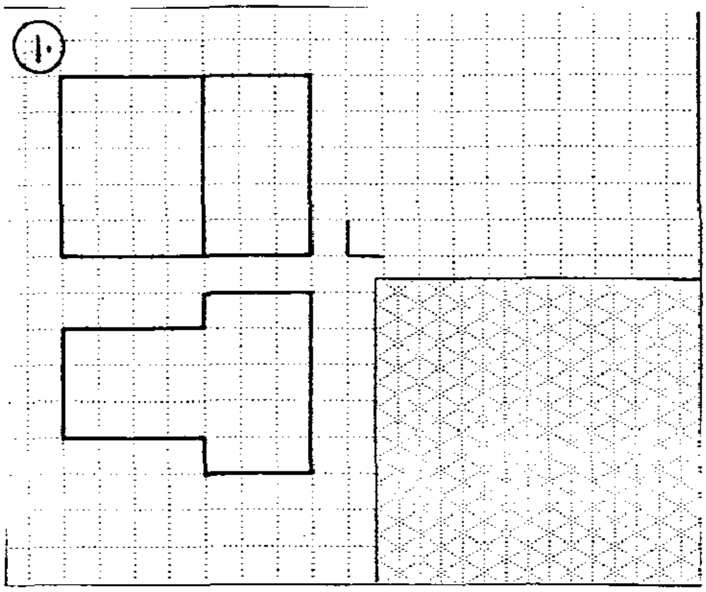


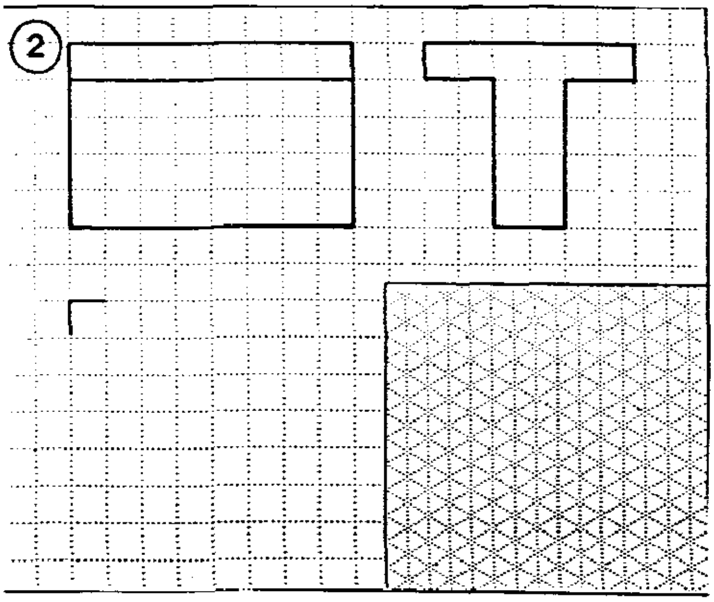
(11) WRITE THE NUMBER IN THE CIRCLE OF THE VIEW THAT CORRESPONDS WITH A VIEW SHOWN BY THE ARROW.





(12) TWO VIEWS OF DIFFERENT MODELS ARE SHOWN BELOW IN FIRST ANGLE ORTHOGRAPHIC PROJECTION. DRAW FIRSTLY AN ISOMETRIC VIEW TO ASSIST YOU TO FIND THE MISSING THIRD VIEW.





(13) WHY IS IT NECESSARY TO COMPLETE A WORKING DRAWING BEFORE MAKING ANY MODEL?.

(GC/95)

APPENDIX

B

SECTION 3. *MEMORANDUM*

ANSWER AS MANY QUESTIONS AS POSSIBLE EVEN IF YOU HAVE NOT HAD AN OPPORTUNITY TO DO THE LORRY PROJECT.

MANAGEMENT

(1) WHAT ARE THE FOUR STEPS IN THE MANAGEMENT PROCESS?.

(a) Planning
(b) Selecting materials
(c) Making
(d) Evaluating

(2) WHAT VALUE HAS MANAGEMENT FOR THE WORLD OF WORK?.

The management process may be applied to any situation as a framework to solve problems by selecting a suitable solution.

(3) WHY IS IT NECESSARY TO FIRST **PLAN** BEFORE WE START MAKING A PROJECT?.

We must identify the need and problem to establish our requirements. This would involve specifications, researching various options and background information. Finally we need to formulate a working plan.

(4) WHY IS IT NECESSARY TO **EVALUATE** THE PROJECT AFTER YOU HAVE FINISHED MAKING IT?.

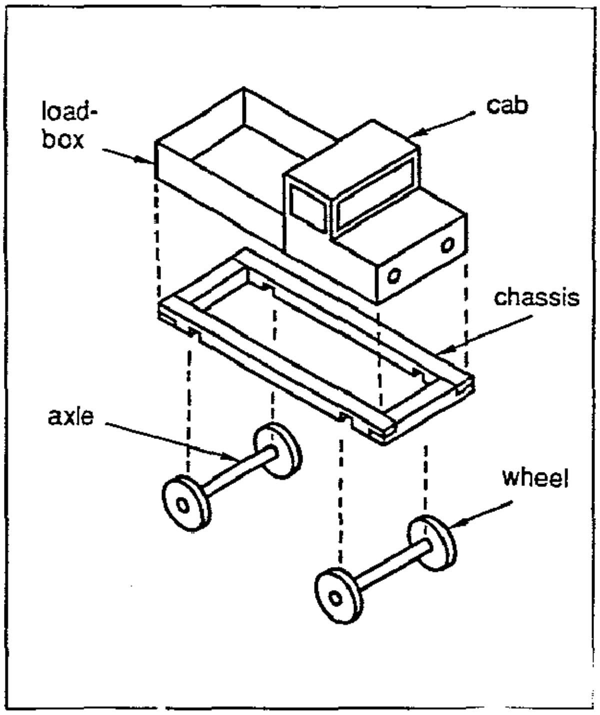
It is necessary to make sure you have solved the initial problem by checking back on the requirements. You can decide on possible modifications to improve your product.

(5) WHAT DOES IT MEAN TO "**MARKET A PRODUCT**"?.

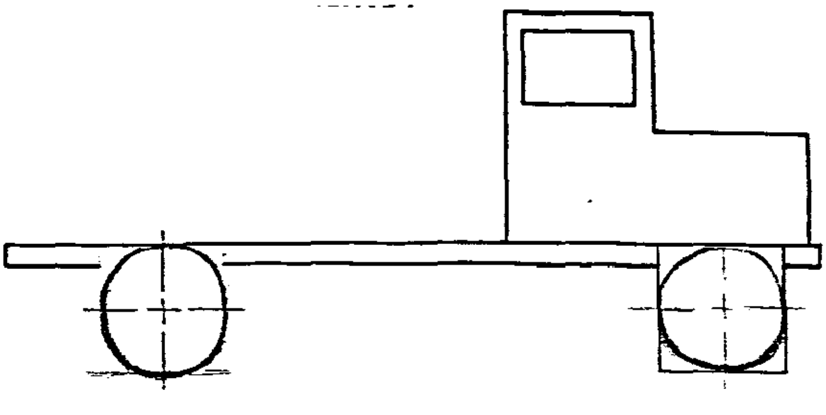
This means that you are able to plan ways of selling your product ie. to whom, quality, type of buyer etc.

DRAWING

(1) IN THE GIVEN DRAWING OF THE LORRY PROJECT, NAME THE PARTS INDICATED BY AN ARROW.



(2) MAKE A FREEHAND DRAWING OF THE WHEELS OF THE LORRY IN THE SPACES PROVIDED. USE ANY METHOD.

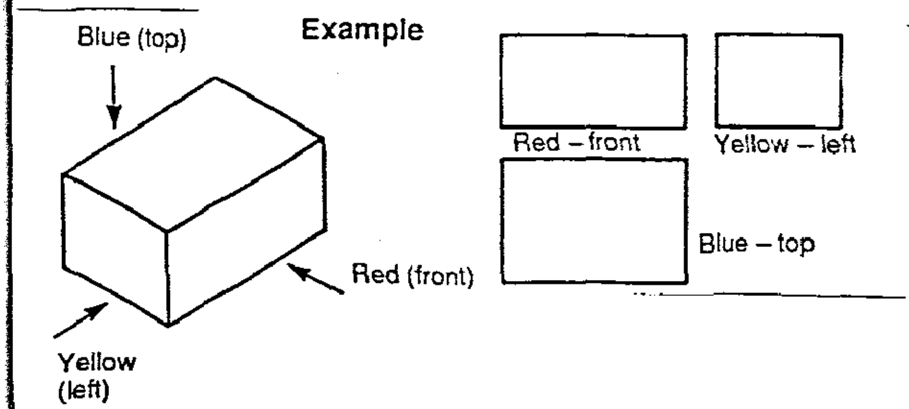


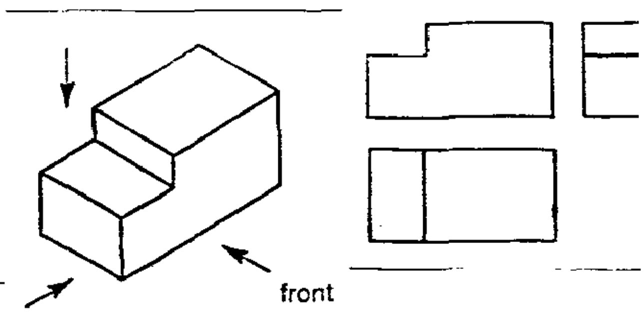
(3) IN THE SPACE PROVIDED PRINT THE FOLLOWING LETTERS.

A B C D E F G H I J K L M

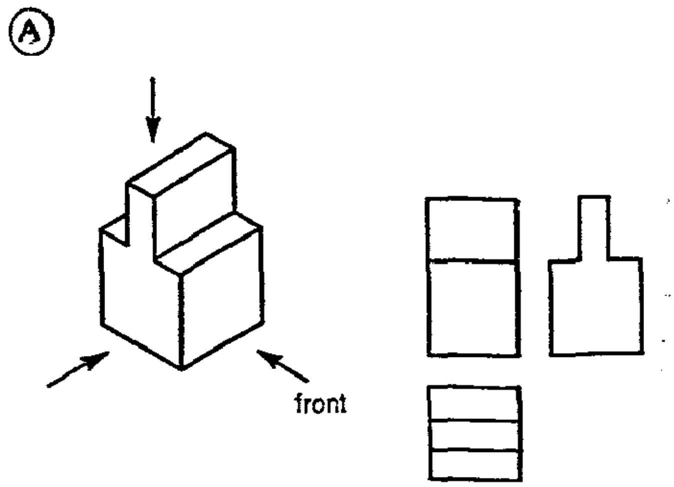
A B C D E F G H I J K L M

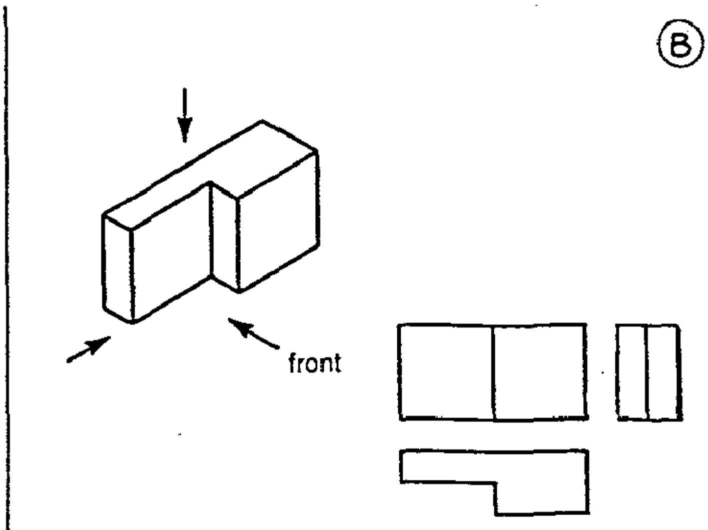
(4) COLOUR IN THE DIFFERENT SIDES OF THE BOX SHOWN AS EXAMPLE. THEN, FILL IN THE MISSING TOP VIEW IN THE SPACE PROVIDED.





(5) LOOK AT THE MODELS SHOWN AND FILL IN THE MISSING VIEW.





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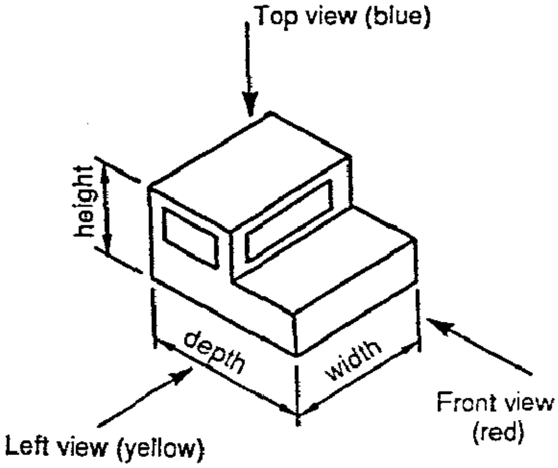
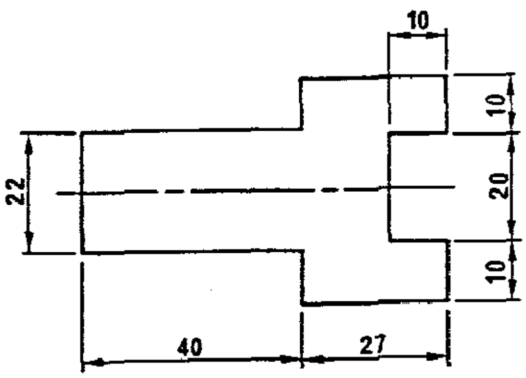


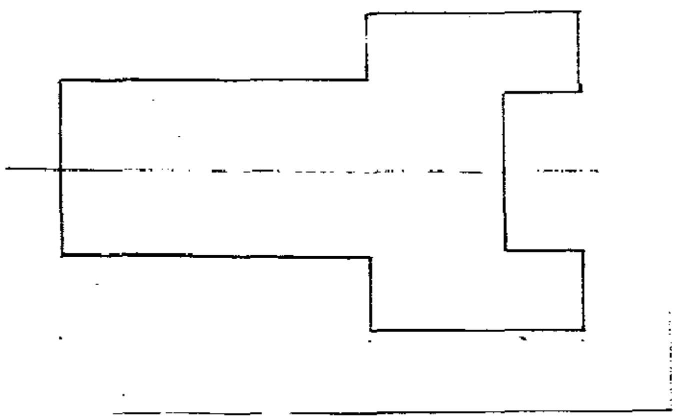
PICTORIAL VIEW DRAWING

View	Dimensions in millimetres (mm)		
	Width	Height	Depth
Front	18	11	0
Top	18	0	21
Left	0	11	21

(7) COPY THE GIVEN DRAWING IN THE SPACE NEXT TO THE ONE SHOWN, USING DRAWING INSTRUMENTS.

Ⓐ



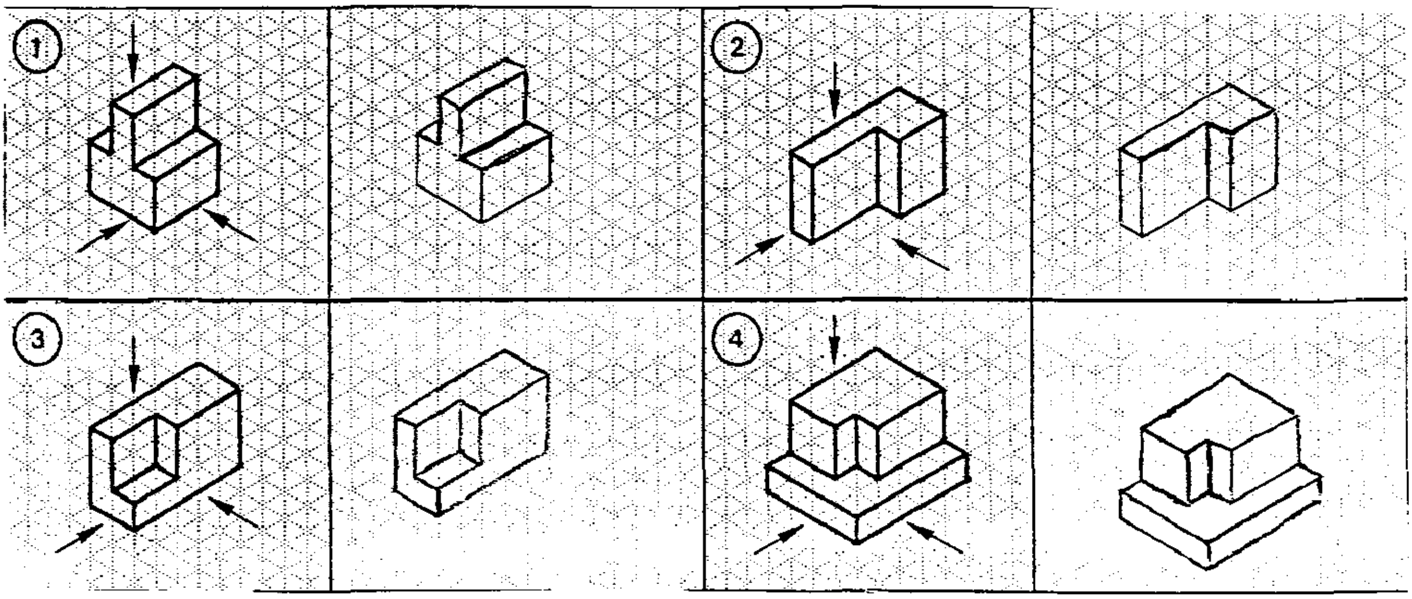


(8) WHEN THREE VIEWS OF A DRAWING ARE SHOWN SEPARATELY IT IS CALLED **FIRST ANGLE ORTHOGRAPHIC PROJECTION**.

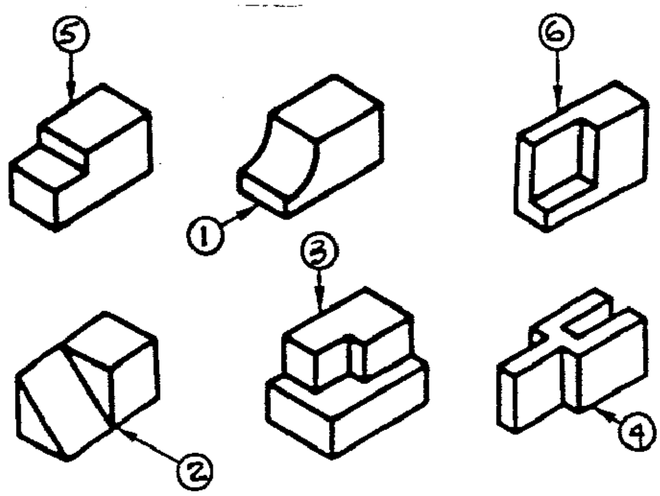
(9) WHEN MAKING THE LOADBOX OF THE LORRY YOU HAD TO MARK-OUT, CUT AND FOLD THE METAL. WHAT IS THIS PROCESS CALLED?.

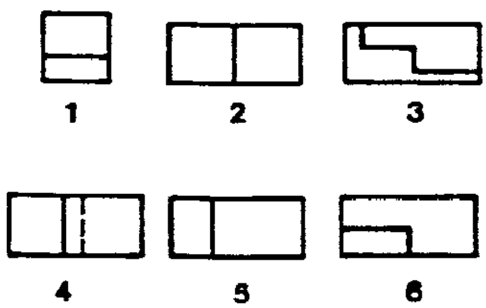
Development.

(10) MAKE ISOMETRIC FREEHAND DRAWINGS OF THE GIVEN MODELS IN THE SPACE PROVIDED ON THE SQUARED PAPER.



(11) WRITE THE NUMBER IN THE CIRCLE OF THE VIEW THAT CORRESPONDS WITH A VIEW SHOWN BY THE ARROW.





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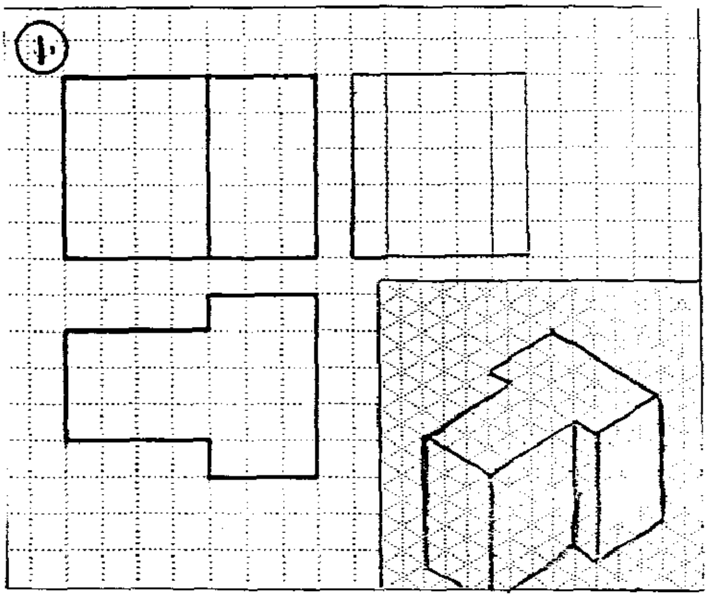
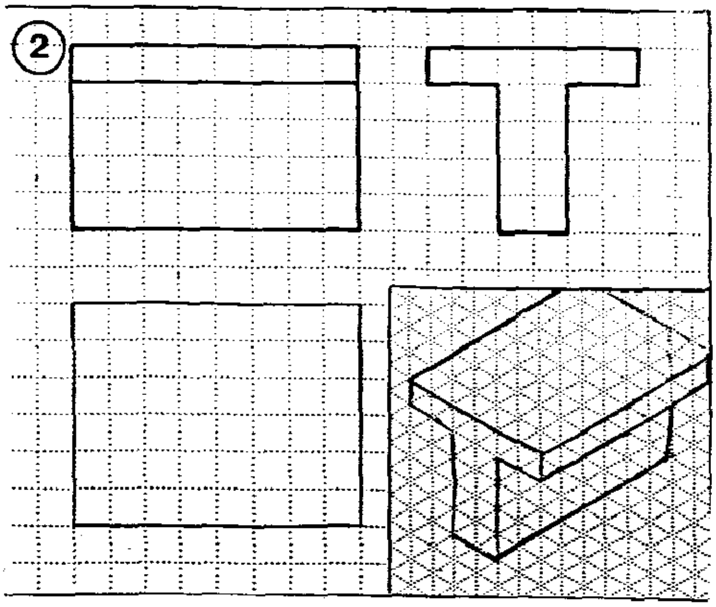




(13) WHY IS IT NECESSARY TO COMPLETE A WORKING DRAWING BEFORE MAKING ANY MODEL?.

To make sure all parts are going to fit together. Different materials are decided upon and ordered in correct quantities. This ensures that someone can make the items.

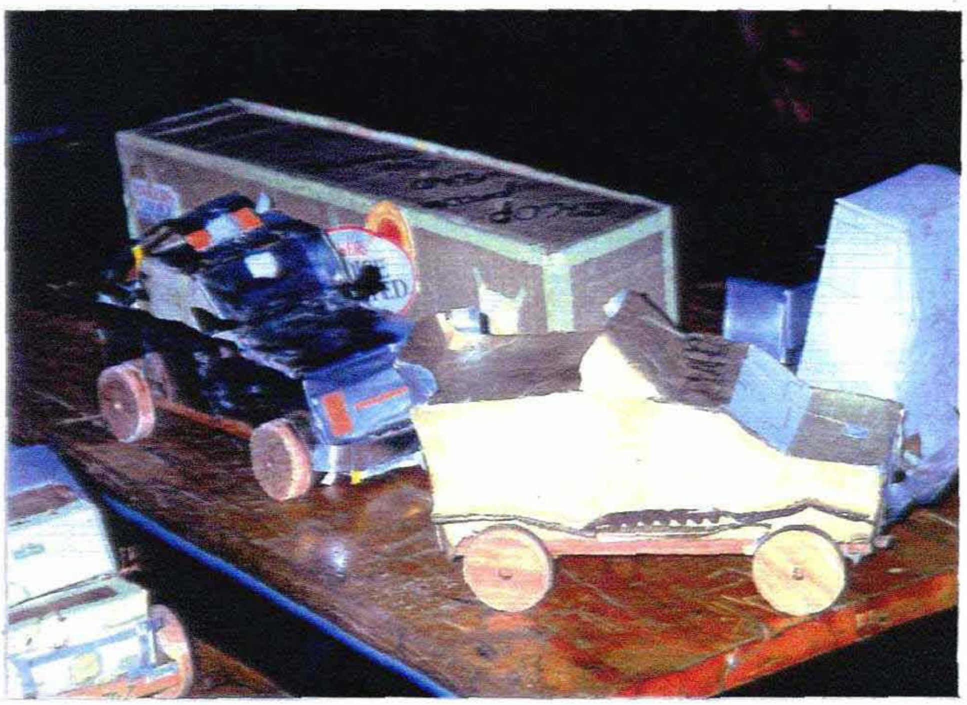
(GC/95)

APPENDIX

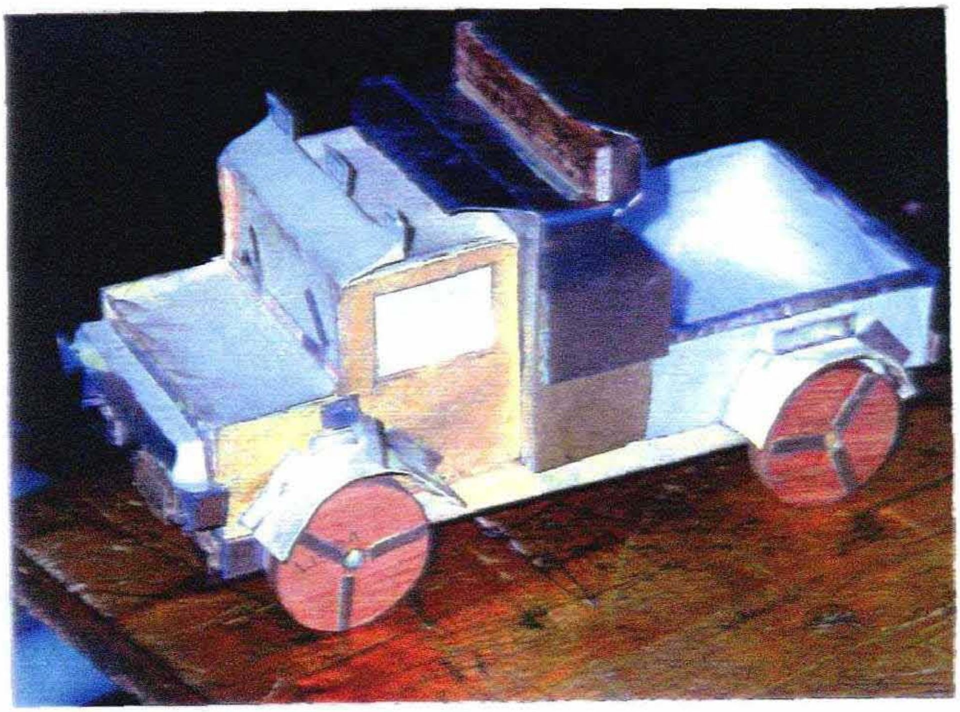
C

A variety of some of the pupils' own designs

Note the use of available resource material constructed on the lorry kit chassis

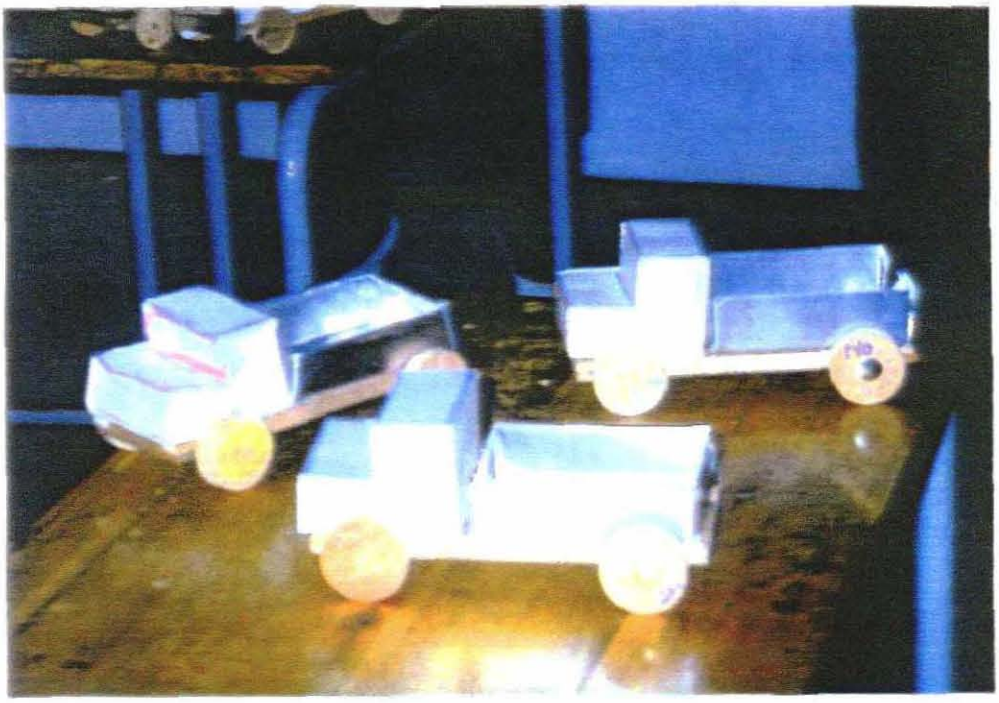


A customised lorry

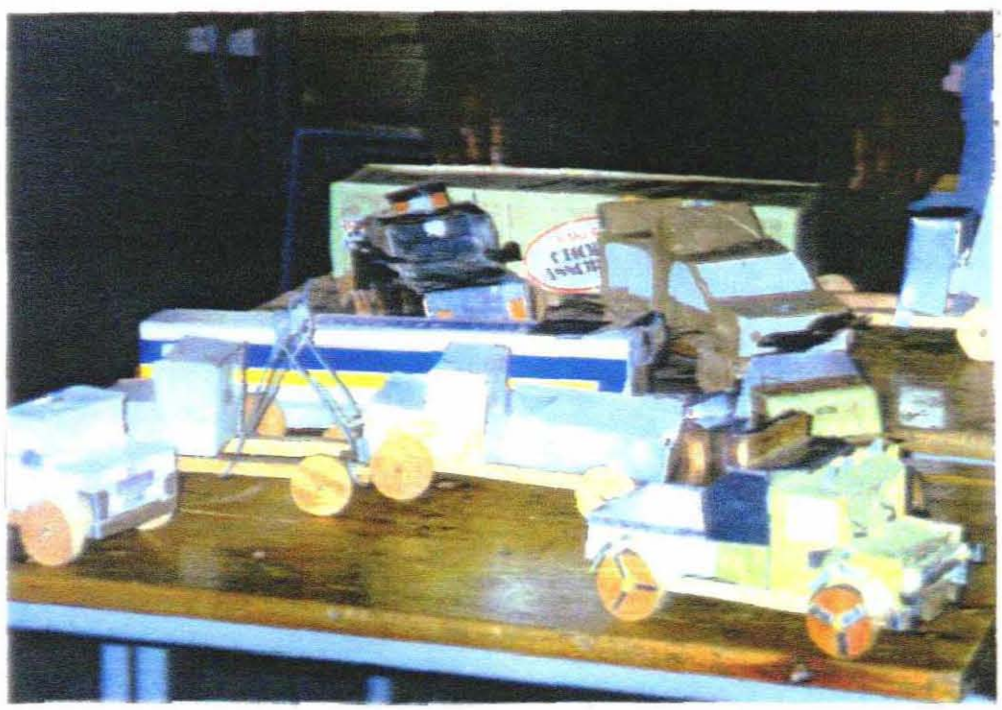


One of the pilot school teachers with the standard lorry kit assembled

A close-up of the lorry kits assembled at School No 8



Project designs included a break-down truck, mechanical horse and trailer, delivery van and a jeep.



RECORD NUMBER:- 14181 ITEM NUMBER:- 24
JOB :- PROJECT NUMBER :- 956125

RESEARCHER Mostert BJ
TITLE Community libraries: the concept and its application with particular reference to The Pinetown community libraries
LANGUAGE English
PURPOSE 11 M Bibl
STATUS Completed YEAR OF COMPLETION :- 1997
University of Zululand (UZ)
Dept of Library Science
FIELD Library and information science
Specific groups of libraries and library users
INTENDED PUBL Dissertation

=

RECORD NUMBER:- 12645 ITEM NUMBER:- 25
JOB :- PROJECT NUMBER :- 956111

RESEARCHER Chapman GA
TITLE A didactic study to identify criteria for project selection in technology
LANGUAGE English
PURPOSE 11 MEd
STATUS Completed YEAR OF COMPLETION :- 1997
University of Zululand (UZ)
Dept of Didactics
FIELD Education
Didactics (General)
INTENDED PUBL Dissertation

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